

FEASIBILITY ANALYSIS OF A PUBLIC STREET LIGHTING PROJECT BASED ON SOLAR POWER PLANT IN JERAMBAH GANTUNG, PANGKALPINANG CITY

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Abstract: Solar Public Street Lighting refers to a public street lighting system that uses electrical power from solar energy. In this system, the lights are powered independently by energy generated from sunlight, which is collected through solar panels or solar cells, and then converted into electricity through the photovoltaic process. The advantages of solar street lighting are energy-efficient and have high durability. This study aims to evaluate the planning of solar-based public street lighting in the Jerambah Gantung area, Pangkalpinang City. Currently, along the Jerambah Gantung road in Pangkalpinang City, there is no public street lighting system, although the road is often used by residents of Balunijuk Village as an access point to Pangkalpinang City. To consider the safety aspects of road users, it is necessary to plan public street lighting that utilizes energy from renewable sources, namely solar energy.

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Introduction

In the city of Pangkalpinang, precisely from Jerambah Gantung road to Balunijuk Village, community activities where (location) the center of activity can be done in many ways, namely using motorized transportation or private cars, public transportation, or on foot. Pangkalpinang City, precisely on Jalan Jerambah Gantung, Gabek District, is facing major challenges in ensuring effective and sustainable public lighting. Street lighting is an important aspect of urban infrastructure, affecting public safety, social activity and traffic efficiency. To meet these needs, while contributing to environmental protection, the idea of solar power plant-based public lighting (PLTS) emerged as a promising solution. In particular, the PLTS-based street lighting project along the Jerambah Gantung road in Pangkalpinang city attracted

attention. Jalan Jerambah Gantung is not only a strategic location with abundant solar energy potential, but also an important symbol of urban infrastructure in the city of Pangkalpinang. The use of solar energy for public lighting in the region is a wise step in achieving the Sustainable Development goals.

The use of solar energy as a renewable energy source has been widely implemented, especially because solar energy can be produced in an environmentally friendly manner. The basic principle of solar energy involves the conversion of sunlight into electrical energy through the use of solar panels (Caroko et al., 2022). The electricity generated by solar panels depends on the intensity of sunlight and the operational temperature of solar panels. Fluctuations in weather conditions and changes in the location of sunlight

cause the output power of solar panels to be irregular or variable, and is not always maintained at maximum capacity conditions (appendix 1, Material Specifications, n.d.). Adopting solar energy as an alternative energy source is very suitable for public lighting. The great potential of sunlight can be converted into electrical energy, making it an environmentally friendly option. In addition, solar-based street lighting systems can be specifically designed without the need for cabling that interferes with visual aesthetics (Sumadi et al, 2019).

Previous research conducted by (Agriawan et al., 2021) in a study entitled "Automatic Street Lighting Based on Light Intensity and the Presence of Fog or Smoke" Solar street lighting is a cheap and economical alternative to be used as a source of lighting power because it uses a free and unlimited energy source from nature, namely solar power.

Previous research conducted by (Rumbayan et al., 2020) in a study entitled "Appropriate Technology Lighting Based on Renewable Energy in Kiama village, Taulad Islands Regency" this research was motivated because the coastal communities of the Taulad islands have limited access to electricity from the PLN network, so there is no street lighting in Kiama village. The electricity crisis is also an important problem in finding solutions for coastal communities in border areas.

Previous research conducted by (Sujono et al., 2022) In a study entitled "Solar and LED-Based Public Street Lighting (PJU) Assistance in Jatiwates Village, Tembelang District", this research was conducted because one of the problems faced by Jatiwates Village is that the lack of community skill level in the maintenance and operation of PJU does not affect the operation of PJU. as it should be. Therefore, support is needed so that the community can operate PJU properly.

Thus, we will explore the concept of PLTS-based street lighting, why it is important for the city of Pangkalpinang, the benefits and potential that can be expected from this invention and the analysis of the costs that will be incurred. In this way, we can understand the great potential of this project to create a greener, more efficient, and safer city for its citizens.

Literature Review

1. Previous research conducted by (Rumbayan et al., 2020) in research entitled "Information on Appropriate Technology Based on Renewable Energy in Kiama Village, Taulad Islands Regency" was based on the background of this research because the coastal communities of the Taulad Islands have limited access to electricity from the PLN network.

