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Determination of Energy Storage Power of Plycrystal Photovoltaic Output Accumulator on the Housetop

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Abstract:- In the use of solar panels, the energy source produced by the sun is converted into electrical energy and can be used directly by the user. However, in its use, solar panels have one weakness, namely dependence on the intensity of sunlight at that location. Therefore, it is necessary to be equipped with an electric charge storage device or battery to store electric charge when the area is not exposed to sunlight or at night. Determination of the correct storage capacity of the battery or battery is necessary to save costs, storage time, and battery or battery storage space. This study aims to determine the optimum battery storage capacity for a polycrystalline solar panel mounted on the housetop for 12 hours. In this study, the design of the solar panel structure mounted on the housetop was carried out and observed the value of the output current and voltage generated from three polycrystalline solar panels. Based on the research data, the average value of the output current from the solar panel for 12 hours is 0.28 A. The value of the energy charge from the solar panel generated for 12 hours stored in the battery is 3.32 Ah. Based on these data, it can be concluded that to store a source of electrical energy from a solar panel, a battery with a capacity of 5 Ah is needed. Determining the right battery capacity can store more power generated by solar panels and can be used to meet electricity needs when there is no sun exposure on solar panels.

Keywords:- *Solar Panels, Polycrystals, Accumulators, Energy Storage, Photovoltaic.*

I. INTRODUCTION

As a country located on the equator, Indonesia is tropical, with sunshine almost all year round. In addition, Indonesia has areas where most water areas are very supportive of the availability of new and renewable energy resources. The location and geographical condition of Indonesia have the potential to provide solar energy and water as a new renewable energy source. Geographically, Indonesia also consists of thousands of small islands surrounding it, allowing for many remote areas that are not necessarily covered by electricity from the National Electricity Company (PLN) (Aryza, Putera Utama Siahaan, and Lubis 2017). In addition, Indonesia, which also has the third highest population in the world, correlates with a significant level of energy consumption. The higher the population level of an area, the higher the energy consumption needed to fulfill people's daily activities (Asy’ari, Rozaq, and Setia Putra 2014). With the design of solar panels on the housetop, it is very easy for people to obtain electricity to meet their daily needs.

New and renewable energy widely used is solar or solar energy. The intensity of sunlight that is spread evenly throughout Indonesia throughout the year can produce around 4.5 kWh/m^2/day (Gede et al. 2015; Yuliananda, Sarya, and Retno Hastijanti 2015). However, the government and society in Indonesia have not been able to take advantage of this. Only 8 solar power plants (PLTS) have been developed in Indonesia, especially on the island of Java (PLN 2020).

Solar panels are one of the main devices in a solar power generation system (PLTS) composed of semiconductor materials to convert sunlight energy into electrical energy (Sivaram, Dabiri, and Hart 2018). Solar panels as an energy source can produce voltage, current, and electrical power. Recently, the use of solar energy using solar panels has been widely developed by the government. Solar panels are strongly influenced by the intensity of sunlight, temperature, and the surface area of the solar panels (Hie Khwee 2013; Suwarti, Wahyono, and Prasetiyo 2018). In practice, the use of solar panels requires additional devices to store the resulting charge energy (energy storage) (Taşçioğlu, Taşkin, and Vardar 2016). Energy storage is used to store the electrical charge generated by solar panels during the day so that it can be used at night or when there is no sunlight. The most used energy storage device is the accumulator (Kuvshinov et al. 2019). The capacity of the accumulator used aims to store excess electrical charge and provide electrical power when there is no solar intensity in the solar panel system (Agung Nugroho, Bani Adam, and Rusdinar 2020). The right power storage capacity can prevent the system from running out of power so that it can still be used to meet electricity needs (Thamrin, Erlangga, and Susanty 2018).

