

Potential Usage of Solar Energy as a Renewable Energy Source in Petukangan Utara, South Jakarta

Eka Purwa Laksana¹, Yani Prabowo¹, Sujono¹, Rummi Sirait¹, Nifty Fath¹, Ardyono Priyadi²,
Vita Lystianingrum², Mauridhi Hery Purnomo²

¹Program Studi Teknik Elektro, Fakultas Teknik, Universitas Budi Luhur
Jl. Ciledug Raya, RT.10/RW.2, Petukangan Utara, Kec. Pesanggrahan, Jakarta Selatan, Jakarta 12260

²Departemen Teknik Elektro, Institut Teknologi Sepuluh Nopember
Kampus Institut Teknologi Sepuluh Nopember, Keputih, Kec. Sukolilo, Surabaya 60111
e-mail: eka.purwalaksana@budiluhur.ac.id

Abstract—Indonesia is a tropical country located on the equator. The average intensity of solar radiation in Indonesia is 4.8 kWh/m². This makes Indonesia a country with new and renewable energy potential, one of which is solar panel technology. The first step that must be done in the process of installing solar panels in a place is to analyze the potential of solar energy. In this study, an analysis of the potential of solar energy as a new renewable energy source has been carried out at Budi Luhur University, North Petukangan, South Jakarta. Based on the research results, the maximum photovoltaic efficiency that can be achieved is 21.45%. During the day, the efficiency of the solar panels increases along with the increase in the value of the voltage obtained. However, the higher the panel temperature, the lower the efficiency of the solar panel. Therefore, a cooling system is needed to anticipate this.

Keywords: *solar panels, renewable energy, solar energy potential, solar panel efficiency*

Abstrak—Indonesia merupakan negara tropis yang terletak di garis khatulistiwa. Intensitas radiasi matahari rata-rata Indonesia adalah 4,8 kWh/m². Hal ini menjadikan Indonesia sebagai negara dengan potensi energi baru dan terbarukan, salah satunya adalah teknologi panel surya. Tahap pertama yang harus dilakukan dalam proses instalasi panel surya di suatu tempat adalah dengan menganalisis potensi energi solar. Pada penelitian ini, telah dilakukan analisis potensi energi solar sebagai sumber energi baru terbarukan di Universitas Budi Luhur, Petukangan Utara, Jakarta Selatan. Berdasarkan hasil penelitian, efisiensi photovoltaic maksimal yang dapat dicapai adalah 21,45%. Pada siang hari, nilai efisiensi panel surya meningkat seiring dengan meningkatnya nilai tegangan yang diperoleh. Namun jika temperatur panel semakin tinggi maka akan menurunkan nilai efisiensi panel surya. Oleh karena itu, diperlukan sistem pendingin untuk mengantisipasi hal tersebut.

Kata kunci: *solar panel, energi baru terbarukan, potensi energi surya, efisiensi solar panel*

I. INTRODUCTION

Indonesia is a country located in the equatorial region and has a tropical climate has abundant solar thermal energy that is always illuminated by the Sun throughout the year. It becomes a source of energy that has the potential to be developed. One example of the use of solar energy to produce electrical energy that is often referred to and better known by the public is the solar cell. Solar cells in producing energy are still in amounts that are not too large. Meanwhile, the continued use of fossil energy to produce coal will cause an increase in environmental problems, namely the increasing amount of pollution and greenhouse gas emissions that lead to global warming [1]. Therefore, solar energy can help reduce greenhouse gas emissions because solar energy is renewable and does not cause carbon dioxide emissions. With the depletion of fossil energy sources, in the world today there is a shift from the use of non-renewable energy sources to renewable energy sources.

Several studies show that the cost of solar power generation in the future will be even cheaper, so this gives hope for the use of solar energy on a broader scale, especially in Indonesia. Therefore, this research was conducted to examine the potential use of solar energy as an alternative energy source.

Photovoltaic (PV) technology, also known as solar panels, is able to convert solar energy into electrical energy. The intensity of solar radiation on average in all regions of Indonesia is very large at 4.8 kWh/m². When solar panels operate, only about 15% of solar radiation is converted into electrical energy, while the rest is converted to heat [2]. The obstacle faced in the application of solar power plant in Indonesia is the high investment costs, the main PLTS devices, namely photovoltaic modules are still imported from other countries and the efficiency of photovoltaic modules is only 16% which causes the price of solar power plants per kW is still very high.

