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Analysis Effect of Light Intensity on Efficiency of the GH 100 WP-72 Solar Cell

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Abstract. Energy is the main need today, with fossil energy sources increasingly depleting. Therefore, the development of renewable energy, such as solar energy, is very important. This article discusses the efficiency produced by solar cells in research conducted at the Energy Conversion Laboratory of the National Development University "Veteran" East Java. Solar cells are devices that convert solar energy into electrical energy through photovoltaic effects, without producing pollution or greenhouse gases, so they are an environmentally friendly energy source. Data was taken at 10.00-10.30, by measuring battery and solar panel voltage, battery charging current, and solar panel temperature. The experimental method was used by collecting data three times every 15 minutes for 30 minutes. The solar panel used is GH solar type GH 100 WP-72. Efficiency is calculated based on input and output power, with the highest efficiency achieved when the battery is full. The results show the lowest efficiency of 3.67% at 10.40 with a light intensity of 313.24 W/m² and the highest efficiency between 20.76% to 23.52% at 13.20-13.50 with a light intensity of 255.64 W/m² to 289. 61 W/m². Solar cell efficiency is greatly influenced by battery condition and light intensity.

Keyword: Renewable Energy, Solar Cell, Solar Cell Efficiency, Light Intensity.

1. Introduction

Energy is a major need today, with various forms including renewable and non-renewable energy. Currently, most of the energy used comes from fossil energy sources, which are included in the non-renewable energy category. Non-renewable energy sources have limited availability and cannot be renewed naturally, or require a very long time to regenerate. As a result, continuous use can result in the exhaustion of energy sources [1]. Currently, the availability of non-renewable energy sources is decreasing and can run out at any time.

Realizing that non-renewable energy sources are running low, various new energy sources are starting to be developed by utilizing natural factors such as heat and sunlight, as well as hydropower. This energy source is classified as renewable energy. Utilization of this alternative energy, which is referred to as new and renewable energy (EBT), can be an alternative in providing energy with a relatively low environmental impact and can guarantee energy sustainability in the future [4]. The development of renewable energy sources is carried out by all scientists in the world, including in Indonesia, to replace existing non-renewable energy sources.

One of the current developments in renewable energy is utilizing solar energy, where this energy is emitted by the sun and utilized through certain technologies [3]. Solar cells or solar cells are devices used to convert solar energy into electrical energy which are known for being environmentally friendly with no pollution or greenhouse gas emissions during the energy creation process [2]. With increasing efficiency and decreasing production costs, solar cells are increasingly attractive as a clean alternative for energy supply [5]. Research and development of solar cells is currently being actively carried out as a potential significant energy substitute.

This article will discuss the efficiency achieved by solar cells during the research carried out. Data collection was carried out at 10.00-10.30 at the Energy Conversion Laboratory of the National Development University "Veteran" East Java. This research includes measuring the voltage of the battery and solar panels, the battery charging current, and the temperature of the solar panels, with the aim of finding optimal efficiency.

2. Methodology

Data collection in this research was carried out using the experimental method by collecting data 3 times every 15 minutes for 30 minutes. The solar panel model specifications used in this research use GH solar type GH 100 WP-72 which is capable of producing a maximum power of 100 watts and has dimensions of 1020 mm in length, 680 mm in width and 30 mm in height. This solar panel has a random arrangement of crystals (polycrystalline) with a type that tends to have a larger surface area and has lower efficiency.

The working principle of the solar panel circuit begins with solar radiation being received and converted into electrical energy by the solar cell and then distributed to the solar charger controller which functions to divide the energy into the battery and output (DC). The battery has the function of stabilizing the voltage of the system so that the output (DC) will have a stable voltage.

The independent variables in data collection for this research include the time of data collection, the dependent variables for this research are input power and output power, and the control variable for this research is the testing equipment used.

The efficiency value in this research can be determined by calculating the input power and output power. Solar cell input power is a concept that refers to the energy received by solar cells from sunlight. The input power of a solar cell depends on the surface area of the solar cell and is in units of watts per square meter (W/m^2). The solar cell input power equation can be seen in equation 1.

$$P_{in} = I \, x \, A \quad (1)$$

Determining the efficiency value in this research also requires an output power equation. This is of course to determine the energy or power released or produced from the work of a tool. Solar cell output power is the electrical power produced by solar cells from the solar energy received. The solar cell output power equation can be seen in equation 2.

$$P_{out} = \bar{V} \, x \, \bar{I} \, x \, FF \quad (2)$$

Then, after the input power and output power have been found, the next step is to look for the efficiency value equation. The efficiency value is the ratio between the input energy received by the device and the output energy produced by the device. Solar cell efficiency refers to the ability of solar cells to convert solar energy into electrical energy. The efficiency value equation can be seen in equation

$$\eta = \frac{P_{out}}{P_{in}} \, x \, 100\% \quad (3)$$

Before collecting data, all necessary equipment must be assembled correctly and ensured that it is connected properly. The necessary equipment must be checked first so that when collecting data there are no problems. The data collection scheme for this research can be seen in Figure 1, and the flow diagram for this data collection can be seen in Figure 2.

