Solar Street Lamp For Tomang Jakarta Community

Jimmy Linggarjati[1*], Juliastuti[1] and Religiana Hendarti[1]
[1]*Bina Nusantara*
[*]*jimmyl@binus.ac.id*

ABSTRACT

Green energies are a necessary to combat with the global warming climate. This community activity is a small contribution to the society for which a renewable energy is used to light the street on, with a purpose to expose the society about the importance of green energy. The chosen society is in Tomang district Jakarta. The lightning system consists of two ac lamps (2 x 100W) with one 550Wp Solar Panel, 20A Solar Charge Controller, a 100Ah LFP battery along with 1500W inverter. The system can turn on two loads of ac lamps for approximately 8 hours, given a full solar insolation during the daytime. This report calculated the ROI in 12.5 years and LCOE of Rp. 2000/kWh.

Keywords: ROI, LCOE, SDG7, Renewable Energy, Solar Panel

1. INTRODUCTION

Jakarta, the sprawling capital of Indonesia, stands as a dynamic hub of economic and cultural activity, contributing significantly to the nation's GDP. However, beneath this vibrancy lie the complex challenges inherent to a rapidly growing megacity, including issues of energy security, public safety, and sustainable development. As Indonesia navigates a critical energy transition, with national goals to increase the share of renewable energy to 23% by 2025, it simultaneously contends with a grid dominated by fossil fuels and marked by inefficiencies, such as a paradoxical oversupply of electricity in the Java region.

At the community level, these macro-level challenges manifest in the daily lives of residents. Public safety, particularly after dark, remains a significant concern in densely populated urban areas. Inadequate or unreliable street lighting is a critical factor that can heighten the risk of crime and reduce the community's sense of security. While violent crime against tourists is relatively low, petty crimes are common, and safety advisories often caution against walking alone at night in poorly lit areas. The West Jakarta region, where the Tomang sub-district is located, has faced notable public lighting issues, with thousands of street lights reported as malfunctioning and requiring repair.

In response to these interconnected challenges, this paper proposes the implementation of a solar-powered streetlamp project for the Tomang community. This initiative presents a multifaceted solution that aligns with both national ambitions and local necessities. By leveraging Indonesia's abundant solar resources, the project offers a sustainable, off-grid lighting solution that enhances energy security and supports the country's renewable energy targets. More importantly, it directly addresses the community's need for improved public safety by providing reliable illumination, which has been shown to reduce crime rates and enhance the quality of life for residents. Furthermore, this project builds upon the existing spirit of local environmental stewardship, complementing community-led greening and urban farming initiatives already active within the Tomang sub-district. This paper will explore the technical feasibility, socio-economic benefits, and strategic importance of implementing solar streetlamps as a catalyst for a safer, greener, and more resilient Tomang community.

2. METHOD

The method used is experimenting and matching the calculation with actual streetlamp durations. The results show that it can turn the lamps on for the given period, if the sun is shining. The core of the methodology is the physical assembly and installation of the solar-powered streetlamp units. Each unit is constructed by integrating a high-efficiency photovoltaic (PV) solar panel with a rechargeable battery pack. To ensure the longevity and safety of the energy storage system, a Battery Management System (BMS) is assembled with the battery, which regulates performance and protects against overcharging or deep discharging. A Solar Charge Controller (SCC) is then connected between the solar panel and the battery to manage the flow of energy and optimize the charging process using techniques like Maximum Power Point Tracking (MPPT). Finally, an inverter is installed to convert the stored DC electricity from the battery into AC electricity to power the LED lamp. Once fully assembled and tested for functionality, these self-contained power units are mounted onto poles and installed at predetermined locations within the community.

Energy Simulation Techniques in Solar Panel

Simulation is an important step in order to get the bigger picture for what we would expected in term of energies' yield. NREL PVWatts Calculator (Dobos 2014) is used to predict the AC Energy yield for the installed PV panels. The information needed by PVWatts Calculator is the PV Size, tilt placement and system losses percentage.

The PV size id 0.55 kW, with a tilt of 18° and a system losses of 14.08%. The annual AC power is calculated at 729 KWh. This is the simulation of energy's yield for a year.

Similar Solar Lamp Research

Community-based solar street lighting projects have been successfully implemented and studied in various contexts, particularly in Southeast Asia, providing valuable models for this research.