Therefore, in this study, we will discuss the storage capacity of the output power of solar panels in the daily period of a polycrystalline solar panel. Suppose an electrical energy storage space does not support the electrical energy produced by the sun. In that case, the solar panels must work around the clock to meet the demand for electrical energy that is continuously used. As we know that solar panels or photovoltaics can work only during the day and depends on the intensity of sunlight (Leonard, Michaelides, and Michaelides 2020; Pawitra Teguh Dharma Priatam, Fitra Zambak, and Harahap 2021). This study aimed to determine the optimal capacity for energy storage purposes produced by a polycrystalline solar panel within 12 hours a day. In this study, an investigation was carried out to determine the optimum battery capacity that can be used to store energy produced by polycrystalline solar panels. Observations of this study were carried out throughout the day.

PLTS began to be developed in Indonesia in 1987 with 80 units of installation (Artiningrum, Havianto, and Winaya Mukti 2019). By observing the optimum capacity determination used to store energy charges from solar panels, solar panel users as an alternative energy source, PLTS can calculate precisely the cost that must be issued for making solar panels according to user needs. Determination of battery capacity space or accumulator is essential to plan the development of PLTS on a household scale. Energy storage using a good battery or battery is to use large capacity storage so that storage lasts long and is not easily damaged. Using a suitable energy storage space can save the operational cost budget and the battery storage space or battery space.

II. MATERIALS AND METHODS

A. Design of polycrystalline solar panels on the housetop

In this research, the first thing to do is to design and assemble polycrystalline solar panels on the housetop. In this study, observations were made of the voltage and current values produced by 3 polycrystalline solar panels. Polycrystalline solar panels are placed on the housetop with a tilt angle (elevation angle) of 10° solar panels according to the elevation angle of the tile or housetop.

The design of three solar panels that have been assembled on the housetop is connected to 3 batteries and a multimeter. The solar panels are placed on the housetop that has been installed with a solar panel supporting frame so that it is not easy to move. The multimeter is installed on the battery (accumulator) and the solar panel to determine the voltage of each. At the time of the research, used batteries that were empty and without being given a load or other obstacles. Thus, from this research, the value of the current and the voltage stored in the battery resulting from each type of polycrystalline solar panel can be obtained.

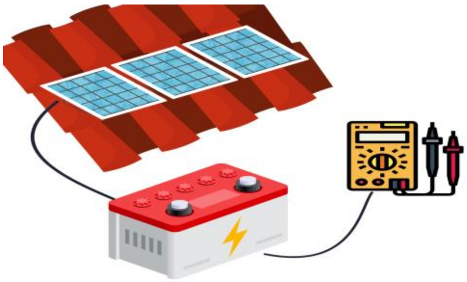

Fig. 1. Design of Polycrystalline Solar Panel Output Current and Voltage Observation

B. Observation of the Output Current-Voltage Value of Polycrystalline Solar Panels

At this stage, observations and data collection of the current and output voltage values will be carried out by three solar panels. Observations of the current and voltage values of polycrystalline solar panels were carried out for one day with a time span of 06:00 – 18:00 (GMT+7).

Data retrieval of the solar panel's current value and the output voltage is carried out every hour. The data is observed on a multimeter. In this study, the value of the output current and output voltage of the solar panel and the output voltage of the battery will be obtained. Observations of the temperature value of the environment and the sunlight intensity are also carried out as supporting data in this study.

This study obtained the average value of the output voltage of polycrystalline solar panels. In addition, the total value of the average solar panel output current is also obtained. At the data analysis stage, we will discuss the battery capacity needed to store the electrical energy produced by polycrystalline solar panels for twelve hours.

III. RESULTS

In this study, the results were obtained in the form of a design of a solar panel assembly installed on a housetop and data on observing the current and output voltage produced by polycrystalline solar panels.

A. Design results of polycrystalline solar panels on the housetop

In this study, the structure of the design of polycrystalline solar panels installed on the housetop was obtained. Polycrystalline solar panels are installed to capture current and output voltage data throughout the day. In this study, the polycrystalline solar panel was directly connected to the battery and connected to a multimeter measuring instrument to observe the solar panel's current and output voltage values.