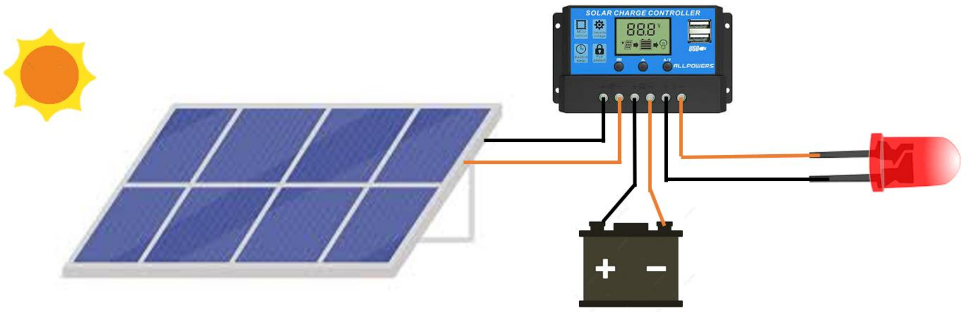

Figure 1. Tool scheme

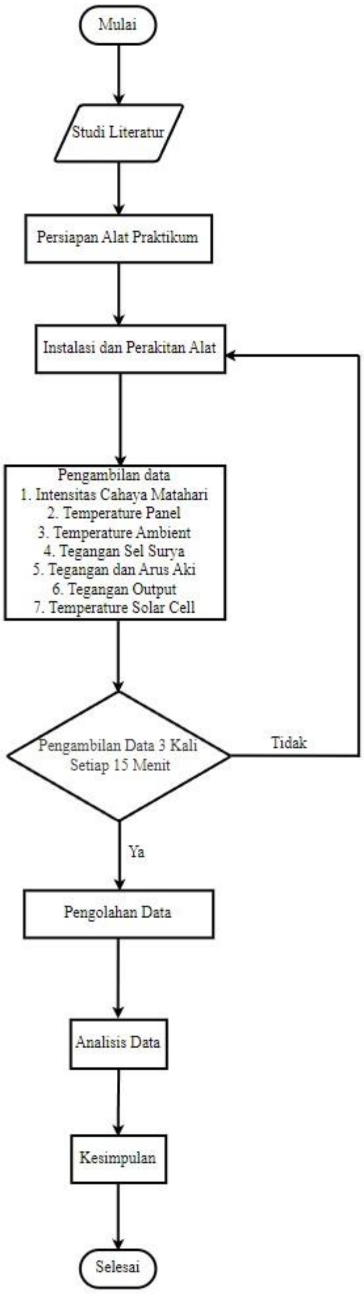

Figure 2. Flow diagram

3. Results and Discussion

Based on the results of data collection carried out 3 times, the results were found which can be seen in table 3.1 and table 3.2.

Table 3.1 Results of voltage data processing

Data	Time	Solar Cell Voltage (V)	Battery Voltage (V)	DC Voltage *Output* (V)
1	12.05	16,13	13,96	13,94
2	12.20	16,03	13,99	13,99
3	12.35	15,75	14,00	13,99

Table 3.2 Data processing results for current, light intensity and solar panel temperature

Data	Time	Battery Charging Current (A)	DC current *Output* (A)	Light Intensity (W/m^2)	Solar Panel Temperature (°C)
1	12.05	2,28	2,33	229,36	54,53
2	12.20	0,47	0,55	180,80	53,60
3	12.35	0,92	1,00	181,31	53,57

Table 3.3 Results of research data processing

Data	Time	*Fill Factor* (FF)	Surface Area (m^2)	Power *Input* P_{in} (W)	Power *Output* P_{out} (W)	Solar Cell Efficiency (%)
1	12.05	0,76	0,69	159,09	13,72	8,63
2	12.20	0,76	0,69	125,41	13,72	10,94
3	12.35	0,76	0,69	125,75	13,72	10,91

This research displays several graphs of the relationship between Solar Cell Voltage and Light Intensity, DC Output Power and Light Intensity, as well as Efficiency and Light Intensity. This graph aims to show how variations in light intensity affect the voltage produced by solar cells, the electrical power produced, and the efficiency of converting solar energy into electricity. By analyzing this graph, it can be understood to what extent lighting conditions affect the overall performance of the solar cell system.

