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Comparative Analysis Of Solar Panel Output Power Using Reflected Light And Direct Sunlight

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Abstract*. This study pertains to the utilization of solar energy as a sustainable energy source, which exhibits considerable promise in Indonesia. The average daily solar radiation intensity in Indonesia is estimated to be approximately 4.8 kWh/m2. Nevertheless, the practical implementation of the Solar Power Plant (PLTS) presents several problems, including the need to improve the output power efficiency of the solar panels. This aspect offers the potential for significant enhancement. This study aimed to evaluate the performance of solar modules when equipped with reflectors, through a comparative analysis. In order to enhance the output power of the solar module, it is vital to augment the solar radiation received by this module. Based on the data acquired, it can be observed that the utilization of reflectors within the time frame of 11.00-12.00 WIT yields the maximum efficiency value.*

Keywords: *Solar Panel, Outgoing Power, Reflector*

Abstrak. Kajian ini berkaitan dengan pemanfaatan energi surya sebagai sumber energi berkelanjutan, yang cukup menjanjikan di Indonesia. Rata-rata intensitas radiasi matahari harian di Indonesia diperkirakan sekitar 4,8 kWh/m2. Meski demikian, dalam praktik penerapan Pembangkit Listrik Tenaga Surya (PLTS) terdapat beberapa kendala, antara lain perlunya peningkatan efisiensi daya keluaran panel surya. Aspek ini menawarkan potensi peningkatan yang signifikan. Penelitian ini bertujuan untuk mengevaluasi kinerja modul surya bila dilengkapi dengan reflektor, melalui analisis komparatif. Untuk meningkatkan daya keluaran modul surya, sangat penting untuk meningkatkan radiasi matahari yang diterima modul ini. Berdasarkan data yang diperoleh terlihat bahwa pemanfaatan reflektor pada rentang waktu 11.00-12.00 WIT menghasilkan nilai efisiensi yang paling maksimal.

Kata Kunci : Panel Surya, Daya Keluar, Reflektor

INTRODUCTION

Technological developments are increasingly rapid due to increasing needs. Technology can be a solution to solve human problems due to human limitations and other factors (Ishan, 2013; Febtiwiyanti & Sidopekso, 2016). A problem that often arises in the household environment is wasteful electricity use (Karim & Sunardi, 2006; Analisa, 2012).

Almost all household electronic equipment users must learn how much electricity and costs are used when using the equipment (Lestari, 2018; Amalia et al., 2022). Because the more electricity you use, the more expenses you have to bear (Muchammad & Yohana, 2010; Subuat et al., 2015). Technology makes everything easier (Pratama, 2019; Nadhiroh et al., 2022). Humans always try to create something to make their activities easier (Ristiyani & Yulianti,

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2014; Ootrum et al., 2021). This has encouraged the development of technology, which has produced many tools to facilitate human activities.

Solar cells are a renewable electricity generator with great potential for future use (Sandy, 2017; Wibowo, 2022). So far, the output voltage from solar cells has been low. Therefore, a solution is needed to optimize solar cells' output voltage. The use of flat mirrors as reflectors is expected to be a solution for optimizing the output voltage from solar cells in geographical conditions in Indonesia, which receive sunlight every year. One of the optimal tools in Indonesia is the "Solar Panel" (R. A. Nugroho et al., 2014; Sandy, 2017). Solar panels work to convert sunlight energy into electrical energy (Sanni & Ishak, 2017; Wibowo, 2022).

Solar panels are solar cells and batteries that convert light into electrical energy (Prastica, 2016; Solly et al., 2019). Solar panels produce direct current or DC electricity, which can be used for DC to AC electricity. The energy produced by the sun is unlimited compared to fossil energy sources, which are increasingly depleting, so efforts are needed to optimize the electrical power output of solar panels so that their efficiency increases (Febtiwiyanti & Sidopekso, 2010). Efforts to increase the efficiency of solar panel electrical power output using a reflector system were carried out in the North Sulawesi area, specifically in Minahasa Regency, South Tondano District, Tataaran Patar II Village. One possible solution is to increase the amount of light that hits the surface of the solar panel with the help of a reflector.

