Bulletin of Electrical Engineering and Informatics
Vol. 15, No. 6, December 2026, pp. 5617~5625
ISSN: 2302-9285, DOI: 10.11591/eei.v15i6.11291

The effect of dirt and shading on the output power of solar panels at the 50 kWp on-grid rooftop solar power plant

Ojak Abdul Rozak[1,2], Mohd Zamri Ibrahim[2,3], Muhamad Zalani Daud[2,3], Syaiful Bakhri[1,4], Muhammad Fadjrirullah[1]

[1]Department of Electrical Engineering, Faculty of Engineering, Universitas Pamulang, Banten, Indonesia
[2]Renewable Energy and Power Research Interest Group (REPRIG), Faculty of Ocean Engineering Technology, Universiti Malaysia Terengganu, Kuala Nerus, Malaysia
[3]Centre For Offshore Renewable Energy, Universiti Malaysia Terengganu, Kuala Nerus, Malaysia
[4]Research Centre for Nuclear Fuel Cycle and Radioactive Waste Technology, Banten, Indonesia

Article Info

Article history:

Received Aug 29, 2025
Revised Sep 21, 2026
Accepted Oct 4, 2026

Keywords:

Dirt
Environmental factors
Output power
Shading
Solar panel

ABSTRACT

The development of solar power plants has penetrated various sectors, both industry and education. Universitas Pamulang has begun using photovoltaic (PV) technology with an installed capacity of 50 kWp in on-grid solar power plants. However, this technology is greatly influenced by environmental factors, not limited to radiation, temperature, tilt angle, wind speed, and direction; the effects of dirt and shading are also important factors that can affect its output power. With this fairly expensive investment, it must be balanced with efforts to maximize energy production, so that there are no losses or damage, especially due to dirt. With these conditions, a comprehensive analysis of the impact of dirt and shade on PV is needed to optimize its output power. This study applied a comparison method between dirty, clean, and shaded PV to analyze their output power. The results showed a decrease in PV output power due to dirt by 4.52% and shading by 3.28% compared to the output power of the cleaned PV, so it can be concluded that dirt and shading have a strong influence on the decrease in output power, and maintenance and cleaning are essential for optimal PV performance.

This is an open access article under the CC BY-SA license.

Corresponding Author:

Ojak Abdul Rozak
Department of Electrical Engineering, Faculty of Engineering, Universitas Pamulang
St. Raya Puspitek, Buaran, Pamulang, South Tangerang City, Banten 15310, Indonesia
Email: dosen01314@unpam.ac.id

1. INTRODUCTION

The construction of a solar power generation system (PLTS) has certainly been well planned, the limited area conditions can affect the planning results [1], [2]. Likewise with the construction of PLTS at Universitas Pamulang (Unpam), because the land conditions are limited but have quite good potential in utilizing solar energy to be converted into electrical energy using photovoltaic (PV) technology [3], [4]. This PV technology is greatly influenced by several environmental factors [5]–[7], such as the intensity of solar radiation, wind direction and speed, environmental temperature, and PV temperature [8]–[11]. Likewise, the tilt angle and shading of the PLTS system on the rooftop can reduce PV output power [12]–[14]. Over time, the operation of the PLTS system is also greatly influenced by the condition of dirt that sticks to the PV surface because open natural factors can hinder the preparation of solar energy by PV, so that the energy generated decreases [15], [16].

Based on the results of the planning of the 50 kWp on-grid PLTS that has been implemented on the rooftop of Unpam Viktor, it is necessary to conduct an analysis of the influence of environmental factors,

especially dirt that sticks to the PV surface and particularly the shading that is exposed to part of the PV surface [17], [18]. The condition of the dirt and shading needs to be analyzed for its influence on the system's output power to ensure that the PLTS system that is built is optimal in generating electrical energy [19]–[21]. This study focuses on the influence of dirt and shading after commissioning, and a comprehensive analysis of both conditions has not been carried out.

In its implementation, this study applies a measurement method to the level of solar radiation (W/m²) at the location where the PLTS is installed to ensure abundant energy sources, then measures the PV temperature (°C) to ensure the effect of solar radiation levels on PV temperature using a solar survey 100-200R, because an increase in PV temperature will affect the decrease in PV output power. Based on previous research related to the PV tilt angle, it is optimally at an angle of 6° [22]. Then, the measurement of operating voltage (V) and operating current (A) using iSolarCloud as a monitoring system for the Sungrow SG40CX inverter. The results of these measurements are then used to calculate how much power can be generated by the PLTS system using the power equation.

