



Planning for Solar Power Plant Installation On-Grid Based

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Abstract. The increasingly rapid development of science and technology has led to the emergence of new technologies in the industrial sector. Renewable energy was developed to meet the increasing energy needs in Indonesia, especially in the renewable energy sector. Renewable energy is used to meet these needs through solar panels, which can be used both off-grid and on-grid. However, the use of renewable energy from solar panels is not only beneficial for the environment but also contributes to the fossil fuel crisis. Therefore, this research is needed to develop an on-grid PLTS system that requires solar panels and is connected to the PLN network. In this paper, A planning for solar power plant installation is purposed. It is including to determine the solar power plant location point, KWH meter and sharing panel location point, roof site condition, roof area measurement, balance of system (BOS) measurement and energy saving planning and calculation. All of the process is implemented in Satker Polda Jatim. The estimated savings results can be known as an amount of Rp. 50,710,597 per month when solar panel is installed in that place.

Keywords: solar power plant, renewable energy, on grid, off grid

1. Introduction

The development of science and technology continues to develop along with the progress of the times. This encourages the creation of new technology, especially in industry. With increasingly advanced technology, this encourages university graduate students to be required to always innovate and have the skills and expertise to always innovate and have the skills and expertise to face the needs of future industry.

The use of renewable energy continues to be developed to meet electricity needs in Indonesia, which increase every year. This is because currently the greatest supply of electrical energy depends on fossil energy sources. One source of renewable energy is solar energy which can be utilized to generate electrical energy using PLTS [1].

Increasing practical and flexible electrical energy can support national energy security by reducing the use of fossil energy, therefore utilizing solar energy to meet electricity needs through the use of solar panels solar energy can be utilized with

off-grid and on-grid systems, apart from that, limited land is the main problem in building PLTS on a household or industrial scale, so for this problem the solution taken is to build a rooftop PLTS.

The problem of saving electrical power is something that needs to be re-addressed in research because it requires electrical energy for the continuity of human life on earth. The use of renewable energy sourced from sunlight is not only intended for home life, but considering the fossil fuel crisis. There have been many developments in solar power plants using battery storage media to store the energy produced by solar panels. However, using batteries actually increases installation and maintenance costs. Based on the above, research was carried out to plan for on-grid PLTs whose use does not require batteries. Instead, it is directly connected to the PLN network to share power with the shared load with the PLN network [3].

Excessive use of electricity from PLN has become an increasingly pressing problem for society today [4]. Even though electricity has become a basic necessity in daily life, excessive use has negative impacts. The more excessive electricity use, the more natural resources are needed to produce electricity and this also has an impact on high electricity bills [5]. Therefore, renewable energy is really needed to save costs and save on PLN electricity use.

This is the background for the author to discuss and further explore the Survey and Design of On-Grid Solar Power Plants in 49 East Java Regional Police Satker. This is where the regional police working unit experienced a very high spike in electricity costs so that to overcome the very high billing costs the East Java regional police working unit chose PLTS on grid as the solution.

2. Method

2.1. Definition of ON-Grid PLTS

ON-Grid PLTS (Solar Power Plant) is a solar panel system that is connected directly to the PLN main electricity network or the electricity grid [6]. In this system, solar panels produce electricity from solar energy, and the electricity produced can be directly used by the house or building where the solar panels are installed.

2.2. Definition of PLTS Survey

A PLTS survey is an inspection and assessment process to determine the potential, needs and design of a Solar Power Generation (PLTS) system at a particular location. The aim of the PLTS survey is to collect the information needed to plan efficient and effective PLTS installations [7]. This survey process is usually carried out by experts or technicians who have knowledge of solar energy and electrical installations. The PLTS survey involves several stages, including:

1. Site evaluation: Identify the location where solar panels will be installed. This involves assessing aspects such as building orientation, roof slope, daylighting, and potential obstructions such as trees or other structures.
2. Energy metering: Collect data about electrical energy consumption at the location to determine how many solar panels are needed to meet energy needs.
3. Financial analysis: Calculating initial investment costs, potential electricity savings, payback period, and other potential benefits from PLTS installation.