METHOD

This research was conducted at Tataaran Dua Location, South Tondano District, Minahasa Regency, North Sulawesi. The research was conducted for two days when the weather conditions were relatively sunny and cloudy—from 09.00 to 16.00. With a measurement interval of 1 hour. The time for conducting research and testing activities will be from 31-1 June-July 2023 until completion.

The first stage carried out was to find out the problem in this research, namely by looking at the surrounding conditions to determine the problem formulation, literature study by searching and reading journals, books, and other sources from the internet and previous research that used methods and literature reviews related to the problem. Study Next, a survey is carried out to find strategic places for analysis and prepare the tools and materials used.

Solar panels, multimeter, reflector (mirror), stationery, camera (cellphone). Field activities include measuring voltage and current strength using a multimeter and thermocouple to measure the temperature around the panel. Next, the resulting data is processed using the Electric Power Formula—the general formula used to calculate Electric Power in an Electric

Circuit. Then, calculations are carried out to determine the difference between using a reflector and not a reflector. The final stage is concluding the research results based on the problem formulation and objectives.

This research was carried out with the following steps:

a. The assembly of the research object is installing solar panels on solar panel stands or supports.
b. Add a flat mirror Reflector next to the solar panel.
c. Prepare the testing equipment, namely, a digital multimeter and thermocouple.
d. Connect a digital multimeter with a solar panel with a flat mirror reflector.
e. Testing was carried out from 09.00 – 16.00 WITA for two days.

RESULT AND DISCUSSION

Table 1 Data from current and voltage measurements on flat solar panels without using reflectors (flat mirrors) First day:

Time Measurement	Volt (Volt)	Strong Current (A)	Output power (Watt)	Temperature (°C)
09.00	4,92	0,61	3,00	63
10.00	5,15	0,65	3,34	53
11.00	5,33	0,66	3,51	67
12.00	5.47	0,69	3,77	55
13.00	5,45	0,69	3,76	51
14.00	5,37	0,68	3,65	51
15.00	4,75	0,67	3,18	38
16.00	4,22	0,56	3,36	34

Table 2. Data from measurements of current strength and voltage on flat solar panels without using reflectors (flat mirrors) Day two:

Time Measurement	Volt (Volt)	Strong Current (A)	Output power (Watt)	Temperature (°C)
09.00	5,48	0,92	5,04	63
10.00	5,52	0,75	4,14	53
11.00	5,58	0,97	5,41	67
12.00	5.65	0,95	5,94	55
13.00	5,60	0,93	5,20	51
14.00	5,58	0,93	5,18	51
15.00	5,40	0,93	5,02	38
16.00	5,25	0,93	4,88	34

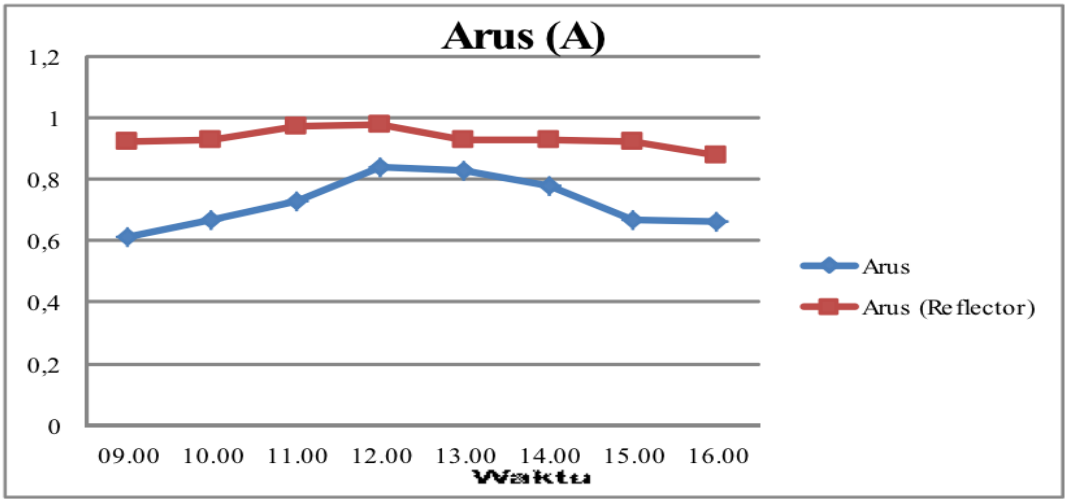

Figure 1. Current graph comparing current using a reflector and without a reflector