The analysis conducted in this study includes the analysis of the effect of increasing solar radiation on increasing PV temperature, the effect of PV temperature on operating voltage and current, so that its effect on PV output power can be known. The data samples taken in this study were only 3 strings installed in parallel, namely: PV string 1 whose condition was not cleaned from natural dirt, PV string 3 whose condition was cleaned from dirt, and finally PV string 5 whose condition was exposed to the shading of a tall building next to it. From the three PV conditions, the effect of the three conditions on operating voltage and current, as well as PV output power will be compared. Technically, the study advances existing research on PV dirt and partial shading in the rooftop grid through measurements using the solar survey and iSolarCloud against sizable capacity systems under three conditions.

2. METHOD

2.1. Research materials

This study aims to determine how much influence cleanliness, dirt, and shading have on PV output power. This system uses 108 PV modules, made into 6 strings, with each string connected in series with 18 modules to obtain the operating voltage value according to the Sungrow SG40CX inverter specification data. This study only focuses on string 5, where the PV surface is exposed to shading, string 3, where the PV surface is cleaned, and string 1, where the PV surface is left uncleaned so that it is in a naturally dirty condition or due to environmental influences. The condition of the solar panels on the 50 kWp on-grid solar power plant rooftop of Universitas Pamulang Viktor is affected by shading, as seen in Figure 1. The specifications of PV data used in 50 kWp on-grid solar power plants on the rooftop of Universitas Pamulang Viktor can be seen in Table 1.

The energy generated by the 50 kWp on-grid solar power plant rooftop of Universitas Pamulang Viktor is then distributed to the Sungrow SG40CX Inverter located on the 7th floor to be converted from direct current to alternating current so that it can be directly integrated with the PLN grid. The specifications of the Sungrow SG40CX Inverter can be shown in Table 2.



Figure 1. Shading on the 50 kWp on-grid solar power plant rooftop

2.2. Data collection

This research stage starts with the preparation of measurement tools and materials; the research data collection of irradiations, temperature, voltage, and current of the solar cell; and the data processing and analysis. In detail, the stages of the research can be seen in Figure 2.

Table 1. HiKu5 Mono PERC CS3Y-485MS [23]

Electrical data | STC*		Mechanical data	
CS3Y	485 MS	Specification	Data
Nominal max. power (Pmax)	485 W	Cell type	Mono-crystalline
Operating voltage (Vmp)	44.4 V	Cell arrangement	156 [2×(13×6)]
Operating current (Imp)	10.94 A	Dimensions	2252×1048×35 mm
Open circuit voltage (Voc)	53.1 V	Weight	25.7 kg (56.7 lbs)
Short circuit current (Isc)	11.62 A	Front cover	3.2 mm tempered glass
Module efficiency	20.6%	Frame	Anodized aluminium alloy
Operating temperature	-45 ℃ ~ +85 ℃	J-box	IP68, 3 bypass diodes
Max. system voltage	1500 V or 1000 V	Cable	4 mm^2 (IEC), 12 AWG (UL)
Module fire performance	TYPE 1 or TYPE 2	Cable length	500 mm/350 mm
Series fuse rating	20 A	Connector	4 series or H4 UTX or MC4-EVO2
Application classification	Class A	Per pallet	30 pieces
Power tolerance	0 ~ + 10 W	Per container	600 pieces

Table 2. Sungrow SG40CX inverter [24]

Specification	Data
Type designation	SG40CX
Max. PV input voltage	1100 V
Min. PV input voltage/start-up	200 V/250 V
Nominal PV input voltage	585 V
MPP voltage range	200–1000 V
MPP voltage range for nominal power	550–850 V
No. of independent MPP inputs	4
Max. number of PV strings per MPPT	2
Max. PV input current	104 A 160 A
AC output power	40 kVA @ 45 ℃, 400 Vac/44 kVA @ 40 ℃, 400 Vac; 40 kVA@50 ℃, 415 Vac/44 kVA@45 ℃, 415 Vac
Max. AC output current	66.9 A
Nominal AC voltage	3/N/PE, 230/400 V
AC voltage range	312–528 V
Nominal grid frequency range	50 Hz/45–55 Hz, 60 Hz/55–65 Hz
Total harmonic distortion (THD)	<3% (at nominal power)
DC current injection	<0.5% In
Power factor at nominal/adjustable	>0.99/0.8 leading – 0.8 lagging
Feed-in phases/connection phases	3/3
Max. efficiency/european	98.6%/98.3%

Data collection was carried out for 7 days at the Unpam Viktor rooftop solar power plant. Data in the form of solar irradiation, temperature, voltage value, and current of solar panels were obtained at an interval of 1 hour, starting from 8:00 a.m. to 4:00 p.m. The data collection process uses several measurement tools, such as measuring the level of solar radiation (W/m²) and PV temperature using the solar survey 100-200R series. The physical form of the solar survey 100-200R series is shown in Figure 3. With the use of the solar survey 100/200R series as a measurement tool, the data specifications in detail can be seen in Table 3.

