

TECHNO-ECONOMIC ASSESMENT OF REPLACING DIESEL POWER PLANTS WITH OFF-GRID SOLAR PHOTOVOLTAIC SYSTEMS IN REMOTE ELECTRIFIED VILLAGES: A CASE STUDY OF GUNUNG PUREI, INDONESIA

Gustiyadi Fathur Rahmandi^{1*}, Atok Setiyawan², Hendro Nurhadi³

¹Department of Mechanical Engineering, Institut Teknologi Sepuluh Nopember

E-mail: gfathurr89@gmail.com

Received : 25 December 2025

Accepted : 27 January 2026

Revised : 02 January 2025

Published : 05 February 2026

Abstract

The electrification of remote and isolated areas remains a major challenge in Indonesia, particularly in 3T (Outermost, Frontier, and Disadvantaged) regions that still rely on diesel power plants with limited operating hours. This study evaluates the technical and economic feasibility of replacing an existing diesel power plant (PLTD) with an off-grid solar photovoltaic (PV) system integrated with battery energy storage at the Gunung Purei Village Electricity Unit (ULD), Central Kalimantan. The proposed system is designed to transform a 14-hour diesel-based operation into a continuous 24-hour electricity supply. Technical analysis was conducted using PVsyst to assess energy production and performance ratio (PR), while economic feasibility was evaluated using HOMER Pro through indicators such as Net Present Value (NPV), Levelized Cost of Energy (LCOE), Profitability Index (PI), and Discounted Payback Period (DPP). The study compares monocrystalline and polycrystalline PV modules under different battery autonomy scenarios. Results show that the optimal configuration consists of a 588 kWp off-grid solar PV system using 940 monocrystalline PV modules, five 100 kW inverters, a 500 kW power conversion system, and 27 battery sets with a total capacity of 2.94 MWh (one-day autonomy). This configuration achieves a performance ratio of 34.78% and satisfies the annual load demand of 896.19 MWh. From an economic perspective, the system is feasible, yielding a positive NPV of IDR 8.36 billion, a PI of 1.30, and a DPP of 24.77 years. The findings confirm that off-grid solar PV–battery systems using monocrystalline modules provide a technically reliable and economically viable solution for replacing diesel generation in remote electrified villages, while supporting Indonesia’s renewable energy mix target of 23%.

Keywords: *Off-grid Solar Photovoltaic, Diesel Power Plant Replacement, Diesel Power Plant Replacement; Battery Energy Storage System, Techno-Economic Analysis, Rural Electrification, Renewable Energy.*

INTRODUCTION

Electricity plays a vital role in supporting socio-economic development, particularly in improving the quality of life in rural and remote communities. In Indonesia, despite significant progress in increasing the national electrification ratio over the past decade, challenges persist in supplying reliable electricity to remote and isolated areas, especially those categorized as 3T (Outermost, Frontier, and Disadvantaged) regions. These areas are often characterized by difficult geographical access, low population density, and limited infrastructure, making grid expansion economically and technically unfeasible (Mahmoud & Ibrik, 2006). To address electrification in remote regions, diesel power plants (PLTD) have traditionally been employed due to their flexibility and relatively low initial investment. However, diesel-based generation systems present several critical issues, including high operational costs, dependence on fuel logistics, vulnerability to price volatility, and significant greenhouse gas emissions (Nafeh, 2009). In many isolated villages, diesel generators operate for limited hours per day to reduce fuel consumption, resulting in restricted electricity access that constrains community activities and economic productivity. Indonesia has committed to reducing greenhouse gas emissions and accelerating the energy transition through the Paris Agreement and national policies targeting a renewable energy mix of 23% by 2025. In line with these commitments, PT PLN (Persero) has initiated strategies to gradually replace fossil fuel-based generation with renewable energy systems, particularly in isolated electricity systems (PLN, 2025). Solar photovoltaic (PV) technology emerges as one of the most promising solutions due to Indonesia’s high solar irradiation potential, modularity, and suitability for decentralized applications (Duffie & Beckman, 2013).