So there is no street lighting in Kiama village. The electricity crisis is also an important problem in finding solutions for coastal communities in the border area of Kiama village who need electricity for public lighting. Based on research and analysis of the current situation, it is possible to form priority problems that need to be resolved through this community service activity, namely the ability of the Kiama Village community to access electricity is still limited, so that the public road infrastructure does not yet have electricity. PLN network. Then there is a lack of understanding by community partners in Kiama village about utilizing the village's energy potential to produce electricity on a small scale without relying on electricity from the State Electricity Company (PLN).

So the conclusion of this research is that the implementation of community service activities in Kiama Village, Taulad Islands, has enabled the introduction and dissemination of appropriate renewable energy-based technology in the form of solar street lights and wind turbines, which can be a solution to this problem. about the electrical energy crisis in the island region. Through the socialization and application of renewable energy technology in the form of solar and wind power, Kiama village residents can increase their knowledge about renewable energy, an energy source that has great potential to be utilized by island communities who are facing the problem of an electrical energy crisis.

2. Previous research conducted by (Sujono et al., 2022) in research entitled "Solar and LED Based Public Street Lighting (PJU) Assistance in Jatiwates Village, Tembelang District" this research was

carried out because one of the problems faced by Jatiwates Village was The lack of community skill levels in maintaining and operating PJUs does not affect the operation of PJUs. as it should be. Therefore, support is needed so that the community can operate PJUs well.

The aim of this activity is to improve community awareness skills and operate PJU street lights independently based on solar and LED power without the help of electricity. This activity was carried out on October 10 2022 in Jatiwates village, Tembelang subdistrict, Jombang Regent. The method used in this activity is Participatory Action Research (PAR) which consists of three stages, namely planning, implementation and evaluation. The results of this activity demonstrate the community's ability to operate PJU in accordance with the support provided to the community.

The result of this operation is a ready-to-use product in the form of solar energy-based PJU. The conclusion of this research is that based on the presentation of the results, it can be concluded that this mentoring activity helps improve community skills in maintaining and operating PJU-based street lights. Solar and LED lights are independent without the help of electricity. The response from the Jatiwates village community was very good and open to this mentoring activity. This can be seen from the enthusiasm of the community during the activity.

3. Previous research conducted by (Artiyasa et al., 2021) in research entitled "Installation of Solar Powered Street Lights for Village Street Lighting in Cibolang Kaler Village" Fossil energy which will be used up is used as the basis for Nusa Putra University's HME activities for educational purposes , as well as carrying out technology transfer that provides direct benefits to the community in the form of Solar Powered Village public lighting facilities (PJD).

Based on the survey results, not all public lighting facilities are available at the village entrance, so that community activity decreases at night and also causes accidents. From the results of this activity, two important things were

obtained for the public to understand renewable energy and energy efficiency to reduce the environmental impact of fossil fuel power plants that dominate Indonesia. Second, with support in the form of solar-powered PJD lights, the community is greatly helped in carrying out nighttime activities and also creates safer conditions in the Cibolang Kaler community. The conclusion of this journal is that PKM activities or community collaboration programs related to the socialization and use of renewable energy are accompanied by the installation and community understanding of renewable energy and also bring real benefits to the residents of Cibolang Kaler Village by installing solar-powered PJDs. This activity also allows for direct and reciprocal relationships that are beneficial for the ulama and the community, especially the residents of Cibolang Kaler, Cisaat District.

The PKM program is implemented in addition to establishing direct relationships between schools and the community, it also contributes to local governments in building and developing craft villages. Based on the activities carried out by HME 20 students, it is hoped that the PKM group can carry out activities to install village street lights using solar cells for public lighting in other villages that do not yet have a public lighting system so that everyone in the village we visited can feel the benefits and can use and maintain it well.

4. Previous research conducted by Poliama, et al (2021) in research entitled "Design and Construction of Solar Powered Public Street Light Monitoring System Tools Based on Lo - Ra Technology" this research was conducted because public lighting and problems often occur in solar powered street lighting (solar cell) goes out during working hours due to damage stored in the battery. This distance This in itself will be a problem if applied Check regularly. Currently, sensing and synchronization of public lighting equipment will be more effective if done remotely.

