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ANALYSIS OF MAXIMUM POWER REDUCTION EFFICIENCY OF PHOTO-VOLTAIC SYSTEM AT PT. PERTAMINA (PERSERO) RU III PLAJU

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Abstract

The purpose of this research was to review the power output generated during the operation of the solar panels. Data that used to be taken of the Solar Power Plant or PLTS that operate PT. Pertamina (Persero) RU III Plaju observed data starting from January 2017 until December 2017 PLTS system installed in PT. Pertamina (Persero) RU III Plaju is a kind of photovoltaic grid connected (on grid). The results obtained that in manual calculations obtained fill factor of 0.7594 and output power of 250.884 Watts. Whereas the data in real time in the field fluctuating occurs at any time. This is because the weather was overcast, the lack of sunlight and shadow position (shading) that occurs due to the PLTS clouded by trees or buildings around also affects the results of the output voltage of the PLTS.

Kata kunci: energy efficiency, solar panels, photovoltaics

INTRODUCTION

The transition of the utilization of renewable energy as an energy source is promising due to the availability of the source of the infinite and continuously dwindling sources of energy generated from fossil energy. (Kananda & Nazir, 2013). Sources of renewable energy are derived from various sources that come from nature, i.e. solar, wind, biomass, water and so on. Solar energy is the source of energy that is always available in nature. Energy from sunlight as a source of renewable energy widely available in nature and solar energy is potential energy that can be developed in Indonesia caused Indonesia is a country located in the region of the equator. (Hasan, 2012).

Utilization of solar energy to electrical energy using a component called the solar panels (photovoltaic) (Dewi et al., 2016). Photovoltaics is a technology that serves to change or convert solar radiation into electrical energy directly. The conversion of sunlight into electrical energy is utilizing the concept of photoelectric effect (Heri, 2012).

Solar energy can be used directly without being connected to the grid (off the grid), connected to the grid (on the grid) or in a hybrid with other sources of energy (Sianipar, 2017). Hybrid energy can be made by combining more than one energy source, it could be combined with other renewable energy sources such as wind turbines (Yudha, Dewi, Risma, & Oktarina, 2018). Utilization of solar energy that is mounted off the grid will be suitable for areas that have not been teraliri an electric current or remote areas because it will be other alternatives. Whereas, solar energy installed on the grid is a great alternative to get continuous energy stability is possible at any time.

The results of the power output generated from each solar panel varies depending on the type of material used to make solar panels and solar panel installation (Ramadhan, Diniardi, & Mukti, 2016). Solar panel installation position can be done on land and can be affected by exposure to sunlight or solar panels can be placed on the roof of a house or building. Power output results will also be affected by the influence of the intensity of the light being absorbed by the solar panels. Sunlight is absorbed into the solar panels will affect the voltage generated. The heat from the Sun's light when it rains it certainly will be different result by the time the weather is bright and the Sun was shining bright (Yuliananda, Sarya, & Hastijanti, 2016).

The position of the shadow (shading) that is absorbed in the solar panels also affects the result. When the solar panel is eclipsed by the shadow of a tree, then the Sun which is supposed to be absorbed into the solar panels is hindered by the trees and reduce the absorption of its sun rays. The things that will reduce the efficiency of the solar panels.

METHOD

Design of system On Grid

PLTS system installed at PT. Pertamina (Persero) RU III Plaju is a kind of photovoltaic grid connected (on the grid). A system of connected solar cells on the grid are working directly from the solar panels without using a battery, so that the system can flow directly to the load. However, the use of a battery can be added if you want a more stable energy source. Photovoltaics on grid solar cell utilizing as a primary source in the daytime while for the evening will be utilizing its own generating resources owned by PT Pertamina (Persero). The working system of the PLTS connected grid (on the grid) can be seen in Figure 1. Photovoltaic system in PT. Pertamina (Persero) RU III Plaju this do not use the battery as a backup energy source, so only utilize the solar cell photovoltaics and power generation systems. PLTS system in PT. Pertamina (Persero) RU III Plaju consists of 3 device where each device generates power of PLTS 3000 Watts with maximum currents are amounting to 250 Watts.

