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Design and Implementation of a Sustainable Solar Lighting System for a Basketball Court in Gulap, Candaba, Pampanga

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ABSTRACT

This study presents the design and feasibility analysis of a solar-powered lighting system for the local basketball court in Barangay Gulap, Candaba, Pampanga. The court plays a significant role in the community as a space for recreation and social engagement. However, its functionality is limited during nighttime due to the lack of proper lighting, which also poses safety risks to users. To address this issue, the research explores the potential of utilizing solar energy to provide a reliable and sustainable lighting solution. The study assesses the court's energy requirements and develops a solar-powered system tailored to meet these needs. The proposed solution aims to improve nighttime accessibility and ensure daily usability of the court, contributing to a safer and more inclusive community space.

Keywords: Solar-Powered; Renewable Energy; Sustainable; Community Basketball; Design; Implementation.

1. Introduction

Having well-lit public spaces is important for helping people stay active, connect with others, and stay safe. In Barangay Gulap, Candaba, Pampanga, the local basketball court is an important place where people, especially the youth, come together to play and socialize. Basketball is a very popular sport in the area, and the court is used by many members of the community. However, because the court has no working lighting, it cannot be used at night. This limits its use, especially for those who are only free in the evening.

A lack of lighting in outdoor areas can lead to accidents and safety problems. When it is too dark, players may trip, collide with objects, or experience eye strain, which can cause injuries [1]. Poor lighting also increases the risk of crime, making the court unsafe at night [2]. This limits the court's role as a place where people can gather, exercise, and enjoys community activities in the evening.

Since Gulap gets plenty of sunlight, using solar power is a good solution to the lighting problem. Solar energy is known for being reliable and easy to maintain, especially in areas where regular electricity is not always available or is too expensive [3]. It is often used for lighting outdoor spaces and can help reduce the need for electricity from the power grid [4].

This research studies how a solar-powered lighting system can be used for the basketball court in Gulap. It looks at how much energy the court needs, how the system can be designed, and how it can be installed. The goal is to create a system that makes the court usable and safe at night, giving the community more time and opportunity to enjoy the space.

2. Methods

The researchers used descriptive design methods as a scientific approach, wherein data were gathered through continuous observation and documentation to help establish accurate conclusions.

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2.1. Conceptual Framework

Based on the theories, related literature, studies, and prior knowledge, a conceptual framework model was developed to guide the research. This framework served as a foundation for the design and fabrication of a Solar-Powered System to light the basketball court. The model helped shape the research direction and provided a structured approach to the development process.