2.3. Survey and Planning of On-Grid PLTS 49 Satker Polda Jatim

Several implementation stages in the On-Grid PLTS survey begin with the stage of using the project method concept. The project method in Figure 1 is a set of planning concepts and working on products that are well prepared and organized to achieve goals [8]. The following stages of survey implementation can be seen in the following flow diagram:

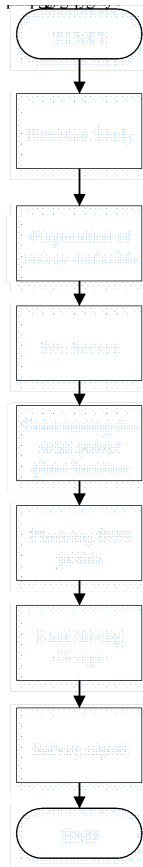


Fig. 1. Project method flowchart

2.4. Implementation Method

2.4.1. Potential Study

A potential study is an initial stage carried out as a general study to collect and obtain data so that it can be developed or used to carry out survey activities for Solar Power Plants or better known as PLTS. Potential studies include data collection and analysis, modeling, and risk assessment to provide the information necessary to make informed decisions regarding the steps to be taken.

2.4.2. Preparation of Survey Materials

Preparation of survey materials is an important step in ensuring that the survey conducted will provide accurate, relevant and useful results. The following is the preparation of materials and tools for the On-Grid PLTS survey:

- The Material including as follows
 1. Preparing data from the East Java Regional Police and Satker
 2. Prepare a survey form for all police stations and East Java Regional Police Units
 3. Preparing Survey Routes for East Java Police and Satker Polda
- Tools
 1. Wheel Meter

The wheel meter is presented in figure 2. It is a measuring instrument used to measure the area of the PLTS installation area by counting the number of wheel revolutions and converting it into distance units such as meters.



Fig. 2. Wheel Meter

2. Digital Meter and Manual Meter

The digital meter and manual meter in Figure 3 are two types of wheel meters used to measure distance or area of the BOS. The main difference between the two is in the way they measure and display information.



Fig. 3. Digital and Manual Meters

3. Drones

Drones, or in technical terms referred to as Unmanned Aerial Vehicles (UAV) in Figure 4 are unmanned aircraft that are controlled remotely or autonomously using remote control technology. Drones are needed to survey installation locations which cannot be done directly.



Fig. 4. Drones

3. Result and Discussion

3.1 PLTS Location Survey

On-Grid PLTS Location Surveys are carried out in sequence, where direct location surveys function to make work or installation of PLTS easier and to find out which location points will be installed, direct location surveys must pay attention to several things that must be carried out, sequence of On-Grid PLTS Location surveys -Grid, as follows:

1. Determining the PLTS Installation Location Point

The activity in Figure 5 is the first step in a PLTS survey, where to determine the installation point there are several factors that must be taken into account, namely the condition of the building, the type of roof used, the roof frame installed, the height of the building, the greatest power usage, the direction the building is facing. To make it easier to determine the location point to be installed, you need to use the G-earth application. For example, the location point of the Gresik Police



Fig. 5. G-Earth Gresik Police

Determining the installation location point is also accompanied by signs and letters, where the building can support the solar panels that will be installed later.

2. KWH Meter and Share Panel Location Points

The next activity after determining the location point where the PLTS will be installed is surveying the KWH Meter and Sharing Panel location points in Figure 6 at the surveyed Police Station. This activity also has an impact on the next stage. The KWH Meter location points that will be surveyed are determined from the PLN police station rates.



Fig. 6. KWH Meter Location Points and Share Panels

3. Roof Site Survey

The roof location survey in Figure 7 is to see the condition of the roof where the PLTS will be installed, where the building is seen from the type of roof, type of roof frame, objects on the roof, the building is not lower than adjoining buildings, this is done directly or using a drone.