TECHNO-ECONOMIC ASSESMENT OF REPLACING DIESEL POWER PLANTS WITH OFF-GRID SOLAR PHOTOVOLTAIC SYSTEMS IN REMOTE ELECTRIFIED VILLAGES: A CASE STUDY OF GUNUNG PUREI, INDONESIA

Gustiyadi Fathur Rahmandi *et al*

Off-grid solar photovoltaic systems integrated with battery energy storage systems (BESS) offer a viable alternative for providing continuous electricity supply in remote areas. Such systems enable 24-hour power availability by storing excess solar energy during daytime for nighttime use, reducing reliance on diesel generators (Deele et al., 2020). However, the successful implementation of off-grid PV systems requires careful technical design and economic evaluation to ensure system reliability, efficiency, and long-term feasibility. Several previous studies have explored the technical and economic performance of off-grid and hybrid PV systems in rural electrification projects. Nugraha (2018) demonstrated the technical feasibility of a 1 MWp PV system in an industrial setting, while Samsurizal et al. (2020) highlighted the suitability of centralized off-grid PV systems for rural communities using PVsyst simulations. Other studies emphasized the superior efficiency of monocrystalline PV modules compared to polycrystalline modules under varying climatic conditions (Puriza et al., 2021; Pagan et al., 2018). Nevertheless, comprehensive studies that integrate detailed technical simulation with long-term economic assessment for diesel-to-solar conversion in isolated village electricity units remain limited.

Gunung Purei Village Electricity Unit (ULD Gunung Purei), located in Central Kalimantan, represents a typical isolated electricity system that relies entirely on diesel generators operating for approximately 14 hours per day. Increasing electricity demand, rising fuel costs, and national renewable energy targets create an urgent need to evaluate alternative generation systems capable of providing 24-hour electricity supply. The specific local conditions, including load growth, land availability, and solar resource potential, necessitate a site-specific techno-economic assessment. Therefore, this study aims to evaluate the feasibility of replacing an existing diesel power plant with an off-grid solar PV–battery system in ULD Gunung Purei. The objectives of this research are: (1) to design an off-grid solar PV system capable of supplying electricity continuously for 24 hours, (2) to compare the technical performance of monocrystalline and polycrystalline PV modules using performance indicators such as energy yield and performance ratio, and (3) to assess the economic feasibility of the proposed system using Net Present Value (NPV), Levelized Cost of Energy (LCOE), Profitability Index (PI), and Discounted Payback Period (DPP). The problem-solving approach adopted in this study involves detailed load analysis, system sizing, and simulation using PVsyst for technical performance evaluation and HOMER Pro for economic optimization. By integrating technical and economic perspectives, this research is expected to provide practical insights and decision support for renewable-based electrification planning in remote and isolated regions of Indonesia.

LITERATURE REVIEW

Rural and remote electrification has long been recognized as a critical driver of social welfare, economic growth, and regional equity. In areas where grid extension is technically challenging or economically infeasible, decentralized power generation systems have become the primary solution. Previous studies emphasize that isolated electricity systems require generation technologies that are reliable, scalable, and cost-effective over long operational periods (Mahmoud & Ibrik, 2006). Diesel power plants (PLTD) have historically dominated electricity supply in remote areas due to their relatively simple installation and dispatch flexibility. However, numerous studies highlight significant drawbacks associated with diesel-based systems, including high fuel transportation costs, low efficiency, frequent maintenance requirements, and substantial carbon emissions (Nafeh, 2009). Mahmoud and Ibrik (2006) demonstrated that diesel-only systems become increasingly uneconomical as fuel prices rise, particularly in geographically isolated regions. These limitations have motivated extensive research into renewable energy-based alternatives for off-grid applications.

Solar photovoltaic (PV) systems have emerged as one of the most widely studied renewable energy solutions for rural electrification. Theoretical frameworks for PV-based electrification commonly emphasize energy balance analysis, system reliability, and long-term economic performance (Duffie & Beckman, 2013). Off-grid PV systems integrated with battery energy storage systems (BESS) are particularly relevant for remote areas, as they enable continuous power supply by compensating for the intermittency of solar resources (Deele et al., 2020). Several studies have employed simulation-based approaches to assess the technical feasibility of off-grid PV systems. Samsurizal et al. (2020) utilized PVsyst to design a centralized off-grid PV system for a rural village, concluding that solar energy potential and system configuration significantly influence energy yield and reliability. Similarly, Rahman (2021) showed that properly sized off-grid PV systems could fully meet household electricity demand in remote areas, provided that battery capacity is sufficient to accommodate load variability. The choice of photovoltaic module technology has also been widely discussed in the literature. Monocrystalline PV modules are generally reported to offer higher efficiency and better performance under limited space conditions, while polycrystalline modules are considered more cost-effective but require larger installation areas (Puriza et al., 2021). Pagan et al. (2018) and Wardani et al. (2019) found that monocrystalline modules consistently produced higher energy output