Fig. 2. The process of installing polycrystalline solar panels on the housetop

B. Correlation of Solar Panel Output Voltage and Current Values with observation time

This study obtained the correlation value between the voltage and current of the solar panel output to observation time, in addition, the daily average value of polycrystalline solar panels' output current and voltage. The graph in Fig. 3 shows that the output voltage value of the polycrystalline solar panel stored in the battery has an insignificant increase between the three solar panels. The graph also shows a significant

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change in value from 06:00 (GMT+7) to 07:00 (GMT+7). The voltage value generated by the three polycrystalline solar panels is then calculated on an average observation time. The average voltage value is obtained as shown in the graph Fig. 3.

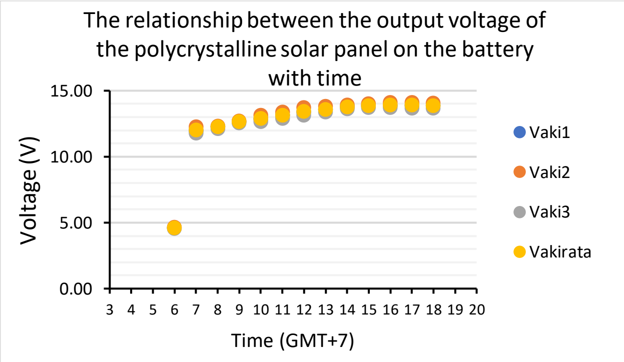

Fig. 3. Graph of Output Voltage Correlation from Polycrystal Solar Panels stored in the Accumulator to the observation time

The observations also obtained the value of the solar panel's output voltage, which is measured directly at the solar panel's output without being connected to the battery. Figure 4 shows the data from observing the polycrystalline solar panel's output voltage value. Based on the data in the graph in Fig. 4, it is shown that the value of the output voltage generated directly by the solar panel is not significantly different between the time of observation. The output voltage value produced by polycrystalline solar panels shows a stable voltage increase value. The graph Fig.4 also shows the average value of the output voltage by polycrystalline solar panels, and there is no significant difference between the three solar panels..

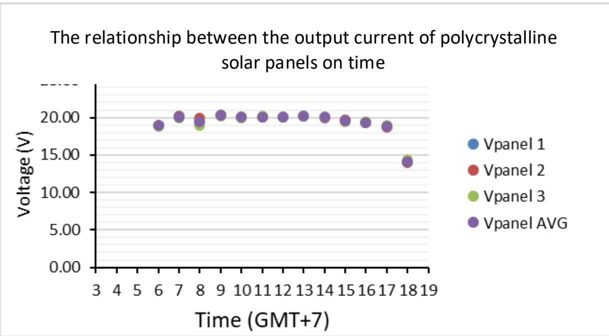

Fig. 4. Graph of Output Voltage Correlation Generated by Polycrystalline Solar Panels to Observation Time

In this study, the observed value of the output current generated by each solar panel was also obtained, as shown in the graph in Fig. 5. Based on the values obtained, there is a significant current surge from 08:00 (GMT+7) to 09:00 (GMT+7). In addition, it can also be seen that in the afternoon, the average output current value begins to decrease. During the day (10:00 – 14:00), the current value of each polycrystalline solar panel the average value reaches a maximum of 0.47 A. The current flow and voltage stored in the battery or accumulator indicate that the battery can work as a charge store electricity generated by solar panels exposed to sunlight.

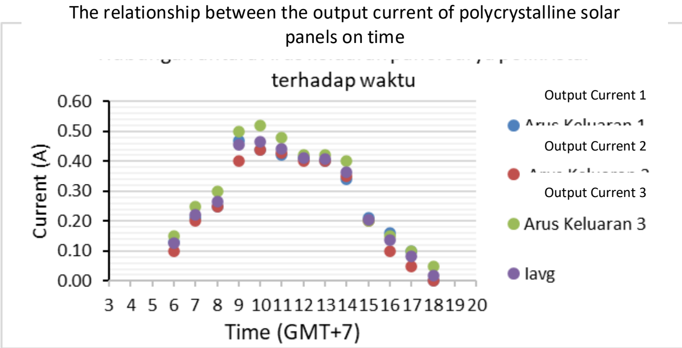

Fig. 5. Graph of Relationship Between Output Current Produced by Polycrystalline Solar Panels to Observation Time