The research on the potential and utilization of photovoltaics as a renewable energy source has started

since 1979 as R & D activity. Prospects for developing solar energy for electricity needs in Indonesia [3], based on data of solar radiation, which is collected from 18 location in Indonesia, the distribution of solar radiation in Indonesia can be classified as follow: in the western of Indonesia is about 4,5 kWh/m²/day with monthly variation around 10%, and in the Eastern of Indonesia is about 5,1 kWh/m²/day with monthly variation around 9%. Thus, the average of potential wind in Indonesia is about 4,8 kWh/m²/day with monthly variation around 9%.

To predict hourly solar radiation in Faculty of Engineering, Universitas Indonesia, Depok, West Java, Indonesia (106.7942 longitude, -6.4025 latitude) as studied site [4]. Analyzing of solar radiation intensity start with calculate the solar radiation intensity based on several empirical models, then compare the prediction data with the measurement data from BMKG and evaluate the statically data use Mean Bias Error and Root Mean Square Error.

The potential of solar energy in Indonesia has also been investigated by taking a location in Medan with the title Solar Energy Potential in Indonesia [5]. The study was conducted for 1 year and found that solar irradiation throughout the year was stable in December with a minimum of 126.9 kWh/m² and a maximum in March of 170.2 kWh/m². This research shows several advantages for solar PV in Indonesia. Because the location is close to the equator, solar modules can be installed in the horizontal plane without losing energy production capacity. Solar tracking systems can be installed to increase energy yields; However, the increase is only about 2% even for both axis tracking systems.

The research of the potential for renewable energy in eastern Indonesia has been investigated. This research was conducted based on RETScreen analysis [6]. This study aims to obtain the feasibility of the generator based on energy, environmental and economic models using RETScreen International software and electricity policy evaluation. The potential of solar energy in Maluku is 5.43 kWh/m²/day, in Papua is 4.97 kWh/m²/day and West Sulawesi is 5.66 kWh/m²/day and the potential wind energy is an average of 6.9 m/s needs to be developed to increase the electrification ratio. This study concluded that PLTS and PLTB in the provinces of Maluku, Papua and West Sulawesi are feasible and profitable.

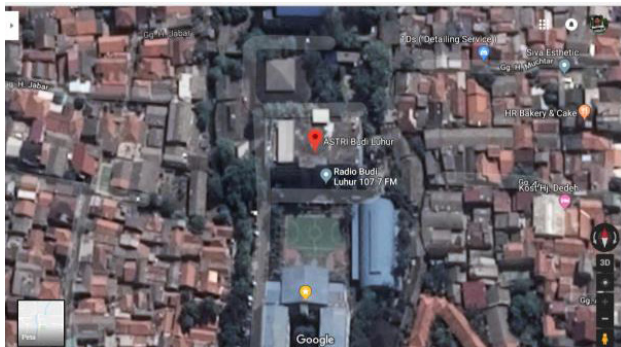


Fig. 1. Location of observation

The potential and role of PLTS as a future alternative energy in Indonesia is examined, the application of PLTS technology in the future is as a substitute or substitute for the use of fuel in PLTD, as well as to increase the electricity ratio [7]. Considering the excellent prospects, it is necessary to formulate legislative policies to support the development of solar power plants both for independent and integrated or grid connected solar power plants so that solar power plants have a greater role in the electricity system in Indonesia in the future.

The case study of the research was carried out at the Universitas Budi Luhur campus in the North Petukangan area, South Jakarta. As an object of study in this paper, a solar power generation system is designed using a PV panel placed on the roof top of the 5th floor of one of the buildings on the Universitas Budi Luhur campus in Jakarta with coordinates - 6.234027°LU, 106.747365°BT. The PV panel is placed in a position with a slope of 30-degree facing the sun.

II. OBSERVATION METHODS

This research is field research conducted on a rooftop with a height of 20 meters above ground level in Unit 7 Building, 5th Floor, Universitas Budi Luhur with coordinates -6.234027°LU, 106.747365°BT. The location of the PV panel placement is shown in Fig.1. This research was formed in order to determine the potential use of solar power plants to be able to supply electricity in Petukangan Utara, Ciledug, especially at Universitas Budi Luhur.