TECHNO-ECONOMIC ASSESMENT OF REPLACING DIESEL POWER PLANTS WITH OFF-GRID SOLAR PHOTOVOLTAIC SYSTEMS IN REMOTE ELECTRIFIED VILLAGES: A CASE STUDY OF GUNUNG PUREI, INDONESIA

Gustiyadi Fathur Rahmandi *et al*

across varying weather conditions, although polycrystalline modules may perform comparably under unobstructed, high-irradiance environments. These findings suggest that module selection should be based not only on efficiency but also on site-specific constraints such as land availability and shading conditions. Beyond technical performance, economic feasibility remains a central consideration in renewable energy deployment. Techno-economic analysis frameworks commonly employ indicators such as Net Present Value (NPV), Levelized Cost of Energy (LCOE), Profitability Index (PI), and Discounted Payback Period (DPP) to evaluate long-term investment viability (Duffie & Beckman, 2013). Studies by Nugraha (2018) and Kristianto (2010) demonstrated that PV-based systems could be economically viable under certain assumptions, particularly when fuel savings and long operational lifetimes are considered. However, these studies also highlight sensitivity to battery costs, discount rates, and system configuration.

Hybrid optimization tools such as HOMER Pro have been extensively used to analyze off-grid and hybrid renewable energy systems. Deele *et al.* (2020) showed that HOMER-based optimization provides valuable insights into optimal system sizing and lifecycle costs. Nevertheless, some researchers argue that HOMER's simplified PV modeling may overlook detailed technical losses, making it necessary to combine HOMER with more detailed simulation tools such as PVsyst for comprehensive assessments (Assalsha, 2024). Despite the growing body of literature on off-grid PV systems, several gaps remain. First, many studies focus either on technical performance or economic feasibility, but relatively few integrate both aspects comprehensively for diesel-to-solar conversion in isolated village electricity units. Second, comparative analyses of PV module types combined with different battery autonomy scenarios in real operational contexts are still limited. Third, site-specific studies that reflect actual load growth, operational constraints, and utility-level decision-making frameworks are scarce, particularly in the context of Indonesia's 3T regions. Therefore, this study addresses these gaps by conducting an integrated techno-economic assessment of replacing a diesel power plant with an off-grid solar PV battery system in an isolated village electricity unit. By combining detailed technical simulation using PVsyst with economic optimization using HOMER Pro, and by comparing monocrystalline and polycrystalline PV modules under varying battery autonomy scenarios, this research contributes new insights into sustainable and economically viable electrification strategies for remote areas.

METHOD

This study employs a techno-economic assessment approach to evaluate the feasibility of replacing an existing diesel power plant with an off-grid solar photovoltaic (PV) system integrated with battery energy storage. The research methodology is designed to systematically analyze technical performance, economic viability, and system optimization under site-specific conditions at the Gunung Purei Village Electricity Unit (ULD Gunung Purei), Central Kalimantan, Indonesia.

Study Area and System Description

The study area is ULD Gunung Purei, an isolated electricity system located in a remote region of Central Kalimantan. The existing electricity supply relies entirely on diesel generators operating approximately 14 hours per day. The system serves residential, social, and small commercial loads with a growing electricity demand. Due to its isolated nature, grid interconnection is not feasible, making off-grid renewable energy solutions a relevant alternative. Solar resource data, geographical coordinates, land availability, and existing load characteristics were identified as key site-specific parameters for system design.

Load Profile Analysis

Electrical load data were obtained from historical operational records of the diesel generators, including hourly load profiles and annual energy consumption. Since the existing system does not operate continuously, the load profile was converted from a 14-hour operation to a projected 24-hour operation using reference load patterns from a comparable village electricity unit with similar characteristics. Load growth was incorporated based on national electricity demand projections, assuming an annual growth rate consistent with utility planning guidelines. The resulting load profile served as the basis for system sizing and simulation.