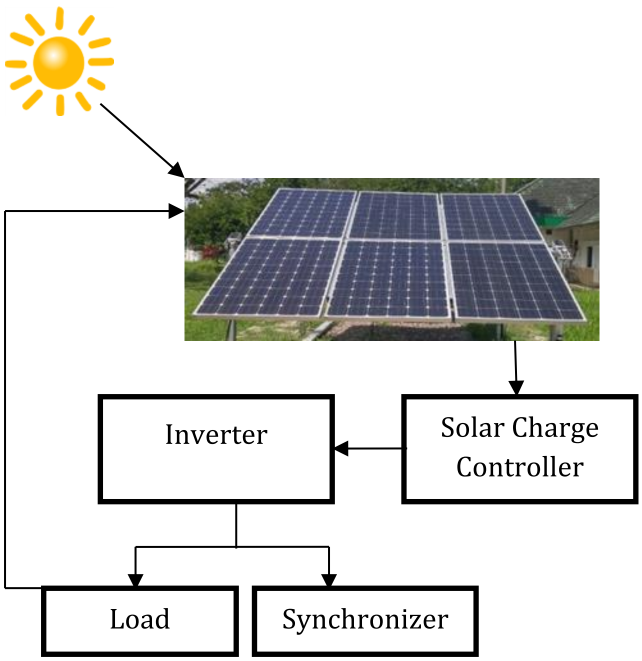

Figure 1. The scheme of work of PLTS on grid

Figure 2. PLTS installed in PT. Pertamina (Pesero) RU III Plaju

System Properties On Grid

The Curve V-I

The characteristics of the output of the Solar Panel can be seen from the performance curve, the curve of V-I shows the relationship between current and voltage. Most of the V-I curve given in the Test Condition 1000 watts/m^2 (conditions at the time of one peak Sun hour) and Solar Panel temperature 25 degrees Celsius. The V-I curve consists of 3 important things, among them, namely the maximum voltage (Vmp) and the maximum flow (Imp); no-load voltage (Voc) and short circuit current (Isc) (Siahaan, Mujahidin, & Nusyirwan, 2011).

Fill Factor

The Fill Factor (FF) is a comparison between the maximum power (Pmax) produced by the solar cell and the open circuit voltage (Voc) and the short circuit current (Isc). The equation for the calculation of the fill factor on the solar cells is as follows:

With the value of the maximum power produced solar cells is:

$$P_{max} = V_{mp} \, . \, I_{mp} \tag{1}$$

Description:

P_{max} = the maximum power produced solar cells (W).

I_{mp} = maximum current generated by the solar cells (A)

V_{mp} = the maximum voltage produced by the solar cell. (Volt)

Calculation of the fill factor obtained as in equation (2).

$$FF = \frac{I_{mp} \, .V_{mp}}{I_{sc} \, .V_{oc}} \tag{2}$$

The value of the V_{mp}, I_{mp}, I_{sc} and V_{oc} obtained from solar panels on the specification, as shown in Figure 3 for the depiction of the illustration V-I curves.

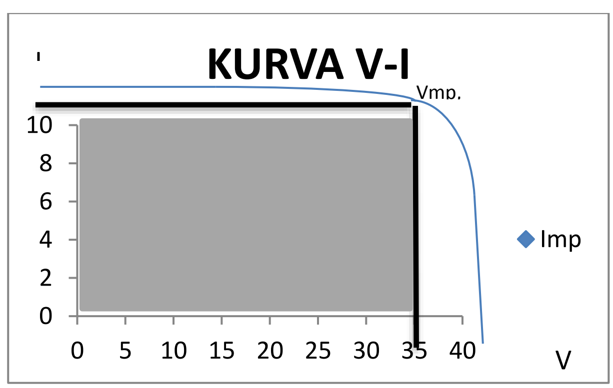

Figure 3. V-I Curve

Solar cell efficiency

To get the value of the peasants who happen to solar panels, the necessary measurements of V-I curves are then retrieved the other parameters such as the Isc (short circuit current), Voc (voltage without load), the fill factor (FF), efficiency (η), Pm. The characteristics of the output of the Solar Panel can be seen from the performance curve, the curve of V-I shows the relationship between current and voltage. The efficiency of the solar panels can be calculated using the following equation:

$$\eta = \frac{P_{max}}{P_{in}} = \frac{I_{mp}V_{mp}}{P_{in}} \quad (3)$$

Description:
η = solar panel efficiency
P_{max} = the maximum power produced solar cells (Watt)
I_{mp} = the resulting maximum current solar cells (Ampere)
V_{mp} = the maximum voltage produced solar cells (Volt)

RESULT AND DISCUSSION

PLTS mounted PT. Pertamina (Persero) RU III Plaju using modules with the materials of monocrystal-line. The specifications of the PLTS that are used on PT Pertamina (Persero) RU III Plaju can be seen in table 1.