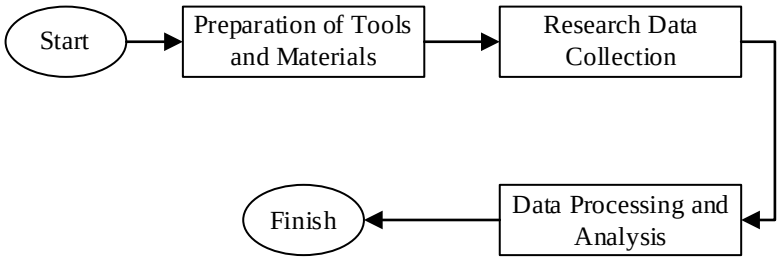


Figure 2. Stage of research



Figure 3. Solar survey 100-200R series

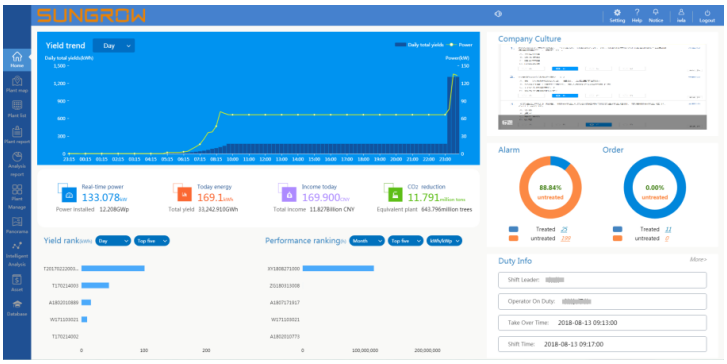
Table 3. Specification of solar survey 100/200R series [25]

Description	Specification
Display range	100–1500 W/m^2 or 30–500 BTU/hr-ft^2
Measurement range	100–1250 W/m^2 or 30–400 BTU/hr-ft^2
Resolution	1 W/m^2 or 1 BTU/hr-ft^2

While the measurement of operating PV voltage and current uses the method of logging into the iSolarCloud O&M platform, the display of the method of logging into the iSolarCloud O&M platform [26] for the Sungrow SG40CX inverter monitoring system is shown in Figure 4 where Figure 4(a) shows login view and Figure 4(b) shows monitor data view.



(a)



(b)

Figure 4. iSolarCloud O&M platform; (a) Sungrow login and (b) run information

2.3. Data collection

The results of the data collection are then processed into a graph with the aim of obtaining an analysis covering the effect of solar radiation on PV temperature, comparison of PV operating voltage, comparison of PV operating current, and comparison of PV output power. While the PV output power is obtained by using (1). Where P_o is the magnitude of the PV output power (kW), V_{mp} is the magnitude of the PV operating voltage (V), and I_{mp} is the magnitude of the PV operating current.

$$P_o = V_{mp} \times I_{mp} \quad (1)$$

2.4. Data analysis

Analyzing the effect of solar radiation (W/m²) on PV temperature (°C), then analyzing the effect of PV temperature on operating voltage (V), operating current (A), and PV output power (kW). Continued by an analysis of the effect of PV surface conditions, with the condition of PV string 1, which is not cleaned, PV string 3, which is cleaned, and PV string 5, which is exposed to shading, on operating voltage (V) and current (A), and PV output power (kW). The final analysis is by comparing the PV surface conditions of the three strings to their output power.

3. RESULTS AND DISCUSSION

3.1. Effect of solar radiation on photovoltaic temperature

During the data collection process, in sunny weather conditions, there was a decrease in the level of irradiation starting at 2:00 p.m. due to rain. The lowest solar radiation occurs at 8:00 a.m. at 217 W/m² and the PV temperature is 30 °C, while the highest solar radiation occurs at 12:00 p.m. with an impact on PV

temperature of 43 °C, but the high level of solar radiation still increased by 1 °C at 1:00 p.m. before experiencing a decrease in PV cell temperature at 2:00 p.m. to 40 °C in line with the decreasing level of solar radiation starting from 1:00 p.m. at 631 W/m² as seen in Figure 5.

