# APPLICATION OF RENEWABLE ENERGY TECHNOLOGY IN HIGHER EDUCATION : STUDY OF SOLAR STREET LIGHT IMPLEMENTATION IN LECTURE BUILDINGS

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## ABSTRACT

The need for public street lighting (PJU) is essential for ensuring a safe and comfortable campus environment, especially during nighttime academic activities. Universitas Teknologi Nusantara addressed inadequate lighting conditions by implementing a solar-powered flood lamp system as an alternative to conventional electricity. This project aimed to improve campus safety, reduce fossil energy dependency, and support green campus initiatives. The methodology included needs identification, technology selection, system installation, and performance evaluation. Three solar-powered lamps equipped with motion sensors were installed in strategic dark zones around the campus. Results showed the lamps operated effectively for 10–12 hours per night, with an average charging efficiency of 85% from solar panels. The motion sensors responded accurately to movement, optimizing energy use without unnecessary consumption. The system also demonstrated stable performance under cloudy weather. The implementation has improved nighttime visibility, reduced energy costs, and contributed to a more sustainable and environmentally friendly campus. These outcomes demonstrate the system's potential for wider adoption and future development, including expanded coverage and integration with IoT-based monitoring. This initiative reflects the university's commitment to technological innovation and sustainable development.

**Keywords :** *Lighting, Solar, Safety, Sustainability, Energy*

## INTRODUCTION

Public street lighting (PJU) is a vital necessity for creating a safe and comfortable environment on campus, especially at night (Andarista, 2023). At Universitas Teknologi Nusantara, proper lighting is essential to support evening classes (regular class B), where students and lecturers are required to be active after sunset. Unfortunately, the campus currently lacks an adequate public street lighting system, resulting in dark conditions around the campus area that pose challenges to mobility and safety (Mohammad et al., 2023). This situation urgently needs to be addressed for the well-being of the entire academic community (Roos et al., 2021).



**Figure 1. Campus Environment Conditions at Dusk**

The use of conventional electricity as an energy source for public street lighting has several drawbacks, particularly in terms of high power consumption and significant operational costs (Bachanek et al., 2021, Hasibuan et al., 2020). Amid increasing global attention to sustainability, renewable energy—especially solar energy—has emerged as a highly attractive alternative. Solar energy is not only environmentally friendly but also holds potential for long-term cost efficiency (Belaid et al., 2023, Maka et al., 2022, Osman et al., 2023). By harnessing abundant sunlight, Universitas Teknologi Nusantara can reduce its reliance on conventional electricity while simultaneously lowering operational expenses.

As a higher education institution focused on technological innovation, Universitas Teknologi Nusantara has a significant opportunity to implement renewable energy-based technology (Mustakim et al., 2024). One relevant solution is the application of solar-powered flood lamps as a public street lighting system on campus. The implementation of this technology will not only fulfill nighttime lighting needs but also serve as a concrete step in supporting eco-friendly initiatives and carbon emission reduction efforts (Ardiyanto et al., 2024).

Therefore, the development and implementation of solar-powered flood lamps will provide long-term benefits for the campus (Alsaqer et al., 2023, Mustakim, 2025). In addition to reducing energy and operational costs, solar-based street lighting will support the university's green campus program. This aligns with efforts to create a safer and more comfortable environment for students, lecturers, and all academic community members who are active at night.

## METHOD

### Approach and Strategy

This project adopts an environmentally friendly technology-based approach by implementing a solar-powered public street lighting (PJU) system. The goal of this approach is to reduce dependence on conventional electricity and support environmental sustainability on campus. The implementation process emphasizes needs analysis, system design, equipment installation, and evaluation of usage effectiveness. The core strategy involves five main stages. The research stages are illustrated in Figure 2 below:

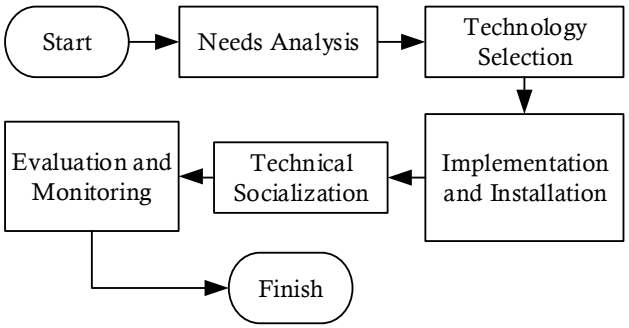



**Figure 2. Research Flowchart**

### Needs Identification

The initial step of this project involves identifying lighting needs at Universitas Teknologi Nusantara, particularly in dark areas at night that are frequently used by students attending evening (Class B) sessions. This identification was carried out through field surveys to assess environmental conditions, high-risk dark zones, and lighting requirements across the campus. In addition, interviews with students and campus staff were conducted to understand current lighting problems and their expectations for improved illumination. The data collection also included assessing the potential of solar energy utilization, considering that the campus is located in an area with high solar irradiance.