Table 1. Specifications of PLTS in PT. Pertamina (Persero) RU III Plaju

Type of module used	Solar Module Sky Energy Monocrystalline 250 Wp
Rated Maximum Power (Pmax)	250 W
Maximum Power Voltage (Vmp)	30.9 V
Maximum Power Current (Imp)	8.12 A
Open Circuit Voltage (Voc)	37.8 V
Short Circuit Current (Isc)	8.74 A

Fill Factor

The fill factor equation uses the parameters of the open-circuit voltage (Voc) of the measurement results directly on the solar panels on the V-I characteristic of a solar panel as shown in table 1.

$$FF = \frac{I_{mp}V_{mp}}{I_{sc}V_{oc}}$$

$$FF = \frac{8{,}12\ x\ 30{,}9}{8{,}74\ x\ 37{,}8}$$

$$FF = 0{,}7594$$

Output Power

Output power calculation equations are obtained by calculation based on the fill factor, open circuit voltage and current of the circuit is open.

$$P_{\ out} = V_{oc}\ x\ I_{sc}\ x\ FF$$
$$P_{\ out} = 37{,}8\ x\ 8{,}74\ x\ 0{,}7594$$
$$P_{\ out} = 250{,}884\ watt$$

Real time data generated by the PLTS PT. Pertamina RU III Plaju

PLTS in PT. Pertamina RU III Plaju consists of 3 modules each of which generates a power of 3000 Watts. Power output data reviewed data from January 2017 until December 2017. In Figure 4 shows the resulting output power data PLTS on module 1. In the figure it can be seen that the resulting power increase and decrease the voltage on each month. Whereas, in Figure 5 can be seen in a comparison between the data outputs resulting PLTS on module 1 and the calculation of the calculated power output through manual calculations by using data that already is available on the specification of the panel Solar installed. It can be seen that the data should be generated at PLTS is 250.884 Watts than with real time data on the field. The difference in results output power can be based on the

State of the weather at the time of PLTS operates so as to increase or penuruna voltage. The position of the shadow (shading) will also affect the magnitude of the voltage to be generated.

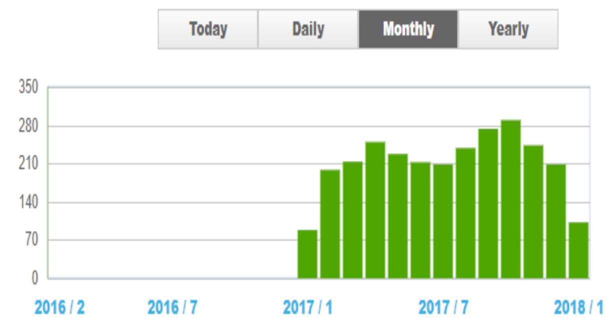

Figure 4. Monthly output power at module 1

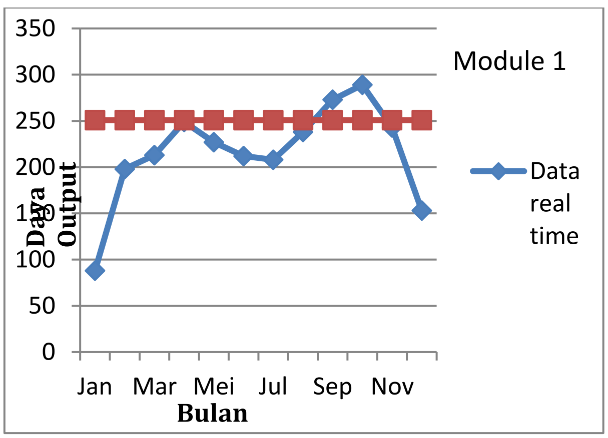

Figure 5 comparison chart of monthly output power at module 1 and manual calculations

Whereas, in Figure 6 shows the resulting output power data PLTS on module 2. The same thing also occurred in module 2, i.e. not the relative power generated compared to the data of the output power should be obtained as at the time of the calculation manually. The cause is also still likely caused by weather or shading when the PLTS on module 2.