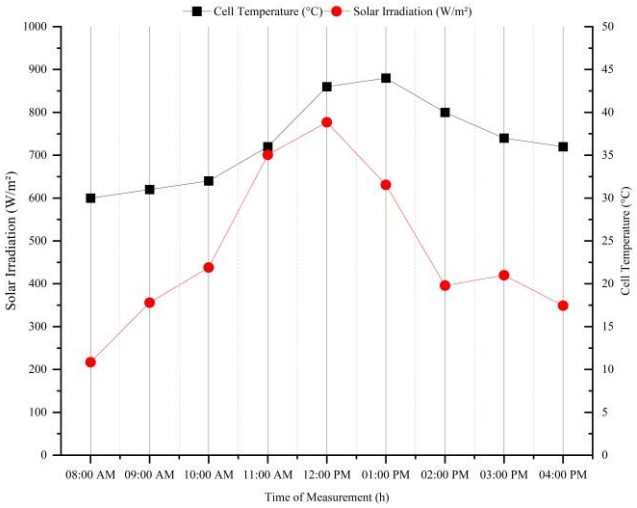


Figure 5. Effect of solar radiation on PV temperature

3.2. Comparison of photovoltaic operating voltage, current, and output power

Figure 6 compares the operating voltage, operating current, and output power of PV strings under different conditions, including uncleaned, cleaned, and shaded PV panels. Figure 6(a) shows that the increase in PV temperature affects the PV operating voltage, but in this case there is no significant difference such as at 12:00 p.m. of the three conditions, the PV that was not cleaned on string 1 had the lowest operating voltage of 722.2 V, while the PV condition that was shaded on string 5 had an operating voltage of 731.2 V, this value is the highest including compared to the condition of the PV that was cleaned on string 3 which had an operating voltage of 722.2 V.

Figure 6(b) shows that the increase in PV temperature is not strongly correlated with the decrease in operating current, in this case what needs to be seen is that there is a significant difference in the magnitude of the operating current at 12:00 p.m., especially PV string 1 with the condition that the PV is not cleaned has the lowest operating current of 5.67A even though the highest solar radiation condition is 777 W/m² and the operating current on PV string 3 which is cleaned is slightly higher compared to the operating current on PV string 5 which is exposed to shading.

Figure 6(c) shows that dirty PV conditions have a significant impact on the decrease in PV output power starting from 11:00 a.m. to 1:00 p.m., which should be the peak time for sunlight with the highest radiation level of 777 W/m². The decrease in output power due to the presence of dirt will have an impact on the amount of the Sun's irradiation that can be received by solar panels.

This is in line with previous research, where light rain can cause sticky dirt patches that degrade the efficiency of PV modules by collecting and storing dust particles from the atmosphere on the surface. Wind disperses dust and dirt onto the surface of the solar panel, affecting the efficiency of the PV, reducing its transparency, and preventing sunlight from reaching the surface of the PV. The amount of sunlight blocked by dirt and debris that accumulates on the solar panel over time, resulting in a loss of power, is referred to as dirt loss.

3.3. Comparison of photovoltaic output

Figure 7 can be explained that string 1 for PV that is not cleaned has an operating voltage of 744.14 V, an operating current of 4.80 A, and an output power of 3.55 kW. String 3 for cleaned PV obtained an operating voltage of 748.34 V, an operating current of 5.03 A, and an output power of 3.74 kW. String 5 for PV affected by shading obtained an operating voltage of 755.45 V, an operating current of 4.86 A, and an output power of 3.65 kW.

So, it can be concluded that the output power of string 3 for cleaned PV has the highest output power of 3.74 kW. Meanwhile, string 1 for PVs that are not cleaned has the lowest output power of 3.55 kW (4.52%) compared to the output power of string 5 for PVs affected by shading of 3.65 kW (3.28%), although the value is still below the output power value of string 3 for cleaned PVs.