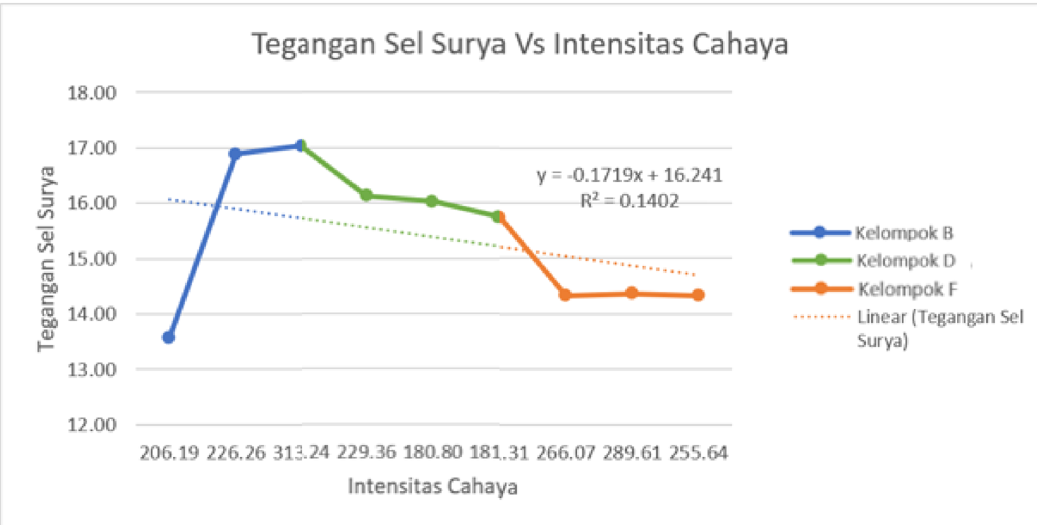

Figure 3. Solar cell voltage vs light intensity

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The graph of the relationship between solar cell voltage and light intensity above shows that the relationship is not constant with the light intensity received by the solar panel, generally the higher the light intensity, the higher the solar cell voltage, which means more electricity is produced, although sometimes it is not linear which can be caused by several reasons factors.

Data collection at 10.10 resulted in a light intensity of 206.19 W/m^2 which was received by the solar panels and resulted in a solar cell voltage of 13.57 V. The voltage produced by the solar cells increased until 10.40 to 17.04 V with a light intensity of 313 .24 W/m^2 which proves that a higher light intensity will produce a higher solar cell voltage as well.

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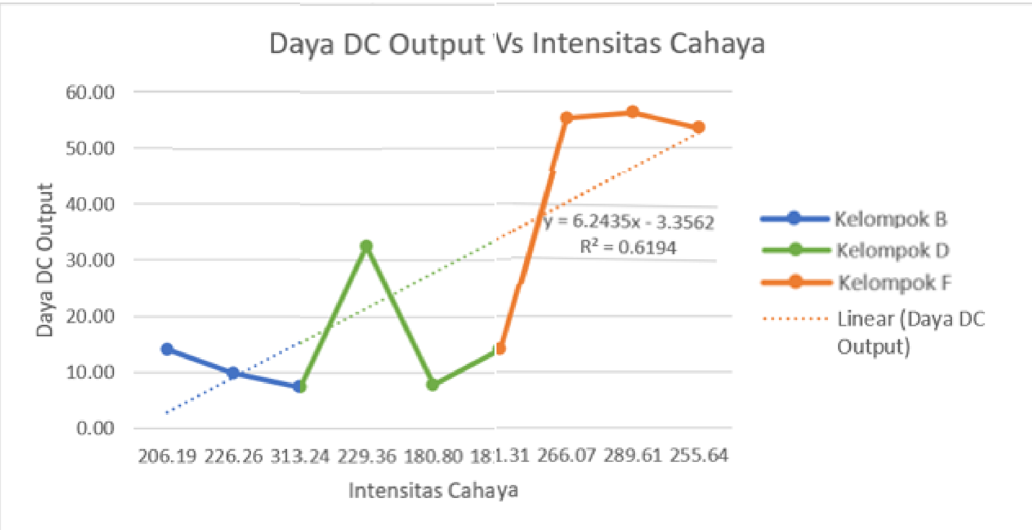

Figure 4. DC output power vs light intensity

The graph of the relationship between DC output power and light intensity shows an inconsistent relationship with light intensity, generally the higher the light intensity, the greater the output power produced, but this is not necessarily completely true because it can also be influenced by the condition of the equipment.