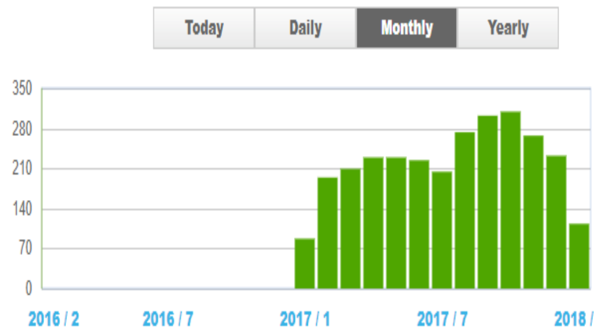

Figure 6. Monthly output power at module 2

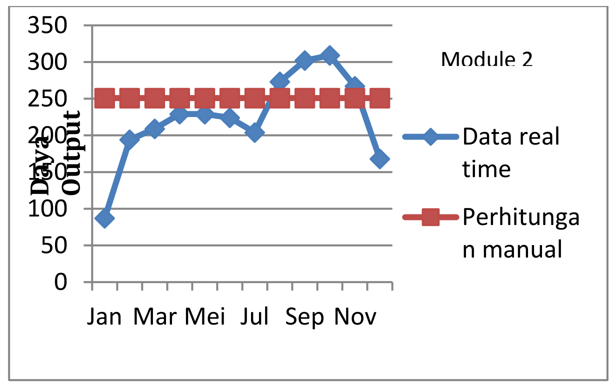

Figure 7. comparison chart of monthly output power at module 2 and manual calculations

Furthermore, in Figure 8 shows the resulting output power data PLTS on module 3. The same thing also happens to modules 1 and 2, that is not the relative voltage generated compared to the data of the output power should be obtained as at the time of the calculation manually. The cause is also still likely caused by weather or shading when the PLTS on module 2.

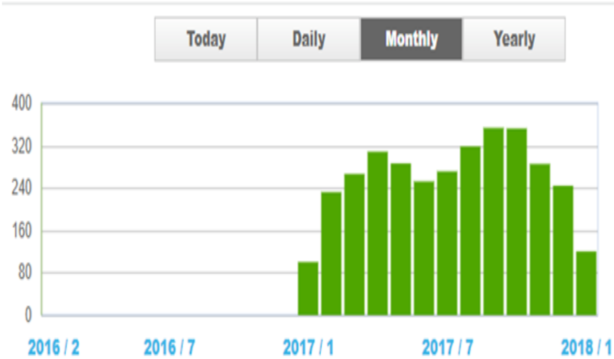

Figure 8. the monthly output power at module 3

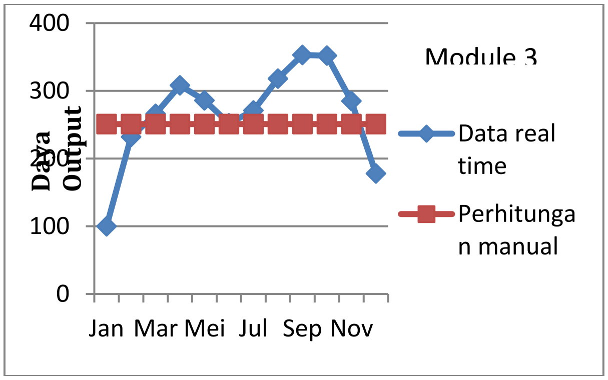

Figure 9 Graph comparison of monthly output power at module 3 and manual calculations

In Figure 4, Figure 6 and Figure 8 to see that the resulting output power is greatest in August, September and October 2017. It is influenced by the location of the position of the Sun at the time of operation of solar panels. In August, September and October the Sun perpendicular to the position of the solar panel, so the absorption of sunlight into maximum power output and results generated also be great. To increase the power output of the results generated by a PLTS, then required the presence of MPPT (Maximum Power Point Tracker) which serve to maximise the absorption of resources will go into solar panels..

CONCLUSION

The fill factor is obtained of 0.7594 and output power of 250.884 Watts. Whereas the data in real time in the field fluctuating occurs at any time. The instability of energy that occur when PLTS are operating in the field compared with the data obtained through manual calculations can be caused by the State of the weather at the time of PLTS is operating. That is, can be overcast weather or lack of sunlight, then sunlight absorbed a little so that the resulting output voltage will be a bit of a (small). The opposite will occur when the weather is in favor or at the time of the Sun's light shines bright, then the absorption of solar energy will be a maximum which will cause absorption maximum energy into the dihasilakn and voltage will be large. The position of the shadow (shading) that occurs due to the PLTS covered by trees or buildings around surely also affect the results of the output voltage of the PLTS.

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