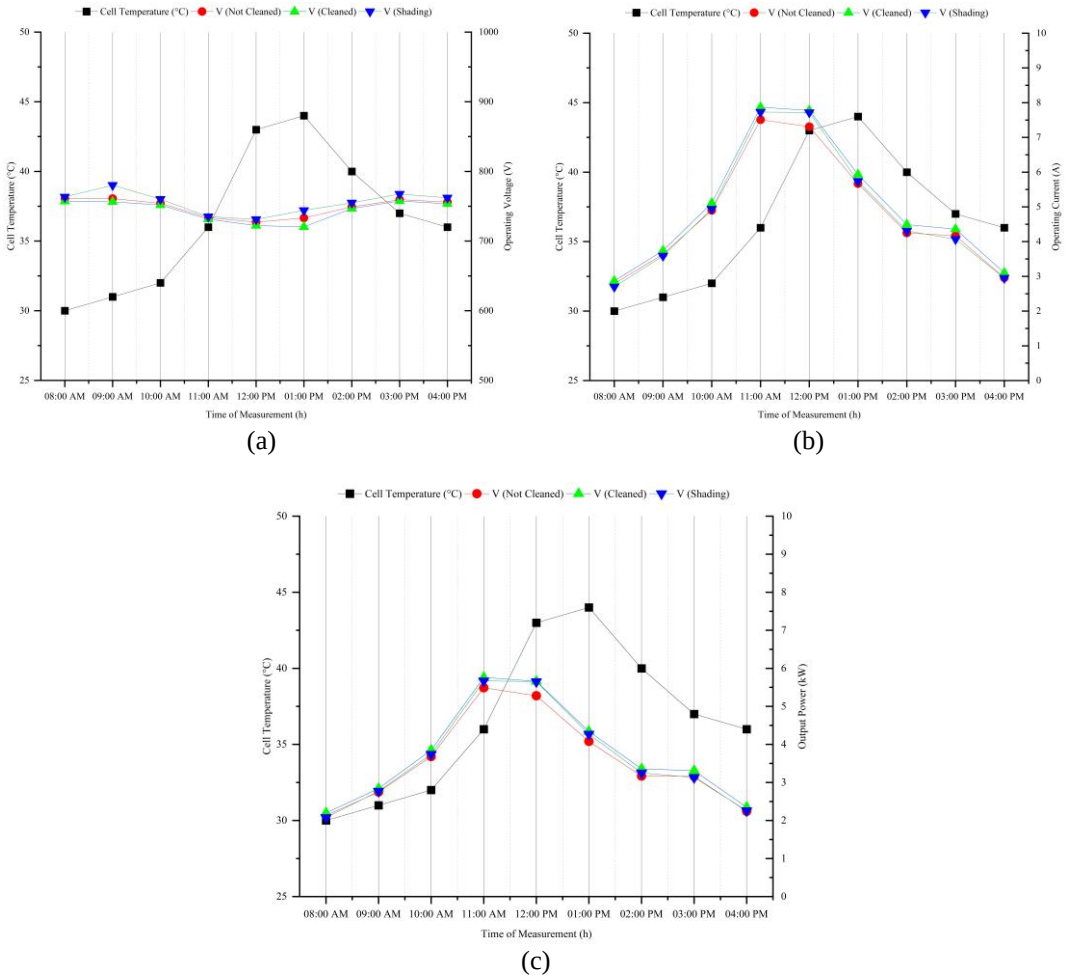


Figure 6. Comparison of PV; (a) operating voltage, (b) operating current, and (c) output power

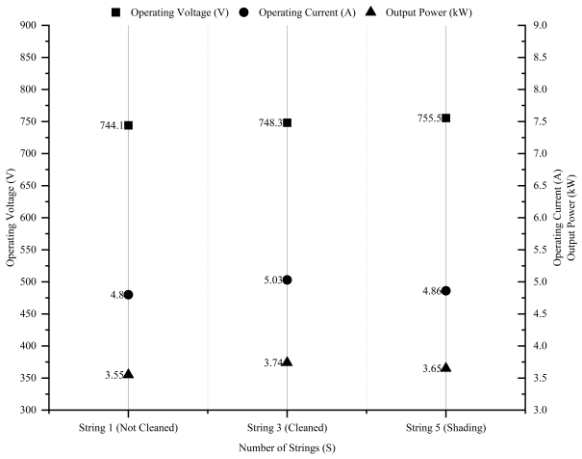


Figure 7. Comparison of PV operating voltage and current with output power

4. CONCLUSION

An increase in solar radiation of 631 W/m² had a strong impact on an increase in PV temperature by 40 °C, while a decrease in solar radiation by 217 W/m² had an impact on a decrease in PV temperature by 30 °C. Dirty PV conditions have an impact on reducing the operating voltage to 722.2 V compared to the shaded PV conditions of 731.2 V. Dirty PV string 1 surfaces have a considerable influence in reducing the

operating voltage and current compared to shaded PV string 5 conditions. Thus, it can be concluded that the effect of dirt is greater than the impact of shadow on the PV output power, so that the system as a whole is in optimal condition if the PV surface is always maintained by cleaning it. In the future, it is hoped that a maintenance schedule will be made so that the PV condition is always in a clean state and needs measurements continuously in different seasons and weather conditions to ensure system optimization.