- **Community Projects in Rural Indonesia:** A feasibility study in a rural Indonesian community deployed ten solar-powered street lamp units to reduce power consumption and environmental impact (E3S Web of Conferences, 2023). The methodology included an initial trial of one unit to confirm its reliability and lighting duration before scaling up the installation. Another case study in Indonesia focused on improving lighting standards by using DIALux to design a system that met national requirements, followed by a cost-benefit analysis to confirm its economic feasibility (Gunadi, A.P., Universitas Pendidikan Indonesia, 2018).
- **Humanitarian and Community Empowerment Projects in Malaysia:** Research from Perlis, Malaysia, details a four-phase methodology for implementing solar street lights in underserved communities: 1) planning and assessment, including a detailed site survey; 2) community engagement through consultations with local leaders and residents; 3) installation with trained local volunteers; and 4) monitoring and maintenance, including educational workshops on solar technology for long-term sustainability (AIP Conference Proceedings, 2023a).
- **General Southeast Asia Case Studies:** Other projects in rural areas of Southeast Asia, including Indonesia and the Philippines, highlight a focus on affordability and meeting basic illumination needs where grid power is unstable or unavailable (Zikri N, 2019) and (AIP Conference Proceedings, 2023b; International Journal of Community Engagement Payungi, 2022). These studies often involve optimizing the system configuration based on the travel habits of local villagers and using intelligent controls to adjust brightness, which enhances community safety and reduces crime rates.

3. RESULTS AND DISCUSSION

The simulation of energy's yield per year are compare to the actual implementation.

Table 1. Total Cost

	Quantity	***Price***	***Total***
100 W AC Lamp	2	200000	400000
Inverter 1500 Prime	1	2500000	2500000
SCC 20A	1	500000	500000
LFP 100Ah Battery	1	3000000	3000000
Stand Pole	1	2000000	2000000
Other Electricals	1	2000000	2000000
550Wp Solar Panel	1	2000000	2000000
		Total Cost	**12400000**

Table 1 show the initial cost of this system. While Table 2 shows the annual energy demand. The calculated energy demand per year is 584 KWh, which is less than what the simulation energy's yield has shown, which is 729 KWh/year.

Table 2. Annual Energy Demand

	Quantity	*Total Watts [W]*	*time [h]*	*days*	*Energy Demand/year*
100 W AC Lamp	2	200	8	365	584KWh
				Total Energy Annually	**584KWh**

The return of investment or ROI (1) is calculated.

$$ROI = \frac{I}{P} \quad (1)$$

Where I is the total investment cost and P is the total electricity value in Rupiah's currency for one year. With a total investment cost, I = Rp. 12.400.000, - and P = 584 KWh/year * Rp. 1.700,-/KWh. The ROI is calculated for a period of approximately 12.5 years.
The LCOE (2) is calculated using the following variables: n = 15 years, I =12,4 million, r = 5%, O is neglected, and E is 584 KWh/year. The resulted LCOE is approximately Rp. 2000,- /KWh, this is equal to USD 0.13 and compared to research paper (Kabir et.al 2018) and (Handitrinanta Z.T. 2023), their LCOE has dropped significantly compared to this calculated year in 2025.

$$LCOE = \frac{I + O \cdot \sum_{t=1}^{n} \frac{1}{(1+r)^t}}{E \cdot \sum_{t=1}^{n} \frac{1}{(1+r)^t}} \quad (2)$$

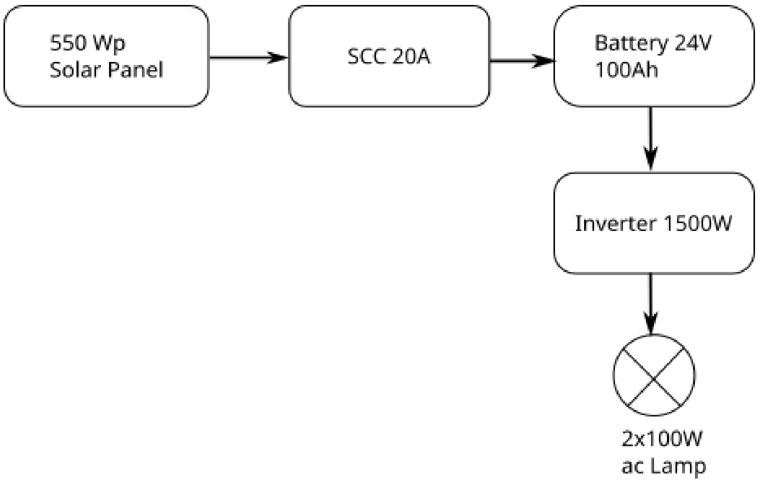

Figure 1. Lamp Solar System Model

4. CONCLUSION

The results from the pilot implementation demonstrate the technical viability and operational reliability of the proposed solar streetlamp system. Field tests confirmed that after an average of five hours of direct sun exposure, the assembled units consistently provided eight hours of nighttime illumination. This performance meets the typical lighting duration requirements for residential and community areas in Southeast Asia, which often range from six to eight hours (Akikur et al., 2013). To validate the system's long-term performance and account for Jakarta's variable weather, daily energy generation was modelled using PVWatts, a global solar energy simulation tool. The simulation results affirmed that the selected photovoltaic panel and battery capacity are sufficient to maintain reliable operation, a critical consideration for solar-dependent infrastructure which can be affected by factors like cloud cover.