IV. DISCUSSIONS

Based on the observations, the output voltage value between the three solar panels is not significantly different. This shows that the solar panel assembly for a larger number will not have a significant difference in value. Solar panels can be assembled in large quantities depending on the value of energy needed by solar panel users as PLTS. Based on the observed values, it can also be seen that the voltage value generated by polycrystalline solar panels has an output value that tends to be stable in value.

In the observations in Fig. 4, it can also be seen that the output voltage value directly measured from the solar panel output voltage has a higher value than the solar panel output voltage connected to the accumulator. This is because there is also a load resistance in the battery that can reduce the value of the solar panel output voltage. The output voltage recorded directly on the three solar panels does not have a significant difference because they have the same material characteristics, the same elevation angle, and are placed in an environment with the same temperature.

Based on the results of the research that has been done, also shown in the graph Fig.5, the largest value of the output current of polycrystalline solar panels occurs at 09:00 - 11:00 WIB, each with an output current value of 0.46; 0.47; 0.44. Based on the value of the output current generated by the polycrystalline solar panel, the energy charge stored in the battery is obtained, which is the product of the average output current value that occurs for 12 hours. So, based on the calculations and analysis carried out, the value of the energy charge stored in the battery is 3.32 Ah. So based on the value of the resulting charge, we can assume that to determine the optimum energy capacity to accommodate the energy output from the solar panel, it is enough to use a battery or battery with an energy storage capacity of 5 Ah.

In this study, the average current value of the output from the solar panel for 12 hours that can be stored in the accumulator is 3.32 Ah. The polycrystalline solar panel generates the average value of the output current without any

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load or other resistance. The average output current value shows a significant current spike from 08:00 (GMT+7) to 09:00 (GMT+7). This is due to the high intensity of sunlight at that time. In the afternoon, it can be seen that the output current value of the solar panel begins to decrease as the intensity of the sunlight exposure to the solar panel decreases. The battery voltage will be lost or decreased if the battery is not connected to the solar panel (Firanda and Yuhendri 2021). In addition, it can also indicate that the battery's capacity has begun to be fully charged.

Various methods of storing solar energy as a producer of electrical energy have been carried out. Several studies have investigated the manufacture of solar energy storage batteries/batteries. Proper and optimal electrical energy storage is essential to save budget, time, and the required storage space. This study made observations of the output voltage and current values of three polycrystalline solar panels connected directly to the accumulator/battery. The study's results obtained the average value of the output voltage and output current of polycrystalline solar panels, which showed no significant difference between the three solar panels. The flow of current and voltage stored in the battery or accumulator shows that the battery can work as a store of electric charge generated by solar panels exposed to sunlight.

The selection of load storage capacity is critical to consider, related to the battery's shelf life, operational costs, and the storage space used. The selection of the right storage capacity from the accumulator or battery can be used to store the excess load generated by the solar panels and serves as a source of charge or electricity when the intensity of sunlight is not high enough. Proper accumulator capacity can prevent power outages during periods of no sunlight (Arai et al. 2008).

V. CONCLUSIONS

In this study, the structure of the solar panel design was obtained, which was installed on the housetop with an angle elevation following the housetop (10°). In addition, based on the study's results, the average output current and voltage values of the three polycrystalline solar panels did not have a significant difference, so later, for greater energy needs, more solar panels could be used as needed. The value obtained from the average output current of the solar panel is 0.28 A for 12 hours. Based on the calculation value, the value of the electric energy charge generated by the solar panels for 12 hours is 3.32 Ah. So, it can be concluded that it is enough to determine the optimum battery storage capacity in a polycrystalline solar panel to use a battery with a storage capacity of 4 to 5 Ah. Determining the right accumulator capacity for the use of solar panels can store excess power and can also operate to produce electricity in the absence of sunlight.

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