ACKNOWLEDGMENTS

The authors thank Ir. Heri Kusnadi, S.T., M.T., Ir. Aripin Triyanto, S.T., M.T., Ph.D., Ir. Ariyawan Sunardi, S.Si., M.T., and Angga Septian MN, S.Pd., M.Pd.T., who have provided all the support in carrying out this research.

FUNDING INFORMATION

Authors state no funding involved.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Ojak Abdul Rozak	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		
Mohd Zamri Ibrahim				✓	✓					✓		✓		
Muhamad Zalani Daud				✓	✓					✓		✓		
Syaiful Bakhri		✓		✓	✓					✓		✓		
Muhammad Fadjrirullah					✓		✓	✓	✓				✓	✓

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors stated that they had no financial interests or personal relationships that could have influenced the results of the work reported in this study.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [initials: OAR], upon reasonable request.

REFERENCES

[1] B. Harianto and M. Karjadi, "Planning of Photovoltaic (PV) Type Solar Power Plant as An Alternative Energy of the Future in Indonesia," *Endless: International Journal of Future Studies*, vol. 5, no. 2, pp. 182–195, 2022, doi: 10.54783/endlessjournal.v5i2.87.

[2] M. Z. Falah, W. T. Handoko, and R. Kurniawan, "Design and Construction of a Solar Power Plant (PLTS) in the 3T rea Tourist Houses of Gangga Murmas Trees Lombok Utara," *Journal Electrical and Computer Experiences*, vol. 1, no. 2, pp. 53–60, Jan. 2024, doi: 10.59535/jece.v1i2.182.

[3] K. Hasan, S. B. Yousuf, M. S. H. K. Tushar, B. K. Das, P. Das, and Md. S. Islam, "Effects of different environmental and operational factors on the PV performance: A comprehensive review," *Energy Science & Engineering*, vol. 10, no. 2, pp. 656–675, Feb. 2022, doi: 10.1002/ese3.1043.

[4] A. A. Firoozi, A. A. Firoozi, and M. R. Maghami, "Harnessing photovoltaic innovation: Advancements, challenges, and strategic pathways for sustainable global development," *Energy Conversion and Management: X*, vol. 27, p. 101058, Jul. 2025, doi: 10.1016/j.ecmx.2025.101058.

[5] R. J. Mustafa, M. R. Gomaa, M. Al-Dhaifallah, and H. Rezk, "Environmental Impacts on the Performance of Solar Photovoltaic Systems," *Sustainability*, vol. 12, no. 2, p. 608, Jan. 2020, doi: 10.3390/su12020608.

[6] M. R. Das, "Effect of Different Environmental Factors on Performance of Solar Panel," *International Journal of Innovative Technology and Exploring Engineering*, vol. 8, no. 11, pp. 15–18, Sep. 2019, doi: 10.35940/ijitee.J9889.0981119.