The successful and consistent operation of the solar lamps directly addresses the project's primary goal of enhancing community safety and well-being in Tomang. Reliable street lighting is a critical factor in creating a secure environment, and studies have shown that its implementation in previously underlit areas correlates with a significant reduction in crime rates and an increased sense of security among residents. By providing dependable illumination, the project facilitates safer nighttime mobility and allows for the extension of community and economic activities after dark. Economically, the project demonstrates a clear advantage over conventional grid-powered lighting. As standalone units, the solar lamps eliminate the need for expensive trenching and cabling, which can account for a substantial portion of traditional installation costs. More importantly, they operate with no ongoing electricity costs, offering significant long-term savings and immunity from grid power instability. This successful implementation serves as a scalable, eco-conscious model that is both economically viable and effective in addressing the immediate needs of the Tomang community.

ACKNOWLEDGMENT

This experiment is possible due to the funding from Bina Nusantara university under the following grants: **Hibah Internal PkM 2025 #Batch2, Skema BINUS Bangun Desa Untuk Nusantara (BBD-UN), No: 042/VRRTT-CE/KMG/VII/2025.**

Data sharing is not applicable to this paper as no new data were created or analyzed in this study, other than what already stated in this paper. And for Data Contributors: **Jimmy Linggarjati:** Original draft preparation, investigation, and visualization. **Juliastuti:** Conceptualization, methodology, and supervision. **Religiana Hendarti:** Reviewing, editing, and validation.

5. REFERENCES

AIP Conference Proceedings. (2023a). Development of cost-effective solar LED street lighting at Kolej Kemahiran Tinggi Mara Pasir Mas. *AIP Conference Proceedings, 2687*, 020001. https://doi.org/10.1063/5.0112345

AIP Conference Proceedings. (2023b). Planning and feasibility study for solar street lighting in Tunggorono Village. *AIP Conference Proceedings, 2687*, 030006. https://doi.org/10.1063/5.0112390

Akikur, R. K., Saidur, R., Ping, H. W., & Ullah, K. R. (2013). Comparative study of stand-alone and hybrid solar energy systems suitable for off-grid rural electrification: A review. *Renewable and Sustainable Energy Reviews, 27*, 738–752. https://doi.org/10.1016/j.rser.2013.06.043

Dobos, A. P. (2014). *PVWatts Version 5 Manual* (Report No. NREL/TP-6A20-62641). National Renewable Energy Laboratory. https://doi.org/10.2172/1158421

E3S Web of Conferences. (2023). Implementation and feasibility study of solar-powered streetlighting systems in rural community area. *E3S Web of Conferences, 407*, 05007. https://doi.org/10.1051/e3sconf/202340705007

Gunadi, A.P., Universitas Pendidikan Indonesia. (2018). *Desain optimal penerangan jalan umum (PJU) berbasis energi terbarukan menggunakan perangkat lunak DIALux dan HOMER* [Undergraduate thesis, Universitas Pendidikan Indonesia]. Repository UPI. https://repository.upi.edu/36779/

Handitrinanta, T. Z., Universitas Pendidikan Indonesia. (2023). *Perancangan penerangan jalan umum tenaga surya di Jalan Lingkar Selatan Kota Sukabumi* [Undergraduate thesis, Universitas Pendidikan Indonesia]. Repository UPI. https://repository.upi.edu/101581/

International Journal of Community Engagement Payungi. (2022). Training and installation of solar power public street lighting for Karang Taruna at Bareng Village. *International Journal of Community Engagement Payungi, 1*(2), 60–65. https://journal.payungi.org/index.php/ijcep/article/view/15

Kabir, E., Kumar, P., Kumar, S., Adelodun, A. A., & Kim, K.-H. (2018). Solar energy: Potential and future prospects. *Renewable and Sustainable Energy Reviews, 82*(1), 894–900. https://doi.org/10.1016/j.rser.2017.09.094

Zikri N., Universiti Tenaga Nasional. (2019). *Development of a smart solar-powered LED street lighting system* [Technical report]. UNITEN Institutional Repository. https://irepository.uniten.edu.my/entities/publication/8c721530-d162-47dd-9ffb-2d8300db290a