System Configuration and Component Selection

The proposed system consists of solar PV modules, inverters, battery energy storage systems, and a power conversion system (PCS) configured as an off-grid AC-coupled system. Two types of PV modules monocrystalline and polycrystalline were evaluated to compare their technical performance and economic implications. Battery storage capacity was varied based on different days of autonomy (DoA) scenarios to assess system reliability under

TECHNO-ECONOMIC ASSESMENT OF REPLACING DIESEL POWER PLANTS WITH OFF-GRID SOLAR PHOTOVOLTAIC SYSTEMS IN REMOTE ELECTRIFIED VILLAGES: A CASE STUDY OF GUNUNG PUREI, INDONESIA

Gustiyadi Fathur Rahmandi *et al*

limited solar availability. Component specifications were selected based on commercially available technologies in Indonesia to ensure practical applicability.

Technical Simulation Using PVsyst

Technical performance analysis was conducted using PVsyst software. The simulation process included solar resource assessment, system layout design, PV array configuration, inverter sizing, and loss analysis. Key technical indicators evaluated in this stage included annual energy yield, performance ratio (PR), and system losses. PVsyst was selected due to its capability to provide detailed modeling of PV system behavior under real climatic and operational conditions.

Economic Analysis Using HOMER Pro

Economic feasibility and system optimization were evaluated using HOMER Pro software. The simulation incorporated capital costs, replacement costs, operation and maintenance costs, battery degradation, and project lifetime assumptions. Economic indicators used to assess feasibility included Net Present Value (NPV), Levelized Cost of Energy (LCOE), Profitability Index (PI), and Discounted Payback Period (DPP). Multiple system configurations were simulated to identify the most economically viable option that satisfies the technical performance requirements.

Comparative and Decision-Making Analysis

The final stage of the methodology involved comparing all simulated configurations based on technical performance and economic indicators. Systems that met the annual energy demand and reliability criteria were further evaluated for economic feasibility. The optimal configuration was determined by prioritizing positive NPV, PI greater than one, acceptable DPP relative to project lifetime, and lower LCOE. This integrated evaluation framework ensures that the selected system is both technically reliable and economically sustainable for long-term operation in remote areas.

RESULTS AND DISCUSSION

This section presents the technical and economic results of replacing the existing diesel power plant with an off-grid solar photovoltaic (PV) system integrated with battery energy storage at ULD Gunung Purei. The results are discussed in relation to system performance, economic feasibility, and implications for rural electrification in isolated areas.

Technical Performance of the Off-Grid Solar PV System

The technical simulation results obtained using PVsyst indicate that the proposed off-grid solar PV system is capable of meeting the projected 24-hour electricity demand of ULD Gunung Purei. The annual energy demand of approximately 896.19 MWh was used as the benchmark for system adequacy. Initial simulations showed that insufficient PV capacity resulted in energy deficits; therefore, system resizing was required to ensure reliability. For the monocrystalline PV configuration, the optimal system size was identified as 588 kWp, consisting of 940 PV modules, five 100 kW inverters, and a battery energy storage system with one-day autonomy. This configuration produced approximately 907 MWh per year, exceeding the annual load demand and providing a small energy surplus. The resulting performance ratio (PR) was 34.78%, reflecting overall system efficiency after accounting for losses related to temperature, inverter operation, and battery charging–discharging processes. In comparison, the polycrystalline PV configuration required a larger installed capacity and land area to achieve a similar energy yield. Despite meeting the load demand after resizing, the polycrystalline system consistently exhibited lower performance ratios across all battery autonomy scenarios. These findings align with previous studies reporting higher efficiency and better energy yield from monocrystalline PV modules under space-constrained and variable climatic conditions (Puriza *et al.*, 2021; Pagan *et al.*, 2018).

Impact of Battery Autonomy on System Performance

Battery autonomy was evaluated using one-day, two-day, and three-day autonomy scenarios. Increasing battery capacity improved system resilience against solar intermittency and enhanced the performance ratio due to reduced energy curtailment. However, the marginal technical benefits diminished as battery capacity increased. While higher autonomy improved reliability, it did not proportionally increase annual energy production, indicating diminishing returns from a purely technical perspective.

TECHNO-ECONOMIC ASSESMENT OF REPLACING DIESEL POWER PLANTS WITH OFF-GRID SOLAR PHOTOVOLTAIC SYSTEMS IN REMOTE ELECTRIFIED VILLAGES: A CASE STUDY OF GUNUNG PUREI, INDONESIA

Gustiyadi Fathur Rahmandi *et al*

The one-day autonomy scenario was sufficient to maintain system stability and ensure continuous power supply, given the local solar resource availability. This result suggests that careful battery sizing based on site-specific solar potential and load characteristics is more effective than oversizing storage systems, consistent with findings by Deele *et al.* (2020).

