Eksergi Halogen

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Submission date: 07-Jun-2023 10:16AM (UTC+0700)
Submission ID: 2110737856
File name: Eksergi_Artikel_Halogen.docx (388.46K)
Word count: 3349
Character count: 17412

The Effect of Solar Panel Efficiency Due to Temperature Changes Using Halogen Lamps on Polycrystalline Type Solar Modules

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ABSTRACT — Solar panels are a technology that utilizes solar energy to be converted into electrical energy. Solar panel technology can be used to generate electricity on a small scale to a large scale. The performance of solar panels depends on environmental factors, namely solar radiation, and temperature. Environmental factors will reduce the electrical efficiency of solar panels due to the increase in operating temperature of solar panels, the greater the temperature will affect their efficiency. Based on tests conducted on photovoltaic (PV) using halogen with different power, the greater the power value in halogen lamp light, the smaller the efficiency, while the greater the temperature of the solar module, the smaller the efficiency. The greater the increase in temperature, the PV efficiency tends to decrease. Based on the results of the study, it shows a significant correlation that, between PV surface temperature and PV efficiency is inversely proportional. While the effect of temperature on efficiency can be said to be quite influential, where in testing with a 300-watt halogen lamp the error rate or R value is 0.6339, while the 500-watt halogen R value is 0.8493 which means it is more accurate and the effect is quite strong.

Keyword — Solar Energy, Efficiency, Temperature

I. Introduction

Electrical energy is a very important energy for human life. Almost everything is needed, ranging from basic needs such as household needs to business needs. Currently, the availability of electrical energy sources is unable to meet the increasing consumption of electrical energy in Indonesia [1][2]. The occurrence of temporary disconnections and rotational distribution of electrical energy is the impact of limited electrical energy that can be distributed by PLN.

Energy needs are an indiactor of increased prosperity. The use of solar energy in Indonesia has very good prospects, considering the geographical area of Indonesia as a tropical country [3][4]. The use of solar energy through photovoltaic conversion is widely applied including, the application of individual systems and hybrid stem *systems*, namely the system of combining conventional resources with renewable energy sources.

Around the world, energy is an important issue for humans. Energy is classified into two different categories, namely non-renewable energy, and renewable energy. As a result of world economic development, the world cannot continue to depend for long on fossil fuels (natural gas, oil and coal) [4][5]. Most of the world's energy is produced from fossil fuels. Limited fossil fuel reserves cause fossil fuel prices to continue to rise. Renewable energy sources are becoming important because of their significant benefits. Among all renewable energy sources, *photovoltaic* (PV) energy is a very effective solution to renewable energy because it is non-polluting, abundant, and completely free of cost. PV energy is the energy that comes from the conversion of the sun into electricity. Today, PV systems are likely to be widely known and used in electric power [6][7]. This is because direct current electrical energy can be produced without environmental damage when exposed to solar radiation. One of the main obstacles facing the operation of PV panels is the conversion of PV cells which are very low in electrical efficiency. It is also a major obstacle for scientists and researchers to improve the electrical efficiency of PV cells.

One of the efforts to overcome the electrical energy crisis is to reduce dependence on fossil energy sources. This is because the amount of fossil energy that exists is limited and cannot be renewed. Therefore, researchers are intensively finding alternative energy to meet the needs of electrical energy. Solar cells are one alternative that can be used because in addition to easier maintenance it is also friendly to the environment [8][9]. This solar cell utilizes sunlight that is converted into electricity, the intensity of light emitted from the sun is very influential on the efficiency of solar cells [9]. In addition, many other factors affect the performance of solar cells such as: wind speed, air mass, ambient temperature, solar cell temperature, and the characteristics of the solar cell material. The efficiency of PV plants is not only highly dependent on solar radiation, but also depends on the operating temperature of PV panels. The cause of low conversion of electric PV cells is overheating efficiency due to excessive solar radiation and high operating temperatures. This is because PV panels only 15% of the sun's energy is converted into electricity and the rest is converted into heat

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ISSN 0216-8685 (print); 2528-6889 (online)

[10][11]. Therefore, in this study the author will conduct a study to determine the effect of increasing temperature on efficiency in *polycrystalline silicon* type solar cells by simulating solar radiation using halogen lamp light.

The temperature of the upper solar panel seems to change during solar panel operation. The gradient of temperature increase is quite large when the temperature of solar panels increases from the ambient temperature to the highest temperature. Solar simulators are needed to assist in solar energy experiments. Because many scientists simulate the performance of PV panels under controllable indoor testing facilities [12][14]. Solar simulators are light supplies providing illumination near natural sunlight. With solar simulators, PV panel performance testing can be performed at a selected time, continued for 24 hours a day, and controlled for humidity and other aspects of the environment [13][15]. The goal to be achieved in this study is to find out how much influence changes in light intensity have on the performance of solar modules and determine changes in the surface temperature of solar modules on the efficiency of *polycrystalline* type solar modules.