The research component used in this study is a solar panel with solar panel characteristics as shown in Table 1. The study was conducted over four days, August 17th-20th 2018. PV panels were placed with a 30-degree tilt facing the sun. There are 8 DS-18B20 temperature sensors (Fig. 2) mounted on the top surface of the solar panel, as shown in Fig. 3. The measurement results are recorded by the data-logger at every 15 seconds, starting from 6 a.m. to 6 p.m. The data-logger is placed behind the solar panel, as shown in Fig. 4. The panel temperature, voltage, and current of the solar panel were all recorded accordingly. The power of the solar panel and its efficiency can be calculated by,

$$Efficiency = \frac{Power\ of\ solar\ panel \times 100\%}{Area\ of\ solar\ panel \times 100\ W / m^2} \quad (1)$$

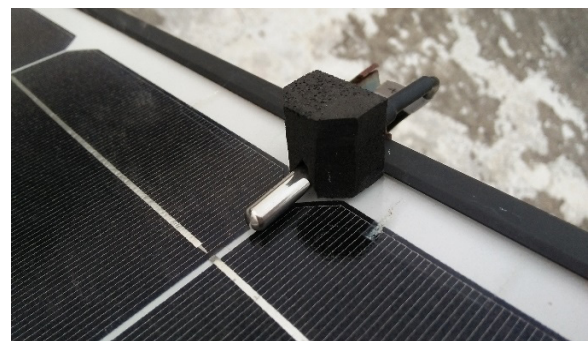


Fig. 2. Temperature sensor

III. RESULTS

A. Temperature Observation

Fig. 5 until Fig. 8 are the results of temperature measurement over time. Based on these data, it appears that the peak temperature occurs at around 11:00 to 13:00. On the first day measurement, the highest temperature

Table 1. Photovoltaic panel specifications

Parameter	Value
Rate Maximum Power (Pm)	200 Watt
Open-Circuit Voltage (Voc)	44.9 V
Short-Circuit Current (Isc)	5.49 A
Voltage at Pmax (Vmp)	36.6 V
Current at Pmax (Imp)	5.19 A
Maximum system Voltage	1000 VDC
Dimension	1580 x 808 x 35 mm
Normal Operating Cell Temp.	470C ± 20oC



Fig. 3. Data logger instruments



Fig. 4. Photovoltaic panel with temperature sensors

reached 49.94°C, the second day measurement reached 48.7°C, the third day reached 53.93°C, and the fourth day reached 47.82°C.

B. DC Current Observation

Based on the results of measurements, it appears that an increase in temperature will generate electron-hole pairs in each photovoltaic module. This causes the movement of electrons in the p-n junction will be greater so that it can increase the current value of the module. In other words,

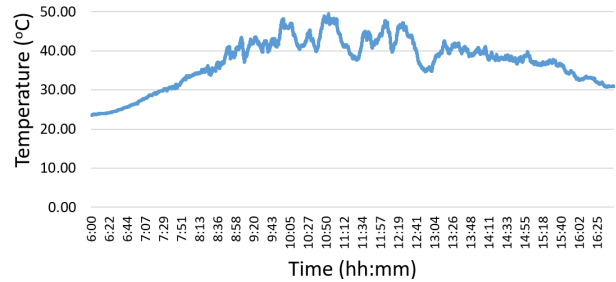


Fig. 5. First day of observation (17/08/2018)

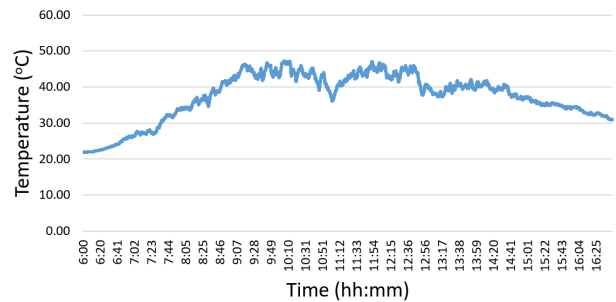


Fig. 6. Second day of observation (18/08/2018)

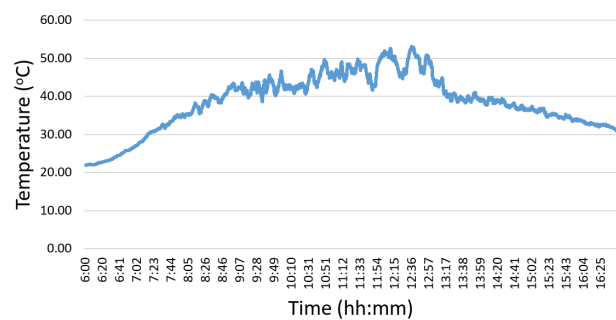


Fig. 7. Third day of observation (19/08/2018)