[7] A. Al-Bashir, M. Al-Dweri, A. Al-Ghandoor, B. Hammad, and W. Al-Kouz, "Analysis of Effects of Solar Irradiance, Cell Temperature and Wind Speed on Photovoltaic Systems Performance," *International Journal of Energy Economics and Policy*, vol. 10, no. 1, pp. 353–359, Jan. 2020, doi: 10.32479/ijeep.8591.
[8] R. Susanto, W. Lestari, and H. Hasanah, "Performance Analysis of Solar Panels in Tropical Region: A Study Case in Surakarta Indonesia," in *Proceeding of International Conference on Science, Health, And Technology*, pp. 1–13, Sep. 2022, doi: 10.47701/icohetech.v3i1.2059.
[9] A. Effendi, A. Yanto, A. Premadi, A. L, and A. Y. Dewi, "The Effect of Temperature and Intensity of Sunlight on the Power Produced by Solar Panels From Data Logger," *Egyptian Journal of Chemistry*, vol. 65, no. 10, pp. 441-445, 2022, doi: 10.21608/ejchem.2022.121739.5458.
[10] N. H. Baranyai, N. Esses, A. Vincze, and H. Zsiborács, "The effect of orientation and tilt angle on PV system energy production in Hungary: regional comparison and optimization possibilities," *Discover Sustainability*, vol. 6, no. 1, p. 1192, Nov. 2025, doi: 10.1007/s43621-025-02082-z.
[11] M. Rani, D. S. Abila, D. P. Aslam, Tahdid, and I. Yunanto, "Effect of Panel Tilt Angle and Electrical Load on Inverter Efficiency in a 24V Off-Grid 200 WP Photovoltaic System," *Journal of Industrial, Energy and Environment Technology*, vol. 3, no. 1, pp. 102–106, Nov. 2025, doi: 10.36257/jieetech.v3i1.11027.
[12] U. H. Ramadhani, D. Lingfors, J. Munkhammar, and J. Widén, "On the properties of residential rooftop azimuth and tilt uncertainties for photovoltaic power generation modeling and hosting capacity analysis," *Solar Energy Advances*, vol. 3, p. 100036, Jan. 2023, doi: 10.1016/j.seja.2023.100036.
[13] F. Y. Al-Aboosi and A. F. Al-Aboosi, "Preliminary Evaluation of a Rooftop Grid-Connected Photovoltaic System Installation under the Climatic Conditions of Texas (USA)," *Energies*, vol. 14, no. 3, p. 586, Jan. 2021, doi: 10.3390/en14030586.
[14] M. L. Adekanbi, E. S. Alaba, T. J. John, T. D. Tundealao, and T. I. Banji, "Soiling loss in solar systems: A review of its effect on solar energy efficiency and mitigation techniques," *Cleaner Energy Systems*, vol. 7, p. 100094, Apr. 2024, doi: 10.1016/j.cles.2023.100094.
[15] A. Shariah and E. Al-Ibrahim, "Impact of Dust and Shade on Solar Panel Efficiency and Development of a Simple Method for Measuring the Impact of Dust in any Location," *Journal of Sustainable Development of Energy, Water and Environment Systems*, vol. 11, no. 2, pp. 1–14, Jun. 2023, doi: 10.13044/j.sdewes.d11.0448.
[16] M. Nezamisavojbolaghi, E. Davodian, A. Bouich, M. Tlemçani, O. Mesbahi, and F. M. Janeiro, "The Impact of Dust Deposition on PV Panels' Efficiency and Mitigation Solutions: Review Article," *Energies*, vol. 16, no. 24, p. 8022, Dec. 2023, doi: 10.3390/en16248022.
[17] G. Abdelaziz, H. Hichem, B. R. Chiheb, and G. Rached, "Shading effect on the performance of a photovoltaic panel," in *2021 IEEE 2nd International Conference on Signal, Control and Communication (SCC)*, IEEE, Dec. 2021, pp. 208–213, doi: 10.1109/SCC53769.2021.9768356.
[18] R. Rahmaniar, K. Khairul, A. Junaidi, and D. K. Sari, "Analysis of Shadow Effect on Solar PV Plant using Helioscope Simulation Technology in Palipi Village," *JTEV (Jurnal Teknik Elektro dan Vokasional)*, vol. 9, no. 1, p. 75, May 2023, doi: 10.24036/jtev.v9i1.122372.
[19] D. Bernadette, M. Twizerimana, A. Bakundukize, B. J. Pierre, and N. Theoneste, "Analysis of Shading Effects in Solar PV System," *International Journal of Sustainable and Green Energy*, vol. 10, no. 2, p. 47, 2021, doi: 10.11648/j.ijrse.20211002.13.
[20] R. Bhallamudi, S. Kumarasamy, and C. K. Sundarabalan, "Effect of Dust and Shadow on Performance of Solar Photovoltaic Modules: Experimental Analysis," *Energy Engineering*, vol. 118, no. 6, pp. 1827–1838, 2021, doi: 10.32604/EE.2021.016798.
[21] M. C. da Silva, D. A. de L. Brandao, and I. A. Pires, "Evaluating the Impact of Dirt Accumulation on Photovoltaic Performance: Insights from an Experimental Plant in Brazil," *Energies*, vol. 18, no. 5, p. 1214, Mar. 2025, doi: 10.3390/en18051214.
[22] J. Jamal, I. Mansur, A. Rasid, M. Mulyadi, M. D. Marwan, and M. Marwan, "Evaluating the shading effect of photovoltaic panels to optimize the performance ratio of a solar power system," *Results in Engineering*, vol. 21, p. 101878, Mar. 2024, doi: 10.1016/j.rineng.2024.101878.
[23] CanadianSolar, "Partner Section Electrical Data | STC* CS3Y 475MS 480MS 485MS 490MS 495MS 500MS Engineering Drawing (mm) CS3Y-490MS / I-V Curves," 2021.
[24] Sungrow, "SG33CX/SG40CX/SG50CX New Multi-MPPT String Inverter for 1000 Vdc System," 2019.
[25] Seaward, "Solar Survey 100/200R Series," 2021.
[26] Sungrow, "iSolarCloud Remote Monitoring and O&M Platform O&M Management User Manual Contents," 2018.