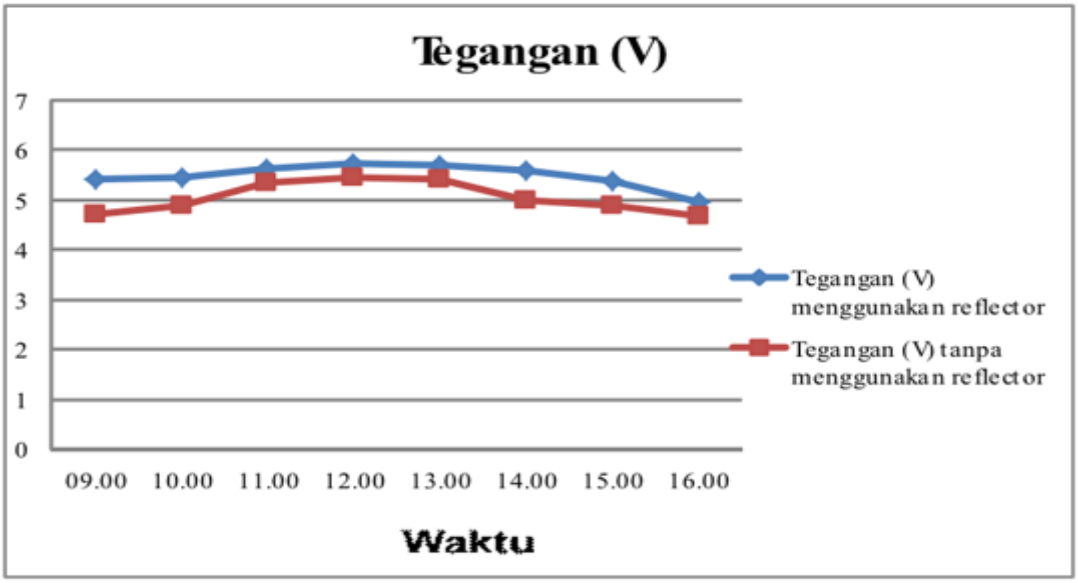

Figure 2. Voltage Comparison Voltage Graph Using a Reflector and Without a Reflector

After looking for the Voltage, Current, and Power Output from the Solar Panel. The results of the average values of Voltage, Current, and Power using and without using a Reflector are as follows:

1. Average Value of Voltage from Solar Panels without Reflectors:

   Average Value of $Vpanel = \frac{Vtotal}{n} = \frac{40.96}{8} = 5.12\ V$

2. Average Value of Voltage from Solar Panels Using Reflectors:

   Average Value $Vpanel = \frac{Vtotal}{n} = \frac{44.96}{8} = 5.50\ V$

3. Average Current Value of Solar Panels without Reflectors:

   Average Value $Itotal = \frac{Itotal}{n} = \frac{4.52}{8} = 0.56\ A$

4. Average Current Value of Solar Panels Using Reflectors:

   Average Value $Itotal = \frac{Itotal}{n} = \frac{6.38}{8} = 0.79\ A$

Table 3. Data from measurements of current strength and voltage on flat solar panels without using a reflector (flat mirror) on the second day.

Time Measurement	Volt (Volt)	Strong Current (A)	Output power (Watt)	Temperature (ºC)
09.00	4,77	0,61	2,90	36
10.00	4,89	0,67	3,27	58
11.00	5,35	0,67	3,58	67
12.00	5,45	0,68	3,70	55
13.00	5,41	0,67	3,62	51
14.00	4,98	0,67	3,33	51
15.00	4,89	0,67	3,27	48
16.00	4,67	0,66	3,08	45

Table 4. Data from measurements of current strength and voltage on flat solar panels without using a reflector (flat mirror) on the second day.