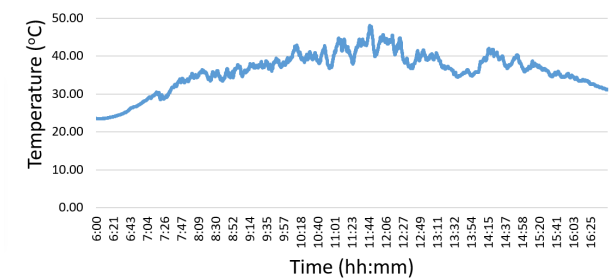


Fig. 8. Fourth day of observation (20/08/2018)

an increase in temperature will increase the current and conversely a decrease in threshold temperature at the 30 °C will decrease the current value, as shown in Fig. 9 until Fig. 12.

C. Effects of temperature, voltage, and current on solar panel efficiency

Based on the measurement table for voltage, current and temperature (Table 2), it can be seen that the maximum efficiency that can be achieved is 21.45%. In the morning, the efficiency of solar panels is very low because there

is no maximum sun exposure. By noon, the value of the efficiency of solar panels increases with increasing voltage values obtained. However, if the panel temperature gets higher, it will reduce the value of the efficiency of the solar panel. Therefore, a cooling system is needed in order to anticipate this.

If looked at the comparison between time, temperature and efficiency, as in Fig. 13 it can be seen that the maximum efficiency occurs at 09.30 a.m. with an average temperature of 41.96 °C. The higher the temperature value can affect the efficiency of the solar panel. The effective temperature that can produce maximum efficiency is around 40°C.

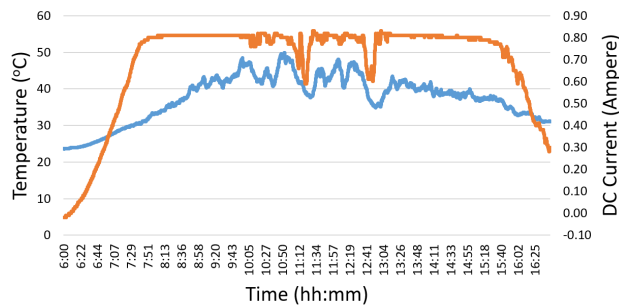


Fig. 9. DC Current Observations (first day of observation 17/08/2018)

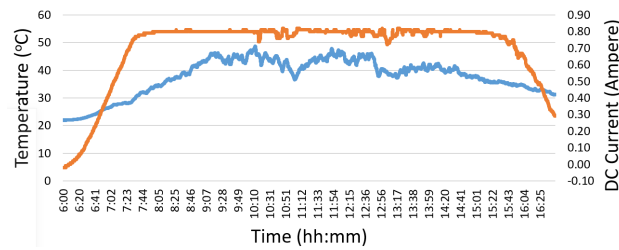


Fig. 10. DC Current Observations (second day of observation 18/08/2018)

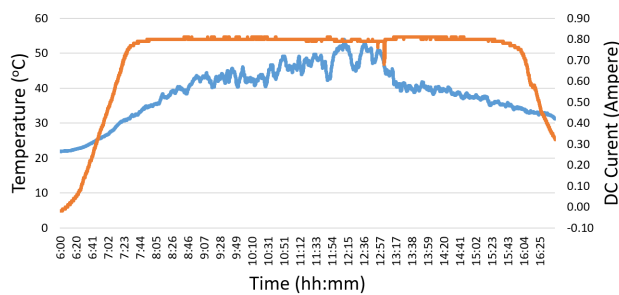


Fig. 11. DC Current Observations (third day of observation 19/08/2018)

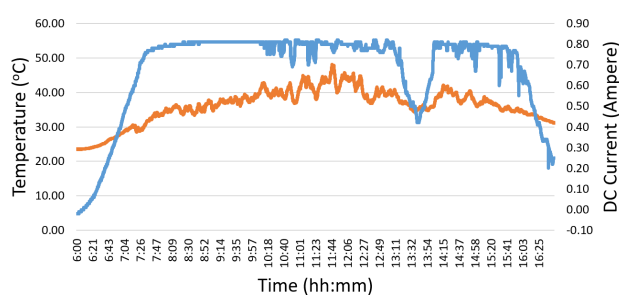


Fig. 12. DC Current Observations (fourth day of observation 20/08/2018)