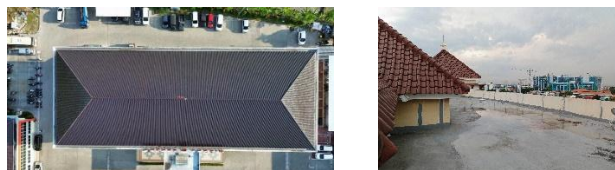


Fig. 7. Survey of Roof Locations Directly or Using Drones

4. Roof Area Measurement

Measuring the Roof Area in Figure 8 is a very important activity to carry out, where measuring the roof area can determine the planning of how many solar panels will be installed at the police station and measuring the roof area also makes it easier for the next process, namely planning how much costs will be saved after installing the solar panels.



Fig.8. Roof Area Measurement

This measurement was carried out using 3 methods of measuring the roof area directly, measuring around the building area, and measuring using the G-earth application. This occurred due to several factors where the place being surveyed could not be accessed directly or had no possibility of access. Basically, these 3 methods are the same to find out how large the roof area is on the building where the solar panels will be installed.

5. BOS (Balance of System) Measurement

The BOS (Balance of System) measurement in Figure 9 was carried out after surveying the location points of the panels for those carried out previously. This activity was carried out for the placement of the ACDB and Inverter panels that will be used. Measurements use a manual meter or digital meter.



Fig. 9. Area Measurement of BOS

It is important to know that BOS measurements can be carried out and can be done because this is done for several reasons. Where the survey locations, namely the 49

East Java Regional Police Satker, not all of them are allowed to measure BOS, for example the hospital ranks. Bhayangkara East Java Regional Police.

6. Savings Planning and Calculation

Planning and Calculations are shown in Figure 10 as an example of a roof to be installed. This calculation is carried out to estimate how much PLTS capacity is needed, estimating how much savings will be after installing PLTS. Gresik Police Calculation:

- Main Building
- Location Coordinates : -7.1671905, 112.6093065
- Roof Area : 21.5 x 55.5 m
- Roof Type : Rooftile
- Types of Roof Frames : Galvalum
- Mounting Type : Roof-hook
- Building height : ±13m (3 Floors)



Fig. 10. Rooftop Drone Survey Results

Estimated Area Available	: 835 m ²
PLTS Capacity Estimation	: 835 m ² x 80%
	626 m ² x 21.5%
	134 kWp
PLTS Energy Estimation	: 134 x 1569 kWp/kWh
	421,417 kWh/year
	35,118 kWh/month
Estimated Savings	: Rp. 50,710,597 / month

In calculating the cost savings if PLTS is installed in the main Gresik Police building, several sequences are calculated from the estimated area of 835m² multiplied by the roof slope tolerance of 80% then the result of the multiplication is 626 m² multiplied by 21.5% which can be seen from the PV datasheet in figure 3.8, the result is the estimated capacity of the PLTS that will be installed in the main building, then the calculation of the estimated PLTS energy which results in the estimated PLTS capacity being 134 kWp multiplied by the PV Out which can be seen in figure 3.10 with a large capacity of 1569 kWp/kWh the result of the addition is 421,417 kWh/year divided by 12 (Number of months in 1 year) with the result 35,118 kWh/month then multiplied by the amount of TDL (Basic Electricity Tariff) at PLN, namely 1,444 taken from the TDL standard so that the estimated savings results can be known as an amount of Rp. 50,710,597 / month.

Datasheet in Figure 11 is a datasheet for Longi brand solar panels as a reference for efficiency, which is what percentage of the panel produces electricity and this datasheet is also a reference for calculating savings after installing PLTS.