In this research, DI succeeded in creating a public road light monitoring system using solar energy based on Lo-

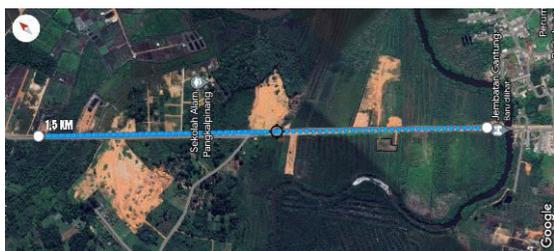
Ra technology. From this research, data and LED current values can be monitored by the LDR sensor, battery voltage, lamp voltage and all data sent in real-time. Apart from tracking data, the lighting control system also implements an energy saving system, namely at night the lights will only turn on when an approaching human object is detected. The lights use a PIR sensor. The method of sending some data from the public lighting control center Server uses data analysis. The data transmission distance between two Lo-Ra modules is used effectively up to a maximum distance of 300 meters.

Based on the research results, a monitoring system for solar powered street lights was designed based on LoRa technology. We can conclude that: Monitor current sensor data and voltage on public street lights using Lo-Ra technology can be sent up to a distance of 300 meters with an RSSI value of 110, send some data : Time, date, battery voltage, lamp voltage, lamp current, LDR value can be sent using data analysis methods.

Method

In this study, quantitative descriptive methods are used that describe or explain research objects or phenomena using statistical data or numbers. This quantitative method involves a systematic investigation of a phenomenon with the collection of measurable data using statistical, mathematical, or computational techniques. (Maswaty, 2013).

Descriptive method is a way of research used to describe, analyze, and understand a phenomenon without changing or manipulating the variables. This approach is useful in describing certain characteristics, conditions, or situations, especially in the development of projects aimed at explaining them. (Melorose et al., 2015).



Research Location

Jerambah Gantung Village is one of the areas in Gabek sub-district, Pangkalpinang City, Bangka Belitung Islands Province. Jerambah Gantung Village as the name implies has a bridge that connects the village with Balunijuk Village, Merawang District. If you pass the road, it is still half the journey covered with asphalt and the rest is still red soil that raises dust. Along this road there are still no street lights available so that this road access is often used during the day only because it will pose a great risk if you pass it at night.

Stages of Research

a. Data Preparation and Collection Phase

The preparatory phase includes steps such as identifying and formulating problems, conducting literature studies, as well as preparing methodologies and planning projects.

In collecting this research data, secondary data is used which is information that has been collected, compiled, and analyzed by other parties. Secondary data is a type of information that is not directly obtained by researchers from original sources or personal experience, but rather comes from pre-existing sources (Eko Ihsanto, 2016).

Observation

In the observation process, the object of research was observed to understand the initial condition of the location of the hanging girder road and the current installation of public street lighting

Documentation

The use of documentation is carried out to collect specific data, especially regarding road segments and their length for planning public street lighting with the use of solar panels.

b. Data Processing and Analysis Stage

Existing data is then processed using data examination techniques, classification, verification, and conclusion. Continued with the analysis calculation technique as follows:

1. NPV (Net Present Value)

Net Present Value (NPV) is a method in financial planning that measures the profitability of a project investment plan by considering the time value of money. NPV is used to evaluate projects by taking into

account the present value of expected future cash flows by applying a discount using the relevant interest rate. (Artiyasa et al., 2021).

$$NPV = \sum_{t=0}^n \frac{CF_t}{(1+r)^t} - C_0 \dots 1.1$$

CF_t : cash flow in the period t
 r : discount rate
 n : number of years (economic life) of the project
 C₀ : initial investment

If the NPV shows a positive number, it indicates that the project being carried out is considered feasible because it has the potential to provide benefits. Conversely, if the NPV is negative, it indicates that the project is not worth continuing because it has the potential to result in losses. When the NPV value is equal to zero, it means that the projected investment value does not cause significant gains or losses.