### Technology Selection

The second stage focuses on selecting appropriate lighting technology that meets the identified needs and campus environmental conditions. This process involved selecting solar panels with sufficient capacity to power the lights throughout the night. Additionally, energy storage batteries were chosen based on durability and efficiency to ensure continued lamp operation under varying weather conditions.

The system design also included selecting lamps with high efficiency and long lifespan. In this case, solar-powered lamps were used with the following specifications:

a) Power: 3W / 810 mA
b) Lumen: 300 lm

c) Dimensions: 178 x 123 x 48 mm
d) Battery: 3.7V / 2000 mAh (Ternary lithium)
e) PV Power: 1.3W
f) Light Color: 6500K (Cool White)
g) CRI: 70
h) IP Rating: IP54 (suitable for outdoor use)
i) Additional Features: Motion sensor, on/off button, 4 lighting modes

The lamp offers several operation modes:
a) 100% brightness when motion is detected, off when no motion.
b) 100% brightness when motion is detected, 10% brightness when idle.
c) Constant 10% brightness (motion sensor disabled).
d) Always off.

Equipped with a motion sensor and solar-powered battery, the lamp was selected for its energy efficiency and ease of installation without requiring an external power connection.

**Needs Identification**

The third stage involves installing the lighting system in designated areas. Installation begins with infrastructure preparation, such as setting up lamp posts, solar panels, and energy storage systems. The solar-powered lamps are mounted using M4 bolts included in the product package, which simplifies installation on various wall surfaces.

After physical installation is completed, system testing is conducted to ensure all components function properly. Testing includes checking solar panel energy absorption, battery energy storage, and lamp illumination effectiveness at night. If technical issues are found, necessary adjustments are made before the system is fully operational.

**Technical Socialization, Evaluation and Monitoring**

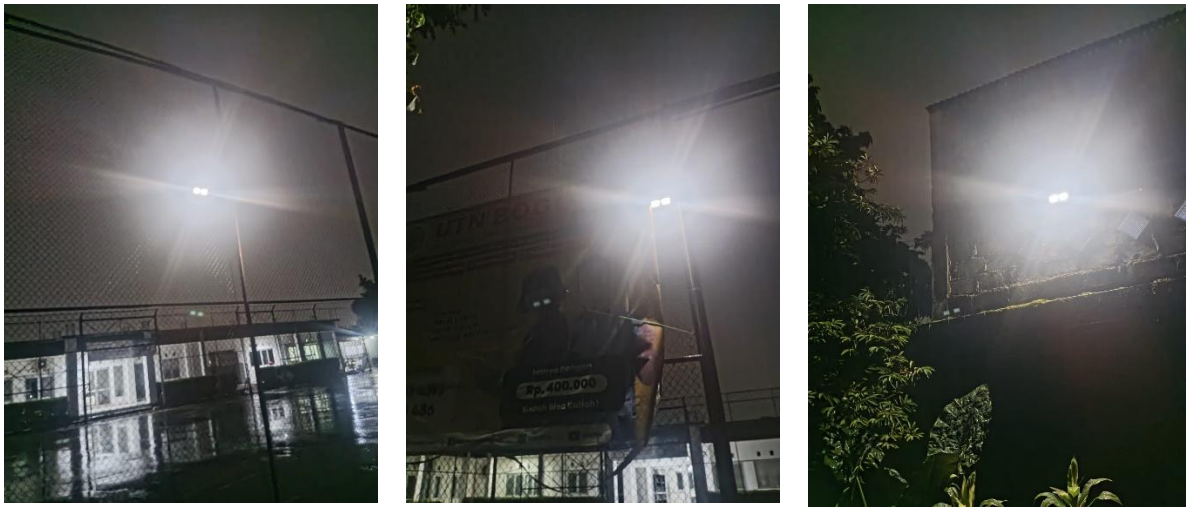
Technical socialization involves providing training to campus technicians on maintenance and troubleshooting procedures. This training covers routine inspection protocols, component replacement, and steps for handling system malfunctions. Through this training, it is expected that the system can operate sustainably with proper maintenance.