II. METHODS

This research was conducted by first conducting tests carried out in a closed room by varying the intensity of lamp light hitting solar panels using Halogen Lamps with several power variations. So that automatically the surface temperature of the solar panel increases with the increase in time in testing. Data collection is carried out every minute until the 10th minute and then data collection is carried out every 3 minutes until the temperature reaches 100 0C for each different power on halogen lamps so that the data obtained is more specific. Furthermore, in this test, measurements were made on the parameters used to analyze the effect of lamp light and temperature changes on the efficiency of solar panels. Therefore, the measuring instrument is placed in such a way that it is easier to place and read. The parameters measured in the test are as follows:

1. Solar panel surface temperature (^{0}C)
2. The intensity of lamp radiation emitted to the surface of solar panels (Watts / m^2)
3. Current generated by solar panels (Amperes)
4. Voltage generated by solar panels (Volts)
5. Environmental Temperature.
6. This measured parameter then becomes input data from calculations to find the efficiency value produced by the solar panel.

The flow diagram of the research to be carried out is shown in the following figure:

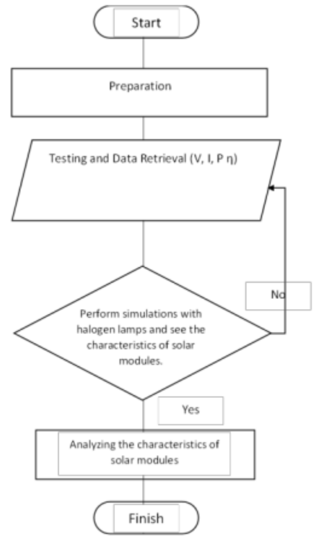

Fig 1. Research Flow Chart

III. RESULTS AND DISCUSSION

In this study, before conducting testing and measurements, checks and inventories of equipment that will be used in testing include:

1.Halogen lamp 300-500 watt
2.Light holder post
3.Polycristalline Solar Module 100 wp
4.Inverter
5.Solar Charger Controller
6.PV Cable and Conector
7.Multimeter
8.Solar power meter

The next stage is assembly and testing to see the magnitude of the irradiation value, current, voltage, characteristics of solar modules, The measurements and tests carried out are seen in figures 2, 3 and 4.

Fig 2. Testing

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Fig 3. Irradiation Measurement

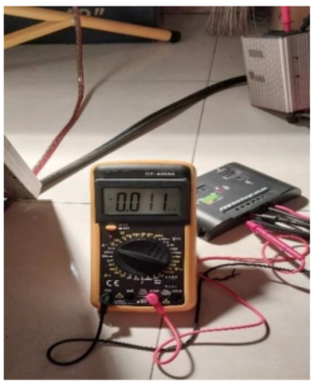

Fig 4. Current Measurement

Tests were conducted to determine several pameters to see the extent and how much influence changes in light intensity produced in 500 watt and 300-watt halogen lamps on the performance of solar modules and determine changes in the surface temperature of solar modules on the efficiency of *polycrystalline* solar modules. In this study after making or assembling the module to be tested is then measured to see the extent of changes in the parameters produced, this test is carried out for 120 minutes where every 10 minutes will be measured and recorded.

Tests using halogen lamps with a power of 500 watts and 300 watts were tested respectively, in the first test we want to see the extent of temperature changes in solar panels with test times ranging from 10 minutes to 120 minutes, from the results of this test obtained results that can be seen in figure 5 of the temperature measurement graph on solar panels.

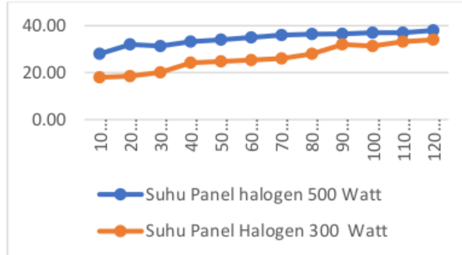

Fig 5. Temperature Measurement on Solar Panel

Based on the graph shown in figure 5 that when testing using 500 watt and 300-watt halogen lamps, the longer the exposure to light irradiation produced from halogen lamps causes the temperature on the surface surface of the solar module to increase. This is the same when the power from halogen lamps is getting bigger, the surface temperature produced in solar modules increases.

While the irradiation produced by solar modules is increasing along with the amount of irradiation produced in halogen lamp light, it is shown in table 1.