2. IRR (Internal Rate Of Return)

The internal rate of return, otherwise known as the internal rate of return (IRR), refers to the interest rate of a project over a certain period. The IRR approach is used to assess whether an investment is worth it by finding an interest rate that makes the present value of expected gains equal to the present value of the cost of capital (NPV = 0). In this method, the time value aspect of money has been considered by basing cash flow on the cost of capital or interest rate applied. Projects with an internal rate of return that exceeds the discount rate or financial policy of the enterprise are considered profitable.

$$IRR = i_t + \frac{NPV_1}{NPV_1 + NPV_2} \times (i_2 - i_1) \dots 2.1$$

Where:

NPV₁ : NPV at interest rate i₁
 NPV₂ : NPV at interest rate i₂
 i₁ : Discount rate that results in NPV₁
 i₂ : Discount rate resulting in NPV₂

3. BCR (Benefit Cost Ratio)

Benefit cost ratio (BCR) is a ratio used in economic analysis to compare the benefits of a project. BCR, or Benefit-Cost Ratio, is a common method of analysis in project selection that is done easily, namely

by comparing the benefits with the costs involved.

$$BCR = (\text{Total benefit}) / (\text{Total cost}) \dots 3.1$$

Total benefit : the value of benefits resulting from the project

Total cost : Total costs incurred to carry out the project

If the BCR value is greater than 1, it indicates that the benefits obtained outweigh the costs incurred, so the project is considered to have viable or profitable economic value. If the BCR is less than 1, it means the benefits are less than the costs, and the project is considered uneconomical or considered unprofitable. If the BCR is equal to 1, it means that benefits equal costs, so the project is considered "break-even" in terms of economics.

4. PP (Payback Period)

Payback period is the duration of time it takes to return capital or investment calculated based on net cash flow. This net cash flow is the difference between revenue and expenses each year. Usually, the payback period is expressed in units of years.

$$PP = (\text{nilai investasi}) / \text{pendapatan} \times 1 \text{ tahun} \dots 4.1$$

To calculate the analysis of this financial aspect, use the current interest rate of 5% per year.

Results and Discussion

Project Design



The planned street lighting for the Pangkalpinang City Hanging Jerambah is 1,500 meters long using 30 light poles with a distance of 50 meters per pole.

The use of solar energy as renewable energy has been widely done to produce environmentally friendly energy. Solar energy has the principle to convert sunlight into electrical energy using solar panels. The electricity generated by solar panels depends on the intensity of sunlight and the operating temperature of solar panels. The electricity generated by solar panels also depends on weather conditions and the location of sunlight which often changes, causing the output power of solar panels to fluctuate or show conditions and conditions are not fixed or varied and do not always maintain at maximum capacity conditions. Solar cells can be the same as devices with two terminals or connections, where conditions are dark and bad.

A. Financial Analysis

1. Net Present Value (NPV)

Table 3.1 Net Present Value (NPV) 10%

| Year | Cash Flow | Present Value |
|--------|-----------------|-------------------|
| Year 0 | IDR 855,700,000 | IDR 855,700,000 |
| Year 1 | IDR 496,306,000 | IDR 451,187,273 |
| Year 2 | IDR 470,635,000 | IDR 388,954,545 |
| Year 3 | IDR 487,749,000 | IDR 366,453,043 |
| Year 4 | IDR 453,521,000 | IDR 309,760,945 |
| Year 5 | IDR 444,964,000 | IDR 276,287,636 |
| | Total PV | IDR 1,792,643,442 |
| | NPV 10% | IDR 936,943,442 |

Source : Data Processed (2023)

Table 3.2 Net Present Value (NPV) 15%

| Year | Cash Flow | Present Value |
|--------|-----------------|-----------------|
| Year 0 | IDR 855,700,000 | IDR 855,700,000 |
| Year 1 | IDR 496,306,000 | IDR 431,570,435 |
| Year 2 | IDR 470,635,000 | IDR 355,867,675 |
| Year 3 | IDR | IDR |

| | | |
|--------|-----------------|-------------------|
| | 487,749,000 | 320,702,885 |
| Year 4 | IDR 453,521,000 | IDR 259,302,104 |
| Year 5 | IDR 444,964,000 | IDR 221,225,749 |
| | Total PV | IDR 1,588,668,847 |
| | NPV 15% | IDR 732,968,847 |