Economic Feasibility Analysis

Economic evaluation using HOMER Pro revealed significant differences in feasibility across system configurations. For the monocrystalline PV system with one-day battery autonomy, the results showed a positive Net Present Value (NPV) of approximately IDR 8.36 billion, a Profitability Index (PI) of 1.30, and a Discounted Payback Period (DPP) of 24.77 years, which is within the assumed project lifetime of 25 years. The Levelized Cost of Energy (LCOE) was also the lowest among all evaluated scenarios. In contrast, increasing battery autonomy to two or three days substantially increased capital and replacement costs, leading to negative NPV values, PI values below one, and longer payback periods. These findings indicate that excessive battery capacity, while improving reliability, can undermine economic feasibility. Similar conclusions have been reported in previous techno-economic studies emphasizing battery cost as a critical factor in off-grid PV systems (Nafeh, 2009; Duffie & Beckman, 2013). For polycrystalline PV configurations, none of the evaluated scenarios achieved acceptable economic indicators, even after increasing PV capacity. Higher land requirements and lower efficiency resulted in increased capital costs, which could not be offset by energy production gains. This outcome reinforces the importance of module selection in off-grid applications, particularly in locations with limited land availability.

Discussion and Implications

The results demonstrate that replacing diesel-based generation with an off-grid solar PV–battery system is technically feasible and economically viable when system design is optimized. The monocrystalline PV configuration with one-day battery autonomy emerged as the most balanced solution, achieving sufficient reliability without excessive investment costs. This finding supports existing literature emphasizing the need for integrated technical and economic optimization rather than maximizing individual performance parameters (Kristianto, 2010; Nugraha, 2018). From a broader perspective, the study highlights the potential of off-grid solar PV systems to support Indonesia's rural electrification and renewable energy targets. By reducing dependence on diesel fuel, the proposed system contributes to lower operational costs and reduced greenhouse gas emissions. The methodology and findings of this study can serve as a reference for similar isolated electricity systems, particularly in 3T regions where grid expansion is impractical. Overall, the integration of detailed technical simulation with comprehensive economic analysis provides a robust decision-making framework for renewable-based electrification planning. The results underline that optimal system performance is achieved not by maximizing capacity, but by aligning system design with local conditions, demand characteristics, and long-term economic considerations.

CONCLUSION

This study aimed to evaluate the technical and economic feasibility of replacing a diesel-based power generation system with an off-grid solar photovoltaic (PV) system integrated with battery energy storage at ULD Gunung Purei, a remote and isolated electricity system in Central Kalimantan. The research was motivated by the limitations of diesel power plants, the increasing electricity demand in rural areas, and Indonesia's commitment to expanding renewable energy utilization. The results demonstrate that an off-grid solar PV–battery system can technically provide a continuous 24-hour electricity supply to replace the existing 14-hour diesel operation. The optimal configuration consists of a 588 kWp solar PV system using monocrystalline modules, supported by one-day battery autonomy. This system is capable of meeting the annual electricity demand of approximately 896.19 MWh while achieving a performance ratio of 34.78%, indicating acceptable operational efficiency under local climatic and load conditions.

From an economic perspective, the selected configuration is financially feasible over a 25-year project lifetime. The system yields a positive Net Present Value, a Profitability Index greater than one, and a Discounted Payback Period that remains within the project lifespan. In contrast, configurations with larger battery autonomy or polycrystalline PV modules result in significantly higher capital costs and unfavorable economic indicators, highlighting the importance of balanced system sizing and appropriate technology selection. The findings confirm that monocrystalline off-grid solar PV systems with carefully optimized battery capacity represent a viable alternative to diesel power plants in isolated village electricity units. Beyond technical and economic benefits, the proposed system contributes to reduced fuel dependency, lower operational risks, and decreased greenhouse gas

TECHNO-ECONOMIC ASSESMENT OF REPLACING DIESEL POWER PLANTS WITH OFF-GRID SOLAR PHOTOVOLTAIC SYSTEMS IN REMOTE ELECTRIFIED VILLAGES: A CASE STUDY OF GUNUNG PUREI, INDONESIA

Gustiyadi Fathur Rahmandi *et al*

emissions, supporting national renewable energy and rural electrification targets. For future development, this approach can be expanded by incorporating hybrid configurations, such as limited diesel or other renewable sources, to enhance system flexibility during extreme weather conditions. Additionally, future studies may integrate real-time operational data, battery degradation analysis, and policy-based incentive scenarios to further refine system design and improve long-term sustainability. The methodology and results of this study provide a practical reference for renewable energy planning and implementation in remote and underserved regions.