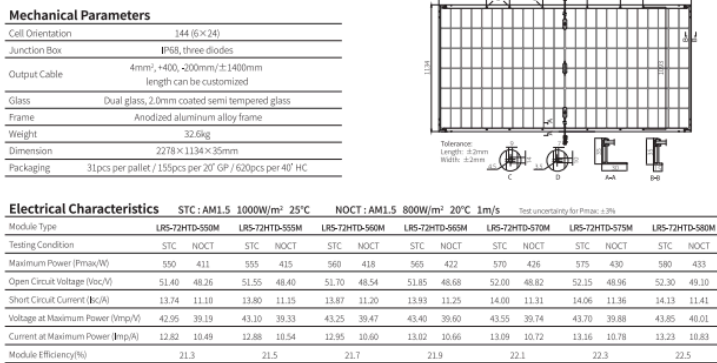


Fig. 11. Longi Solar Panel Datasheet

Carrying out savings calculations for each survey also requires the help of additional software, namely Global Solar Atlas or it can also be found on the website in Figure 12, namely www.globalsolaratlas.com. This software helps to find out how much heat radiation there is in each area because the radiation produced by the sun is not always the same. For example, in Figure 13, the heat radiation in the Gresik area, East Java is around 1,569 PV Out.

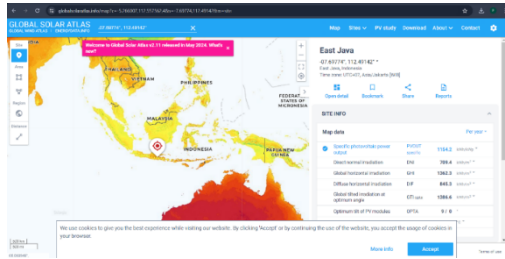


Fig. 12. Global Solar Atlas website

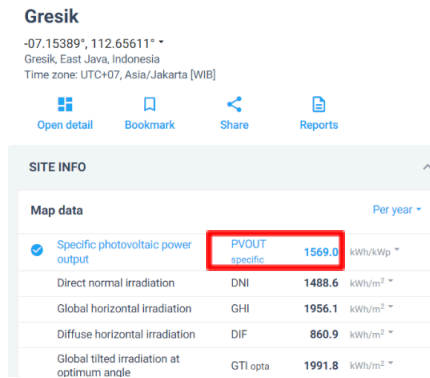


Fig.13. Gresik City Radiation at PV Out

3.2 Survey Report

A survey report is a document prepared after conducting a survey to analyze and present the survey results systematically. This report serves to provide a comprehensive overview of the findings obtained from the survey. What are the contents of the survey report prepared as material for the next study, as follows:

- Precinct Police Plan
- Savings planning calculations
- List of monthly electricity bills
- Documentation of PLN kWh meters and share panels
- BOS measurement documentation

4. Conclusion

Installing PLTS on grid in this plan can produce savings which can reduce costs for the East Java Regional Police Satker which is calculated in direct surveys in the field. PLTS installed on the grid

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article (salin dan tempel kalimat ini ke naskah).

References

1. Chairat, ASN (2020). Socialization of the Use of Solar Energy as a Source of Electrical Energy in Ciherang Pondok Village, Bogor Regency. Community service journal illuminates the country.
2. Ramadhana, RR, Iqbal, M., Hafid, A., & Adriani, A. On Grid PLTS analysis. Vertex Electro, **14**, 1, 12-25 (2022). doi : <https://doi.org/10.26618/jte.v14i1.9143>
3. Pratiwi, NF, Pudin, A., & Mursanto, WB, Design of on grid rooftop PLTS with Capacity 163.8 kWp for power supply for textile industry. In Proceedings of the Industrial Research Workshop and National Seminar, **13**, 297-303 (2022)
4. Gultom, J.E., Analysis and Design of a 120 Watt Digital Power Supply Using 2 PLN Inputs and a Solar Cell (Doctoral dissertation, Bengkalis State Polytechnic), (2022)
5. Desti, I., & Ula, A. (2021). Analysis of Natural Water Resources. Indonesian Journal of Educational Science (JSEI), **3**, 2 (2022)
6. Pramayasa, IPY, Kumara, INS, & Setiawan, IN, Survey of Initial investment costs for rooftop PLTS in Indonesia, SPEKTRUM Journal, **9**, 3, (2022)
7. Putra, FF (2023). Planning for 2 mWp Rooftop On-Grid PLTS Using Helioscope in Industrial Areas.
8. Hariansyah, M, Planning and installation of electrical installations, 28-36. (2015)

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