Table 2. Measured instrument

Time of the day	Temperature (°C)	Voltage (V)	Current (A)	Power (W)	Efficiency (%)
06.00	0.35	0.03	0.02	0.00	0.00
06.30	3.72	0.25	1.17	0.29	0.23
07.00	21.21	0.56	12.67	7.10	5.56
07.30	38.88	0.78	30.23	23.58	18.47
08.00	41.4	0.8	33.17	26.54	20.79
08.30	41.88	0.81	33.72	27.31	21.39
09.00	41.87	0.81	33.72	27.31	21.39
09.30	41.96	0.81	33.8	27.38	21.45
10.00	41.34	0.8	33.09	26.47	20.74
10.30	40.7	0.79	32.3	25.52	19.99
11.00	39.46	0.78	30.94	24.13	18.90
11.30	41.69	0.8	33.44	26.75	20.96
12.00	41.3	0.8	32.93	26.34	20.64
12.30	39.07	0.77	30.37	23.38	18.32
13.00	39.24	0.77	30.72	23.65	18.53
13.30	35.83	0.73	27.65	20.18	15.81
14.00	41.5	0.8	33.19	26.55	20.80
14.30	41.15	0.8	32.74	26.19	20.52
15.00	40.78	0.79	32.33	25.54	20.01
15.30	36.64	0.75	27.52	20.64	16.17
16.00	20.87	0.55	12.18	6.70	5.25
16.30	5.1	0.3	1.71	0.51	0.40
17.00	0.97	0.1	0.12	0.01	0.01

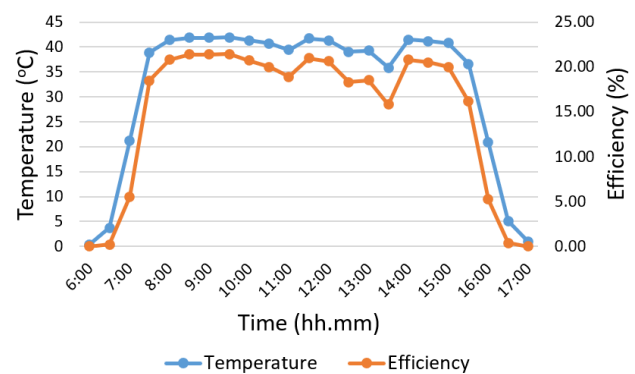


Fig. 13. Efficiency and temperature

IV. CONCLUSION

The maximum efficiency that can be achieved is 21.45%, the efficiency of solar panels is very low in the morning because there is no maximum sun exposure. By noon, the value of the efficiency of solar panels increases with increasing voltage values obtained. However, if the panel temperature gets higher, it will reduce the value of the efficiency of the solar panel. Therefore, a cooling system is needed to anticipate this. Based on the comparison between time, temperature and efficiency, the maximum efficiency occurs at 09.30 am with an average temperature of 41.96 °C.

REFERENCES

- [1] N.A. Handayani and D. Ariyanti, "Potency of Solar Energy Application in Indonesia", *Int. Journal of Renewable Energy Development (IJRED)*, 1(2): 33-38.
- [2] H. G. Teo, P. S. Lee, and M. N. A. Hawlader, "An active cooling system for photovoltaic modules," *Appl. Energy*, vol. 90, no. 1, pp. 309–315, 2012
- [3] R. Y. Valdi, "Prospek pengembangan energi surya untuk kebutuhan listrik di Indonesia", *Jurnal Ilmu Fisika (JIF)*, vol 4, no.1, pp. 14-19, 2012
- [4] Nasruddin et al., "Hourly solar radiation in Depok, West Java, Indonesia (106.7942 Longitude, -6.4025 Latitude)", 2nd International Tropical Renewable Energy Conference (i-TREC), 2017, pp.1-7.
- [5] M. Dang, "Solar Energy Potential in Indonesia", The International Conference of Young Scientists (58th ICYS), 2017, pp. 1-5.
- [6] I. Amin et al., "The Study of renewable Energy Potential in Eastern of Indonesia Based on RETScreen International Analysis", Electrical Engineering, Universitas Hasanuddin.
- [7] A. O. Njok and J. C. Ogbulezie, "The Effect of Relative Humidity and Temperature on Polycrystalline Solar Panels Installed Closed to a River", *Physical Science International Journal*, vol. 20. no 4, pp. 1-11, 2018.
- [8] A. M. Fathoni, N. A. Utama, and M. A. Kristianto, "A Technical and Economic Potential of Solar Energy Application with Feed-in Tariff Policy in Indonesia", 4th International Conference on Sustainable Future for Human Security, Procedia Environmental Science 20, 2014, pp. 89-96G.