Table 1. Temperature and Irradiation Measurement Results

Halogen	Time (Menit)	Panel Temperature (°C)	Environmental Temperature (°C)	Solar Panel Radiation Intensity (W/m²)
500 Watt	10	28,00	29,00	12,80
	20	32,00	29,00	13,50
	30	31,30	29,10	14,90
	40	33,20	29,10	15,80
	50	34,00	29,10	54,00
	60	35,00	29,30	60,00
	70	36,00	29,40	60,80
	80	36,40	30,00	74,90
	90	36,50	30,30	155,30
	100	37,00	31,00	155,30
	110	37,00	32,00	178,40
	120	38,00	32,00	218,80
300 Watt	10	18,00	24,00	10,80
	20	18,50	25,50	11,20
	30	20,10	25,90	11,70
	40	24,20	26,55	11,05
	50	24,75	26,90	11,28
	60	25,35	27,20	11,80
	70	26,00	27,45	11,45
	80	28,00	28,65	12,80
	90	32,00	29,00	13,50
	100	31,30	27,60	14,90
	110	33,20	28,10	15,80
	120	34,00	29,10	34,00

Furthermore, to determine the magnitude of the influence of temperature on efficiency on polycrystalline type solar mudl, it is necessary to know the amount of current and voltage produced in the solar module to see the extent of the

ISSN 0216-8685 (print); 2528-6889 (online)

efficiency produced, based on the results obtained in the results seen in table 2.

Table 2. Current and Voltage Measurement Results

Halogen	Time (Menit)	Current on solar panels (Ampere)	Panel Voltage (Volt)
500 Watt	10	0,50	14,23
	20	0,62	16,20
	30	0,70	16,40
	40	0,84	17,80
	50	1,13	17,00
	60	1,14	18,00
	70	1,20	18,45
	80	1,35	19,51
	90	1,45	19,87
	100	1,70	20,10
	110	1,82	21,20
	120	1,94	22,32
300 Watt	10	0,28	11,23
	20	0,30	11,80
	30	0,35	12,30
	40	0,41	13,53
	50	0,45	13,75
	60	0,46	13,80
	70	0,48	14,03
	80	0,50	14,23
	90	0,62	16,20
	100	0,70	16,40
	110	0,84	17,80
	120	1,13	17,00

In table 2 with the value of current and voltage increasing if exposure to light irradiation of halogen lamps hits solar modules, halogen lamps that have greater power, the current and voltage produced are also large. In measurements with a 500-watt halogen lamp, the measured current is 1.94 Amperes when the exposure time to halogen lamp light irradiation is 120 minutes, while the measured voltage is 22.32 volts. For a 300-watt halogen lamp, a current of 1.13 Amperes and 17 Volt voltage values are read with a test time of 120 minutes. The greater the power in halogen lamps, the faster irradiation received in solar modules, where when the power of 500 watts is large, the current is measured by 0.50 Amperes within 10 minutes, while using a 300-watt halogen lamp the current is 0.28 which means half of the power value in a 500-watt halogen lamp.

To see the efficiency value of the effect of temperature changes on solar modules, data in table 1 of the measurement results are used and calculations are obtained as shown in figure 6.

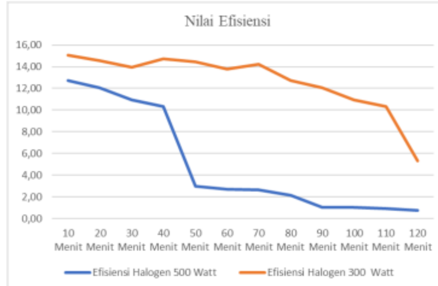

Fig 6. Solar Module Efficiency Value

From figure 6 of the graph of the efficiency value of the solar module, it can be said that with a large power in a 500-watt halogen lamp has a lower efficiency value than the power of a 300-watt halogen lamp. Based on the data obtained, it can be said that the amount of power in halogen lamps affects the efficiency value of solar modules. The next stage is to find out the extent of the influence of temperature on efficiency by modeling to see the extent of the relationship that occurs between the inpu variable in this case temperature and the efficiency output variable, the results that have been done are obtained results shown in graphs in figures 7 and 8.

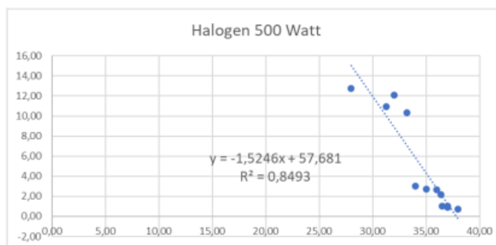

Fig 7. Graph of the Value of the Effect of Temperature on Efficiency

Based on the graph in figure 7, from the model that has been carried out, the R value is 0.8493, which means that from the modeling carried out the error is quite good, in other words that the temperature of the 500-watt halogen light hitting the solar module has a strong enough influence on the efficiency value. In another test, the same thing was done using a 300-watt halogen shown in the graph in figure 7, the effect of temperature on efficiency was obtained with an R value of 0.6339, meaning that in a 300-watt halogen it is said that the effect is there but not too large.