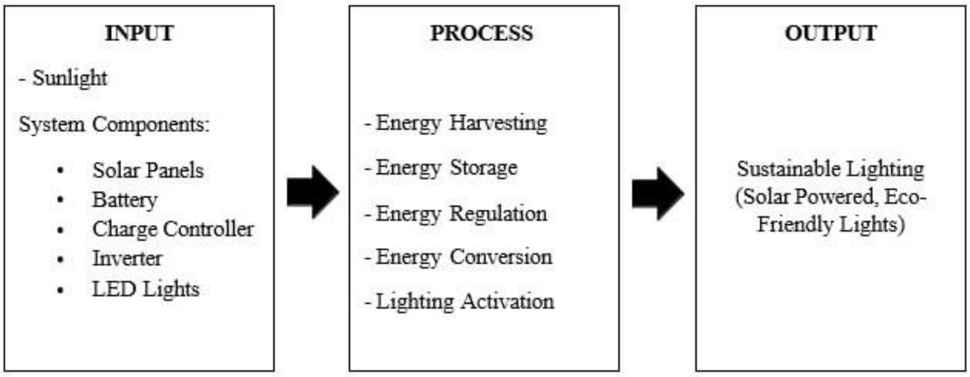


Figure 1. Conceptual Framework

2.2. Single line Diagram

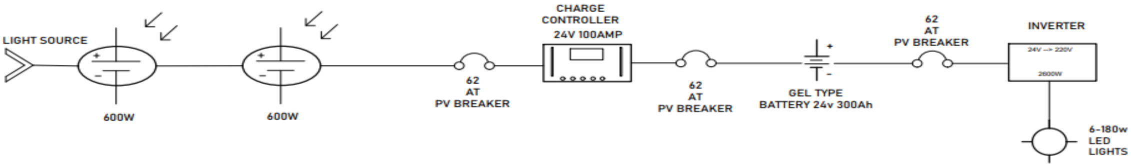


Figure 2. Single line Diagram

The one-line diagram shows how the solar power system supplies electricity for LED lights. It starts with two 600W solar panels that collect sunlight and produce electricity. This electricity passes through a 62A breaker for protection, then goes to a 24V 100A charge controller, which manages battery charging. The energy is stored in a 24V, 300Ah gel battery. Another 62A breaker protects the battery before the power flows to a 2000W inverter. The inverter converts the stored 24V DC into 220V AC, which is used to power six LED lights.

2.3. Pictorial Diagram

Meanwhile, the following figure below presents the pictorial diagram of the sustainable solar lighting system, showing its overall operation.

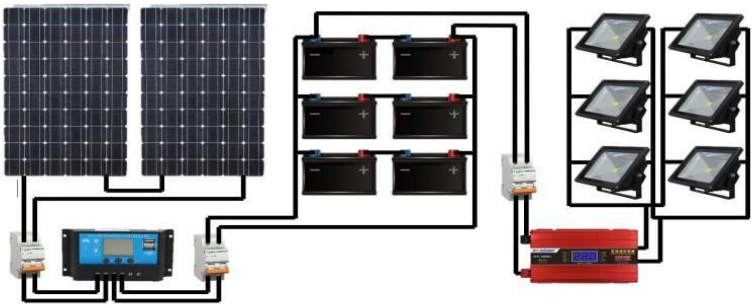


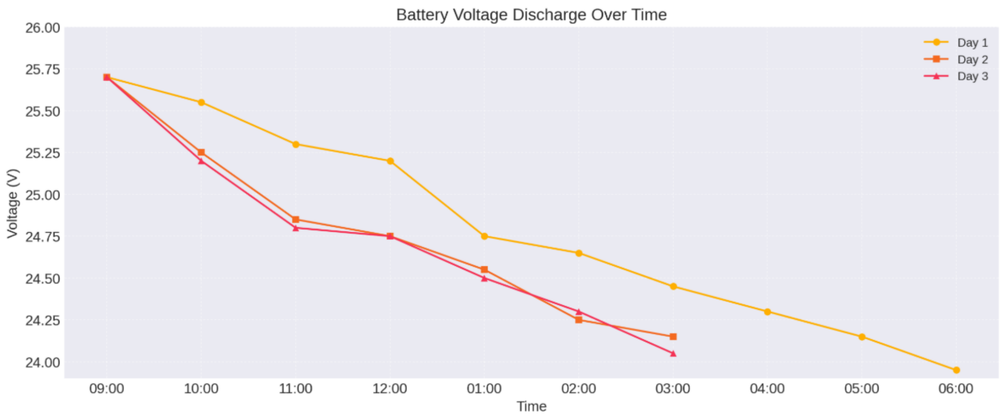
Figure 3. Pictorial Diagram

3. Results and Discussions

The Results and Discussions section contains significant results and interpretations of the results. Basically, this section presents the answers on the research objectives, creates arguments to support your conclusion and provides comparison with previous studies to validate the results.