BIOGRAPHIES OF AUTHORS



Ojak Abdul Rozak, S.T., M.T., is an expert assistant at Department of College of Electrical Engineering, Faculty of Engineering, Universitas Pamulang, South Tangerang, Banten, Indonesia. He holds a master's degree in Electrical Power Engineering. His research area is the simulation of THD improvement in power distribution systems with harmonic filters based on ETAP 12.6.0 software. Currently studying for his Ph.D. at the Faculty of Ocean Engineering Technology and Informatics, Universiti Malaysia Terengganu, Mengbang Telipot, Kuala Terengganu, Terengganu, Malaysia. His research interests are in monitoring systems, IoT, electric power, renewable energy, and especially solar panels. He can be contacted at email: dosen01314@unpam.ac.id.



Professor Ts. Dr. Mohd Zamri Bin Ibrahim received his first degree in Mechanical Engineering from the University of Sunderland, UK in 1995. In 1997, he graduated from Warwick University, UK with a master's degree in Advanced Mechanical Engineering. In 2007, he completed his Ph.D. in Renewable Hydrogen Energy Production System at the National University of Malaysia (UKM), Malaysia. He started his career as a consultant engineer in 1996. In 1997, he was named Production Engineer at Hyundai Pipe Company in Pusan, Korea. He currently holds the title of Deputy Vice Chancellor (Academics and International) at Universiti Malaysia Terengganu from 1 Nov 2020 onwards. He is also appointed as the head of a research cluster in Technology, Marine Engineering and Science, UMT from Dec 2020 to Nov 2022. His recent work focused especially on renewable energy systems and renewable energy resources. It includes research interests in renewable energy system technology design and techno-economic studies, such as wind, solar, wave, and ocean current energy. His research interests also concentrate on the fields of hydrogen fuel, energy sources forecasting, and clean technology systems. He can be contacted at email: zam@umt.edu.my.



Professor Madya Ts. Dr. Muhamad Zalani Bin Daud completed his bachelor's degree in Electrical and Electronic Engineering at Ritsumeikan University, Kyoto, Japan in March 2003. In February 2010, he completed his M.Sc. by research at the School of Electrical, Computer and Telecommunications Engineering, University of Wollongong, Australia. Later in 2014, he completed his Ph.D. in renewable energy from the Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia (UKM). He is currently a senior lecturer at Universiti Malaysia Terengganu (UMT), Faculty of Ocean Engineering Technology, where his research interests are in renewable energy, smart energy meter development, and energy efficiency. He can be contacted at email: zalani@umt.edu.my.



Prof. Syaiful Bakhri, S.T., Meng.Sc., Ph.D., is the dean of the Faculty of Engineering at The University of Pamulang, Indonesia. He was head of the Department of Electrical Engineering at the University of Pamulang. He was also the head of the Reactor Technology and Safety Division and the head of the Reactor Physics and Technology Division for the Centre of Nuclear Reactor Technology and Safety, National Nuclear Energy Agency of Indonesia. He earned Meng.Sc., Ph.D. both at the School of Electrical and Electronic Engineering, the University of Adelaide. South Australia. His research interests are embedded systems, IoT, electric power, electric machines, and renewable energy. He also has experience in nuclear reactor technology research and development. He was involved in the design and development of the high-temperature gas-cooled reactor nuclear power plant of Indonesia as the project manager and executive director of a joint laboratory with INET Tsing Hua University. He has experience in aging management, conditioning monitoring, and maintaining the 30 MW G.A Siwabessy research reactor of Indonesia. He also produces scientific publications and patents in his research interest and was recognized as a certified international research reviewer. He can be contacted at email: dosen00047@unpam.ac.id.



Muhammad Fadjrirullah, S.T., received his bachelor of Engineering degree (Electrical Energy Engineering) from Department of Electrical Engineering, Faculty of Engineering, Universitas Pamulang. Currently working at PT. Jakarta Prima Cranes as QC staff. He can be contacted at email: fajrirullah@gmail.com.