REFERENCES

- Assalsha, M. A. B. (2024). Comparative analysis of on-grid and hybrid solar PV system designs at the ITS Robotics Building using PVsyst 7.4 and HOMER Pro. Institut Teknologi Sepuluh Nopember.
- Bhattacharyya, S. C. (2012). Energy access programmes and sustainable development: A critical review and analysis. *Energy for Sustainable Development*, 16(3), 260–271. <https://doi.org/10.1016/j.esd.2012.05.002>
- Chamdareno, P. G., Budiyanto, B., Fadliandi, F., & Isyanto, H. (2017). Experimental study of solar panels and inverters. *Proceedings of SEMNASTEK*, 1–6.
- Deele, L. B., Simeon, O., & Essang, O. S. (2020). Sizing of an off-grid photovoltaic power supply system with battery storage. *Journal of Multidisciplinary Engineering Science and Technology*, 7(12), 13659–13666.
- Duffie, J. A., & Beckman, W. A. (2013). *Solar engineering of thermal processes* (4th ed.). John Wiley & Sons.
- Khatib, T., Mohamed, A., & Sopian, K. (2013). A review of photovoltaic systems size optimization techniques. *Renewable and Sustainable Energy Reviews*, 22, 454–465. <https://doi.org/10.1016/j.rser.2013.02.023>
- Kristianto, A. N. (2010). Investment feasibility study of a solar power plant (PLTS) on Biaro Island using the real option method (Master's thesis). Universitas Indonesia.
- Lau, K. Y., Yousof, M. F. M., Arshad, S. N. M., Anwari, M., & Yatim, A. H. M. (2010). Performance analysis of hybrid photovoltaic/diesel energy system under Malaysian conditions. *Energy*, 35(8), 3245–3255. <https://doi.org/10.1016/j.energy.2010.04.008>
- Mahmoud, M. M., & Ibrik, I. H. (2006). Techno-economic feasibility of energy supply of remote villages in Palestine by PV systems, diesel generators, and electric grid. *Renewable and Sustainable Energy Reviews*, 10(2), 128–138. <https://doi.org/10.1016/j.rser.2004.09.001>
- Nafeh, A. E.-S. (2009). Design and economic analysis of a stand-alone PV system to electrify a remote area household in Egypt. *The Open Renewable Energy Journal*, 2, 33–37. <https://doi.org/10.2174/1876387100902010033>
- Nugraha, A. (2018). Feasibility study of the construction and installation of a 1 MWp solar power plant at PT Pertamina EP Tanjung. Institut Teknologi Sepuluh Nopember.
- Pagan, S. E. P., Sara, I. D., & Hasan, H. (2018). Performance comparison of monocrystalline and polycrystalline solar panels under Banda Aceh weather conditions. *KITEKTRO: Journal of Electrical Engineering*, 3(4), 19–23.
- PLN. (2025). Rencana Usaha Penyediaan Tenaga Listrik (RUPTL) PLN 2025–2034. PT PLN (Persero). <https://web.pln.co.id>
- Puriza, M. Y., Yandi, W., & Asmar, A. (2021). Comparison of energy conversion efficiency between polycrystalline and monocrystalline solar panels based on Arduino in Pangkal Pinang City. *Jurnal Ecotipe*, 8(1), 47–52. <https://doi.org/10.33019/jurnalecotipe.v8i1.2034>
- Rahman, R. (2021). Analysis of off-grid solar power plant planning for residential applications in Banjarbaru City. *Electrical Engineering and Information Communication Technology*, 4(1), 2–7.
- Samsurizal, S., Christiano, C., & Husada, H. (2020). Feasibility study of solar energy utilization as a solar power plant in Dusun Toalang. *SETRUM: Sistem Kendali–Tenaga–Elektronika–Telekomunikasi–Komputer*, 9(1), 75–82. <https://doi.org/10.36055/setrum.v9i1.7494>
- Wardani, A. L., Andriawan, A. H., & Basyarach, N. A. (2019). Comparison between monocrystalline and polycrystalline solar cells under shaded conditions for solar power plant selection. *Proceedings of ReTII*, 251–256. <https://journal.itny.ac.id/index.php/ReTII/article/view/1525>