Time Measurement	Volt (Volt)	Strong Current (A)	Output power (Watt)	Temperature (ºC)
09.00	5,43	0,62	3,36	36
10.00	5,45	0,91	4,95	58
11.00	5,64	0,97	5,47	67
12.00	5.72	0,95	5,43	55
13.00	5,68	0,94	5,33	51
14.00	5,59	0,93	5,19	51
15.00	5,39	0,93	5,01	48
16.00	4,95	0,93	4,60	45

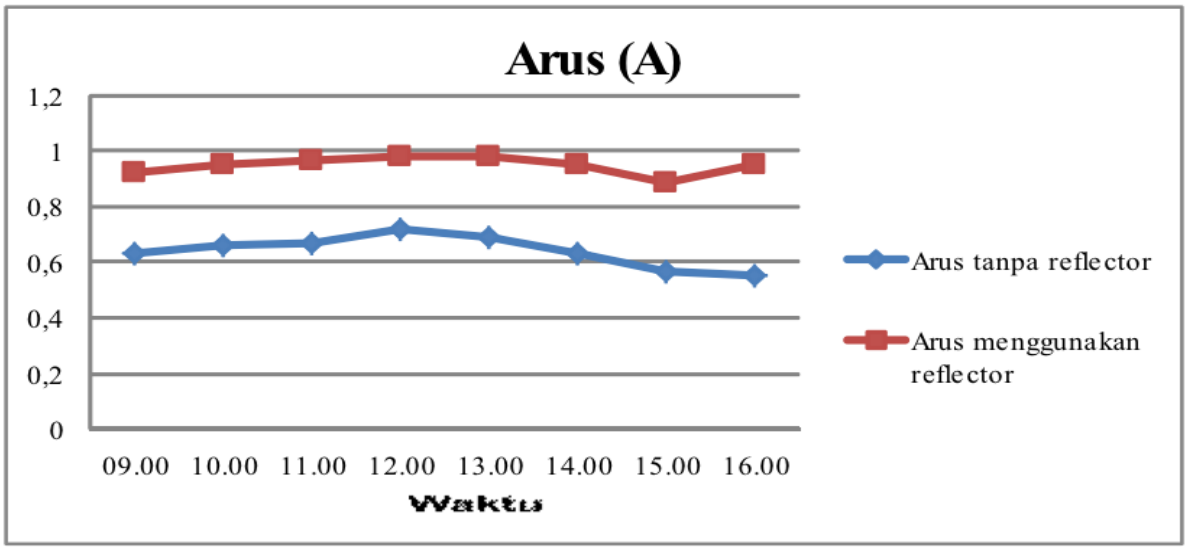

Figure 3. Output current graph comparison of current using and without a reflector