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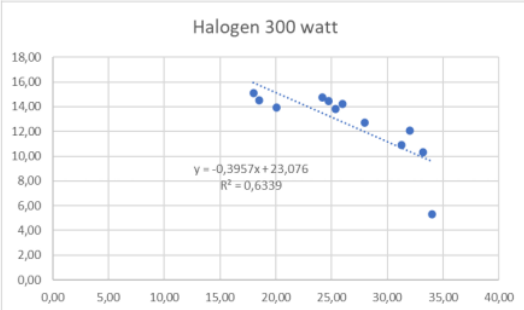

Fig 8. Graph of the Effect of Temperature on Efficiency

Based on modeling that has been made and known, it can be said that 500-watt halogens have a very strong influence between temperature and efficiency than 300-watt halogens. The greater the power from halogens, the greater enough temperature that will hit the solar module but affect its efficiency.

Dari model yang dilakukan maka kita perlu melihat nilai Mean Absolute Percentage Error (MAPE) merupakan ukuran kesalahan relatif, dengan kata lain MAPE merupakan ukuran ketepan relatif yang digunakan untuk mengetahui persentase penyimpangan hasil prediksi. Pendekatan ini berguna ketika ukuran atau besar variabel ramalan itu penting dalam mengevaluasi ketepatan estimasi. MAPE mengindikasikan seberapa besar kesalahan dalam menduga yang dibandingkan dengan nilai nyata Semakin kecil MAPE maka semakin akurat sebuah model dalam melakukan peramalan. Hal ini berarti sebuah model yang memiliki nilai MAPE sebesar 5% merupakan model yang lebih baik dalam melakukan peramalan dibandingkan model lain yang memiliki MAPE sebesar 10%. Interpretasi nilai MAPE dapat dilihat dari interval nilainya pada tabel 3.

Table 3 MAPE Value Interval

Nilai MAPE	**Interpretasi**
≤ 10	Forecasting results are very accurate
10 - 20	Good forecasting results
20 - 50	Forecasting results are decent (good enough)
> 50	forecasting results

To get the MAPE value based on the data obtained and the equation in figures 5.6 and 5.7 we can calculate the value of % absolute error and get the value of Mean Absolute Percentage Error (MAPE) obtained the results shown in table 4.

Table 4. Results of MAPE Value Effect of Temperature on Efficiency

Halogen	MAPE
500 watts	44,22
300 watts	13,37

Based on table 4, it can be seen the magnitude of the Mean Absolute Percentage Error (MAPE), where the greater the value of the error, the greater the value, which means that there is no or no significant influence between the variables. With the tests that have been done the power of the 300-watt halogen lamp is high in error or accuracy is good, compared to 500-watt halogen, but in the two tests carried out that the effect of temperature with efficiency exists.

In research that has been carried out the test time is limited to only 120 minutes or 2 hours, this is a start to see the characteristics of solar modules when exposed to halogen lamps, where testing is carried out using halogen lamps with different power. Further testing can be done with the development and power variation of halogen lamps that are larger or can also use other types of solar modules.

IV. Conclusion

Based on the tests and results obtained in this study stated that, when testing using a 300 watt halogen lamp, the efficiency of a polycrystalline type solar module was 5.33 when the test time was 120 minutes with a temperature of 34 0C while testing using a 500 watt halogen lamp obtained the efficiency results of a polycrystalline type solar module worth 0.74 when the test time was 120 minutes with a temperature of 38 0 C So that in the research that has been done by looking at the comparison of testing using a larger halogen lamp capacity, the more power efficiency that polycrystalline type solar modules have, the smaller the efficiency value, otherwise if the power of halogen lamps is small, the greater the efficiency.

The results of the study found that the greater the increase in temperature, the PV efficiency tends to decrease. Based on the results of the study, it shows a significant correlation that, between PV surface temperature and PV efficiency is inversely proportional. While the effect of temperature on efficiency can be said to be quite influential, where in testing with a 300-watt halogen lamp the error rate or R value is 0.6339, while the 500-watt halogen R value is 0.8493 which means it is more accurate and the effect is quite strong.

Acknowledgment

The author would like to thank LPPM through the PLN Institute of Technology for funding and providing support this article, hopefully this article will be useful.

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ISSN 0216-8685 (print); 2528-6889 (online)

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