3.1. Battery Discharge Test

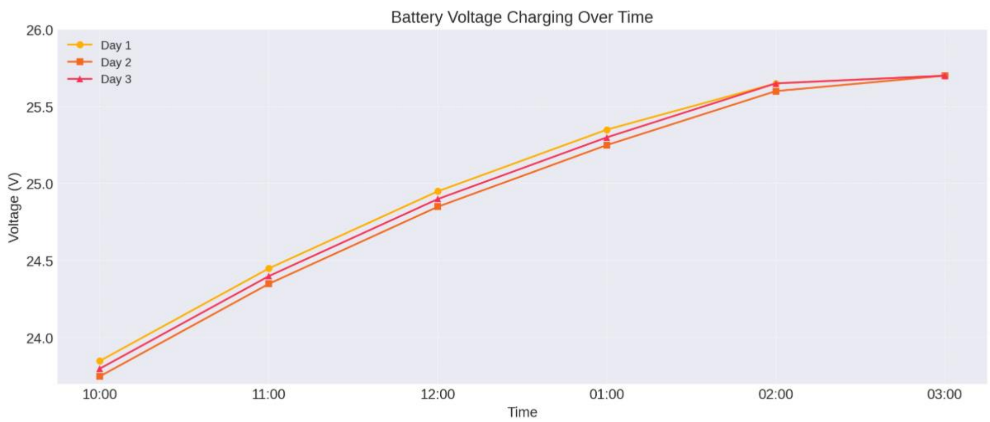
The graph shows battery voltage and percentage levels from 09:00 AM to 06:00 PM over three days, based on data from the solar-powered lighting system in Gulap, Candaba, Pampanga. Each day begins with a full charge at 25.7 V (100%), gradually dropping to 23.9 V (30%) by 06:00 PM, indicating normal discharge during system use.



Graph 1. Battery Discharge Test

3.2. Battery Charging Test

The graph shows battery charging over three days, with voltage rising from 23.8–23.9 V at 10:00 AM to 25.7 V by 03:00 PM. This consistent 4–5 hour charging pattern confirms the system's reliability and efficiency under typical conditions.



Graph 2. Battery Charging Test

4. Conclusion and Recommendation

4.1. Conclusion

The solar-powered lighting system installed at the basketball court in Gulap, Candaba, Pampanga proved effective in enhancing nighttime usability. Though designed to provide four hours of lighting, the system operated for up to eight hours, exceeding expectations and improving community access to the facility after dark. However, discrepancies were noted between theoretical estimates and actual performance, likely due to differences in light wattage, environmental conditions, and system efficiency. Despite these factors, the system remained consistent and reliable in charging and discharging cycles.

Overall, the project confirmed the practicality and sustainability of solar-powered lighting in rural settings, supporting both community engagement and reduced reliance on grid electricity.

4.2. Recommendations

To further improve the efficiency, durability, and long-term success of the solar-powered lighting system, several recommendations are proposed. First, regular maintenance should be prioritized. This includes cleaning the solar panels to maintain peak energy conversion, checking battery performance, and replacing worn-out components when needed. Consistent maintenance will help preserve the system's functionality and extend its operational life.

Second, future projects should consider upgrading system components. While this study utilized PWM charge controllers and sealed lead-acid batteries for cost-efficiency, replacing them with MPPT charge controllers and lithium-ion batteries would improve energy conversion and storage. Though initially more expensive, these upgrades offer better performance, longer lifespan, and lower maintenance, which could additionally reduce costs in the long run.

Lastly, future researchers are encouraged to conduct long-term system monitoring. This includes observing how the system performs during different seasons, tracking battery efficiency over time, and adjusting the design based on real usage patterns. Exploring the scalability of the design to larger facilities and incorporating smart monitoring tools can also provide valuable improvements. These steps will not only improve future installations but will also support the adoption of solar-powered systems as a reliable energy solution in rural communities.

Declarations

Source of Funding

This study received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Competing Interests Statement

The authors declare that they have no competing interests related to this work.

Consent for publication

The authors declare that they consented to the publication of this study.

Authors' contributions

All the authors took part in literature review, analysis, and manuscript writing equally.

Availability of data and materials

Authors are willing to share data and material on request.

Institutional Review Board Statement

This study was approved by the Institutional Review Board of Don Honorio Ventura State University, Philippines.

Informed Consent

Not applicable for this study.

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