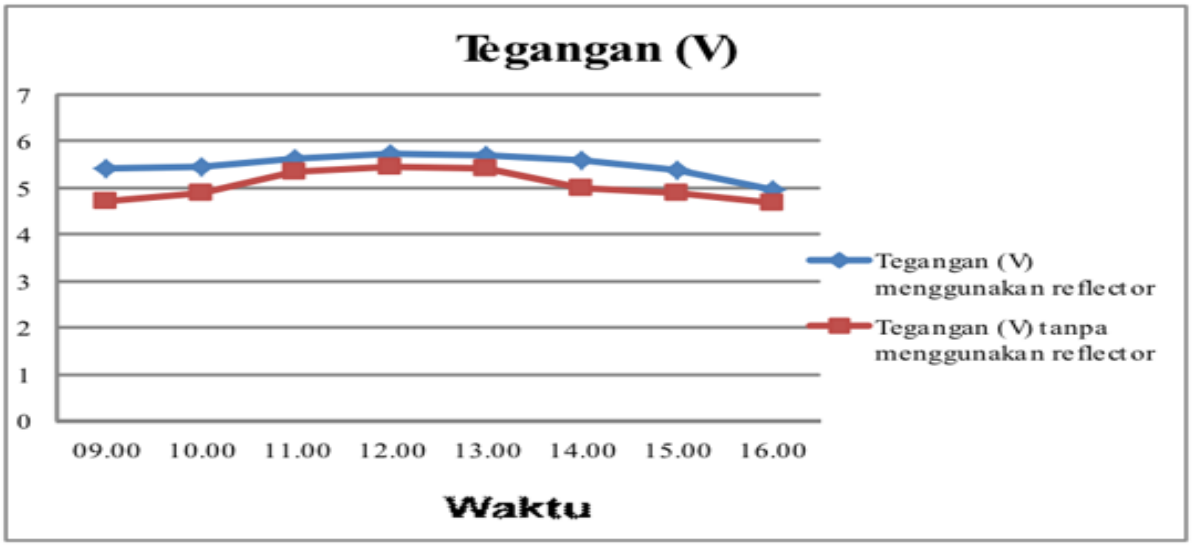

Figure 4. Comparative Output Voltage Graph of Voltage Using a Reflector and Without a Reflector

The average values of voltage and current on solar panels using reflectors and without reflectors are as follows:

1. Average Value of Voltage from Solar Panels without Reflectors:

   Average Value $Vtotal = \frac{Vtotal}{n} = \frac{40.6}{8} = 5.07\ A$

2. Average Value of Voltage from Solar Panels Using Reflectors:

   Average Value $Vpanel = \frac{Vtotal}{n} = \frac{43.89}{8} = 5.48\ A$

3. Average value of current from solar panels without reflectors:

   Average Value $Ipanel = \frac{Itotal}{n} = \frac{5.3}{8} = 0.66\ A$

4. Average value of current from solar panels using reflectors:

   Average Value $Ipanel = \frac{Itotal}{n} = \frac{7.18}{8} = 0.89\ A$

Table 5. Final average result data comparing Solar Panel Power without reflectors and using reflectors

Results of Average Output Voltage, Current and Power								
Time			Without Reflector			Using Reflectors		
First day	Time Testing	Average Temperature	(Volt)	(Ampere)	(Watt)	(Volt)	(Ampere)	(Watt)
1 Hari	8 jam	51,5º	5,12	0.56	2,8	5,50	0.79	4,3
Hasil Rata-rata Output Tegangan, Arus dan Daya								
Time			Without Reflector			Using Reflectors		
Second day	Time Testing	Average Temperature	(Volt)	(Ampere)	(Watt)	(Volt)	(Ampere)	(Watt)
1 Hari	8 jam	53,8º	5,07	0,66	3,3	5,48	0,89	4,8

The table shows the final results of the average output voltage, current, and power from solar panels without using reflectors and using very clear reflectors. Table 5 shows the comparison between solar panels using reflectors and those without use. The best comparison is solar panels using reflectors because the value of The absorption is greater compared to solar panels without reflectors. The increase in temperature causes the open circuit voltage (Voc) to decrease, but the short circuit current (Isc) increases. The increase in temperature is the result of an increase in irradiance, where every time the irradiance increases, other variables such as temperature, current, and voltage also increase so that automatically, if the irradiance increases, then the output power also increases. (Muchammad & Yohana, 2010) In general, the more radiation is converted into power, the more efficiency will increase. Because increasing temperature is followed by increasing output power, increasing temperature will also increase efficiency. The highest efficiency was achieved in tests using reflectors at 11:00-12:00 WIT.

CONCLUSION

Based on the discussion of the results of this research, several things can be concluded as follows: (1) The average output power produced by solar panels without using reflectors during the 2 days of testing is 6.1 Watts and the average output power of solar panels using reflectors namely 9.1 Watts. Meanwhile, the average output power produced by PLTS; (2) From this research, knowing the voltage and current is by measuring using a multimeter, while

knowing the power is by using the formula calculation of voltage times current; (3) The comparison of the output power produced in this research can be seen very clearly in the data presented in each measurement. Where the addition of reflectors greatly influences the output value produced.Suggestions for further research are to research different reflectors, apart from flat mirror reflectors, to find out which ones are more efficient compared to using flat mirrors. After seeing how a solar power plant works which is environmentally friendly and also a renewable energy source, we as Indonesian citizens should start to care and also participate in using and developing this solar panel technology. If this technology is successful and develops rapidly, you can imagine how much pollution will be reduced. And it can also reduce Global Warming and the impacts it causes

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