At the start of data collection from 10.10 to 12.20 the DC output power decreased even though the light intensity varied, the DC output power decreased to 7.74 W from the original 14.13 W which shows that the electrical energy produced by the solar cells was used to charge the battery. and only a small amount of electrical energy produced by solar cells can be utilized at DC output.

However, at the end of the DC output power data there was a very significant increase, namely data taken at 13.20 to 13.50 which produced DC output power ranging from 53.50 W to 56.33 W. This was caused by the battery being full so that the electrical energy produced by the solar cells flowed directly to the DC output. Once the battery is full, the output DC power will be directly proportional to the light intensity received by the solar cell.

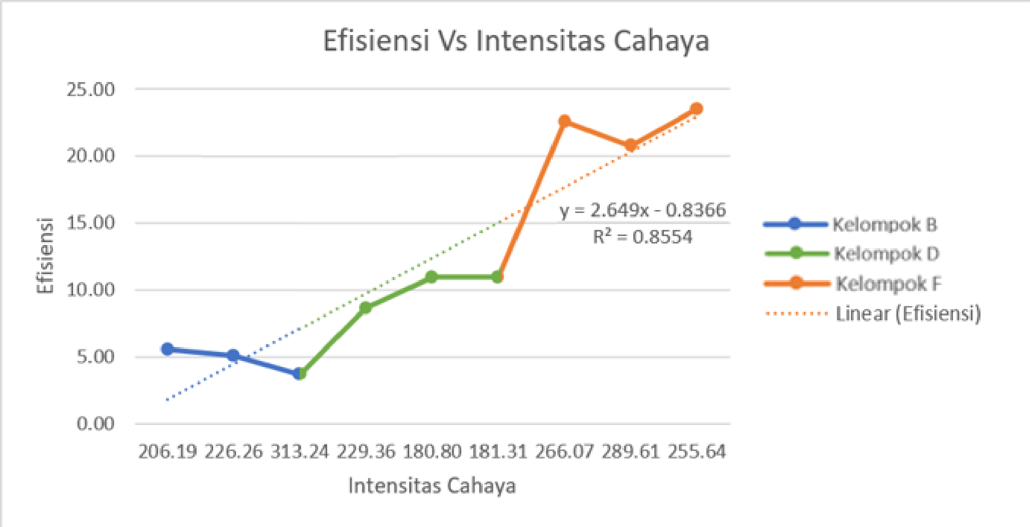

Figure 5. Efficiency relative vs light intensity

The graph of the relationship between efficiency and light intensity shows a less constant relationship with the light intensity received by the solar cell. Generally, the higher the light intensity, the higher the efficiency of the solar panel, but this is also influenced by several factors.

In the initial data collection at 10.10 to 10.40 the efficiency of the solar cells was very small, ranging from 3.67% to 5.58%, this was caused by the power produced by the solar cells being used almost entirely for charging the battery so that the power that came out was at the DC output. there will be very little which causes the efficiency of the solar cells to be small.

However, when the charging battery is full, the efficiency of the solar cells will increase according to the intensity of light received by the solar cells. This is proven by taking data from 12.05 to 12.35, the efficiency of the solar cells has increased because the battery is almost full resulting in solar cell efficiency ranging from 8.63% to 10.94% and continues to increase according to the data taken at 13.20 to 13.50. which produces an efficiency of solar cells ranging from 20.76% to 23.52% which is caused by a fully charged battery.

4. Conclusion

The solar panel system works when exposed to solar radiation which can be measured through the intensity of the light received. The higher the light intensity received, the more electrical energy is produced. In the practical data, it was found that the efficiency of the smallest solar cell at 10.40 was 3.67% with a light intensity of 313.24 W/m^2 which was caused by the power produced by the solar cell being used to charge the battery, but when the battery was fully charged then The efficiency of the solar cells will increase as in data collection at 13.20 to 13.50 which produces an efficiency ranging from 20.76% to 23.52% with a light intensity ranging from 255.64 W/m^2 to 289.61 W/m^2 so that the efficiency of the solar cells is very high. depending on the condition of the battery and the intensity of light received by the solar cells.

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