Source : Data Processed (2023)

2. Internal Rate of Return (IRR)

Known

$$i_1 = 10\% \quad NPV_1 = \text{IDR } 936,943,442$$

$$i_2 = 15\% \quad NPV_2 = \text{Rp } 732,968,847$$

$$IRR = i_1 + \frac{NPV_1}{NPV_1 + NPV_2} \times (i_2 - i_1)$$

$$IRR = 10\% + \frac{\text{Rp } 936,943,442}{\text{Rp } 936,943,442 + \text{Rp } 732,968,847} \times$$

$$(15\% - 10\%)$$

$$IRR = 10\% + \frac{\text{Rp } 936,943,442}{\text{Rp } 1,669,912,289} \times 5\%$$

$$IRR = 10\% + 0.56 \times 5\%$$

$$IRR = 10\% + 2.8\%$$

$$IRR = 12.8\%$$

2. Benefit Cost Ratio (BCR)

$$\text{Benefits} = \sum PV \text{ manfaat } (1 - 5)$$

$$= \text{IDR } 1,792,643,442$$

$$\text{Cost} = \text{IDR } 855,700,000$$

$$B/C = \frac{\text{Benefit}}{\text{Cost}} = \frac{\text{Rp } 1,792,643,442}{\text{Rp } 855,700,000}$$

$$B/C = 2.09$$

3. Payback Peroid (PP)

Known

$$\text{Investment Value} = \text{IDR } 855,700,000$$

$$\text{Income} = \frac{\text{Rp } 2,353,175,000}{5}$$

$$= \text{IDR } 470,635,000$$

$$PP = \frac{\text{Nilai Investasi}}{\text{Pendapatan}} \times 1 \text{ year}$$

$$PP = \frac{\text{Rp } 855,700,000}{\text{Rp } 470,635,000} \times 1 \text{ year}$$

$$PP = 1.18$$

Operating expenses are work plans that cover all the main activities of the company in obtaining revenue in a certain period. Therefore, the operating budget includes:

- Preparatory Costs are costs incurred prior to Construction. The required preparation fee is IDR 14,500,000.
- Operating costs are costs incurred to pay for labor, electricity, water and telecommunications, hygiene and consumables. Operational costs in this

construction amounted to Rp 306,600,000.

- c. Investment costs are the costs incurred to make investments such as the purchase of assets. The required investment cost is IDR 13,600,000.
- d. The renewal/replacement fee is an additional cost in the development process. The required renewal fee is IDR 400,000,000.

From the calculation of the financial feasibility analysis of the Street Lighting Construction project in Jerambah Gantung Pangkalpinang City, that in the construction of this project was declared financially feasible using Net Present Value (NPV) analysis with an interest rate of 10% getting a result of IDR 936,943,442 and an interest rate of 15% getting a result of IDR 732,968,847, and an Internal Rate of Return obtained a value of 12.8%, and Benefit Cost Ratio (BCR) with benefits of IDR 1,792,643,442 and costs of IDR 855,700,000 resulting in a value of 2.09. In the Payback Period calculation, the result is 1.18. So within a period of 1.18 years, the investment capital from the solar power plant public street lighting project along Jalan Jerambah Gantung Pangkalpinang City can be returned.

The installation of lighting along Jerambah Gantung aims to make it easier for road users and vehicle drivers to see clearly the road or terrain that will be passed at night. This is expected to improve traffic safety and security of road users from potential accidents and criminal activities. In addition, the existence of street lighting also helps facilitate access to economic activities.

Conclusion

Based on the calculation of the financial feasibility analysis of the PLTS public street light construction project along the Hanging Jerambah Pangkalpinang City using NPV (net present value), IRR, the construction of the project is declared feasible from all financial aspects (internal rate of return), BCR (benefit-cost ratio) and PP (return period of investment).

The budget used to plan the construction project of public street lighting solar power plant on Jalan Gantung Jerambah Pangkalpinang City uses funds from the 2024

Pangkalpinang City Regional Budget of Revenue and Expenditure.

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Conflict of Interest

The author conducted research as a road user who needs access to lighting. In this case, the author as a designer provides the feasibility of a street lighting project.

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