Once the solar lighting system has been fully implemented at Universitas Teknologi Nusantara, regular evaluations are conducted to ensure the system operates efficiently. This includes monitoring the performance of solar panels, battery capacity, and lighting quality during nighttime. Evaluated aspects include lighting duration, system reliability under various weather conditions, and the effectiveness of solar energy in meeting lighting demands. User feedback from students and staff is also gathered to assess satisfaction levels and the system's success in creating a safer and more comfortable nighttime campus environment. If the evaluation results indicate that the solar-powered lighting system functions effectively and efficiently, further development plans may include expanding lighting coverage or enhancing system capacity in the future.

## RESULTS AND DISCUSSIONS

### Implementation Results

The implementation of the solar-powered public street lighting (PJU) program at Universitas Teknologi Nusantara was successfully carried out according to the planned stages. The installation of solar-powered lamps in areas identified as dark and risky zones significantly improved campus lighting, especially at night. Lamps were installed in parking areas, pedestrian pathways, and other strategic locations frequently used by evening class students (Regular Class B), with a total of three lamps installed. The system implementation is shown in Figure 3.



(a) Lamp 1 (Campus Entrance Road)

(b) Lamp 2 (Academic Staff Parking Area)

(c) Lamp 3 (Campus Exit Road)

**Figure 3. System Implementation**

Initial testing showed that the system operated according to the designed specifications. The motion-sensor lamps functioned properly, turning on when motion was detected and dimming or turning off when there was no activity. The solar panels effectively absorbed sunlight during the day and supplied sufficient power to operate the lamps throughout the night. The implementation results are shown in Table 1.

**Table 1. System Implementation Results**

| Installation Area | Test Result |
|---|---|
| Lamp 1 (Campus Entrance Road) | Turns on when motion is detected, dims when no activity |
| Lamp 2 (Academic Parking Area) | Functions well, optimal lamp endurance |
| Lamp 3 (Campus Exit Road) | Responsive motion sensor system, stable lighting |

**System Performance Analysis**

Based on monitoring conducted one month after installation, several system performance indicators were obtained. The lamps were able to operate for 10–12 hours per night, depending on the intensity of sunlight stored during the day. The solar panel's charging efficiency averaged 85% of maximum battery capacity, which was sufficient to support the system's operation throughout the night. The motion sensor demonstrated high accuracy, helping to optimize energy use without unnecessary power consumption. The system also continued to function well under adverse weather conditions such as cloudy or rainy days. Detailed test results are presented in Table 2.

**Table 2. System Performance Test Results**

| Parameter | Test Result |
|---|---|
| Lamp Operational Duration | 10–12 hours per night |
| Charging Efficiency | 85% of maximum battery capacity |
| Motion Sensor Accuracy | High (responsive to movement) |
| Performance in Bad Weather | Operated well even under cloudy or rainy conditions |

**Environmental Impact**

The application of the solar-powered PJU system brought several positive impacts to the campus environment, especially in terms of safety, comfort, and energy efficiency. In terms of safety, previously dark and crime-prone areas are now well-lit, increasing the sense of security for students and campus staff during nighttime activities. From an energy efficiency standpoint, the use of solar energy reduces dependency on conventional electricity and contributes to operational cost savings. Additionally, the use of solar-powered systems supports the green campus concept by reducing the carbon footprint associated with fossil fuel-based energy.

## CONCLUSIONS

The implementation of the solar-powered public street lighting (PJU) system at Universitas Teknologi Nusantara has successfully improved lighting and security on campus, particularly during nighttime. Test results indicate that the lamps can operate for 6–10 hours with a charging efficiency reaching 85% of maximum capacity. In addition, the motion sensors function effectively, helping to optimize energy use without unnecessary power consumption. This system also has a positive environmental impact by reducing reliance on fossil fuel-based energy and supporting the green campus concept.

Although the system has performed well, several challenges were encountered, such as reduced charging efficiency during cloudy weather and limited space for installation. Solutions implemented include increasing battery capacity and using flexible mounting systems on existing walls or poles. These solutions allow the system to continue operating optimally. Moving forward, further development is needed, including adding more lighting points, increasing solar panel power capacity, and integrating IoT-based monitoring technology to ensure the system's long-term effectiveness and efficiency.

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