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Planning Study of Solar Power Plant (PLTS) in Lelewi Village, Gane Tengah District, South Halmahera Regency

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Lelewi Village, Gane Tengah District, South Halmahera Regency, there are 80 families (heads of families) whose livelihood is farmers and fishermen. Geographically, Lelewi village is located in an area with a fairly high potential for solar energy, making Lelewi village a suitable place for the construction of a Solar Power Plant. Frequent sudden power outages due to lack of load capacity and natural disturbances (such as broken branches and trees and animals) cause a large number of electronic equipment to be damaged. And the operating time of PLN starts from 18.00 – 07.00, so a Solar Power Plant (PLTS) system is designed for use during the day only.So that this research will be discussed in more depth about the Analysis of Power Calculation at Solar Power Plants in Lelewi Village, South Halmahera Regency. To design an electric energy plant so that it meets the load needs for 10 years in Lelewi Village, South Halmahera Regency, it is necessary to carry out a load forecast (forecast electricity load). The method used to carry out load forecasting is the Linear Regretion method. Solar power energy is calculated at 50% of the daily load during the day, total electrical energy that can be generated from solar power plants is 12 Wh. The solar components used after accounting for the need for electrical power backup are 48 100 wp solar panels, 48 units of 12V voltage batteries with a capacity of 100 Ah which are expected to be charged in about 10.05 hours, 2 units of solar charger controllers, and 1 unit of inverter with a capacity of 226.25 Watts.

Keywords: Android, Malfunction, Expert system, Reliability, Accuracy

1. INTRODUCTION

In Indonesia, electricity problems arise due to the need for electrical energy which increases faster than PLN's ability to meet the supply of electrical energy. As a result, there are rotating blackouts and there are still several areas in Indonesia that have not been electrified. The ratio of the number of people in a country who enjoy electricity to the total population in that country is called the electrification ratio. In 2014, the national electrification ratio was 84.12%, which means that only 16% of Indonesian people have not been electrified. In the household sector, as many as 10 million households that have not been electrified, the sector is spread evenly throughout Indonesia. One of the reasons is the geographical location which is generally remote and far from the PLN electricity network.

Lelewi Village, Gane Tengah District, South Halmahera Regency, there are 80 families (heads of families) whose livelihood is farmers and fishermen. Geographically, Lelewi village is located in an area with a fairly high potential for solar energy, making Lelewi village a suitable place for the construction of a Solar Power Plant. Now in Lelewi village, electricity has been supplied from PLN, but there are frequent sudden power outages from PLN which cause a lot of electronic equipment to be damaged.

Frequent sudden power outages due to lack of load capacity and natural disturbances (such as broken branches and trees and animals) cause a large number of electronic equipment to be damaged. And the operating time of PLN starts from 18.00 – 07.00, so a Solar Power Plant (PLTS) system is designed for use during the day only. In general, the analysis of the power consumption of Centralized Solar Power Plants is carried out based on load usage, including, the power generated by solar panels is distributed based on the system and reaches the load user or consumer. So that this research will be discussed in more depth about the Analysis of Power Calculation at Solar Power Plants in Lelewi Village, South Halmahera Regency.

This research is specifically a study of the use of new and renewable energy, especially the use of solar energy. The issue of renewable energy, especially the use of solar energy, has not only become a national issue but has become a global issue, especially related to climate change, so that the use of solar energy in the electricity sector is expected to be able to encourage the energy transition process so that it can reduce carbon emissions in nature which can ultimately prevent the process of climate change.

It is necessary to increase the effectiveness of installing solar power plants by prioritizing and selecting suitable locations to maximize electricity generation and minimize the damage that may occur. The results of such site evaluation can help solar utility companies, energy companies, and policymakers select potential sites for the construction of solar power plants [1] - [3].

Chen et al. [7] proposed an evaluation model of demand-side energy resources (DSER) for urban power grids based on geographic information. The commonality and individuality indices for five kinds of DSER, revolving wind power generation, photovoltaic power generation, electric vehicles, energy storage, and flexible load, were selected based on geographic information. Then, the weight of each sub-index of the commonality and individuality indices was determined by the analytic hierarchy process (AHP) and entropy weight method. Finally, the weighted overlay was generated according to the weights and quantized values of each index, and a comprehensive score was obtained from the commonality indices [4]. The results depicted that the evaluation model is beneficial for the planning of the city and the power grid [5].

The installation of PV panels on the ground can cause some problems, especially in countries where there is not enough space for installation. As an alternative, floating PV, with advantages in efficiency and for the environment, attracted attention [6] [7]. Kim et al. [8] analyzed the water-level data from 3401 reservoirs in South Korea and selected suitable reservoirs for floating PV systems, with an average reservoir water depth greater than 5 m and minimum water depth greater than 1 m. The results were utilized to estimate priorities and potentiality prior to the actual floating PV installation and detailed analysis. Before installing a solar power system, it is crucial to ensure that the system is not over- or undersized. Therefore, the designer should investigate the viability of the system carefully to operate in optimum conditions regarding produced unit costs and power reliability. Alsadi and Khatib [9] reviewed the sizing procedures of grid-connected and standalone PV systems, including system component modeling, available optimization software, optimization criteria, optimization methods, and sizing constraints. The study revealed that PV modeling and battery modeling are essential in system sizing optimization to predict the systems' performances. The performance of a PV system depends significantly on the tilt angle of the PV panels. Chou et al. [10] conducted a wind-load analysis using wind tunnel experiments and numerical simulations for a stand-alone panel at high tilt angles. The effects of wind direction were also investigated. The findings of this study will be useful for the detailed structural design of offshore PV panels.

2. METHOD

To design an electric energy plant so that it meets the load needs for 10 years in Lelewi Village, South Halmahera Regency, it is necessary to carry out a load forecast (forecast electricity load). The method used to carry out load forecasting is the Linear Regretion method. The following is the data on load needs for Lelewi Village, South Halmahera Regency.

A. Load Data, Load Operating Hours and Load Profile

Based on calculations below 79,000 Wh is the maximum limit of electrical energy quota in residential houses, mosques and schools. By using the calculation of electrical energy needs in the table above, the load profile of the resident's house can be determined as shown in the figure below:

Table 1. Calculation of Electricity Needs

No.	**Load type**	**Sum**	**Power**		**Operations per day**		**Energy requirements**		**Energy Requirements Per Month Wh**	**Total Daily Needs (Wh)**
			Noon (watt)	Night (watt)	Noon (Hour)	Night (Hour)	Noon (Wh)	Night (Wh)		
1	House	78	35	65	6	12	210	780	990	77220
2	School	1	60	20	6	6	360	120	480	480
3	Mosque	1	60	96	2	6	120	576	696	696
	Total Amount		155	181	14	24	690	1476	2166	78396

Based on the calculation table, the daily energy requirement for home lighting is 78396 Wh so it is rounded to 79,000 Wh or 79 kWh.

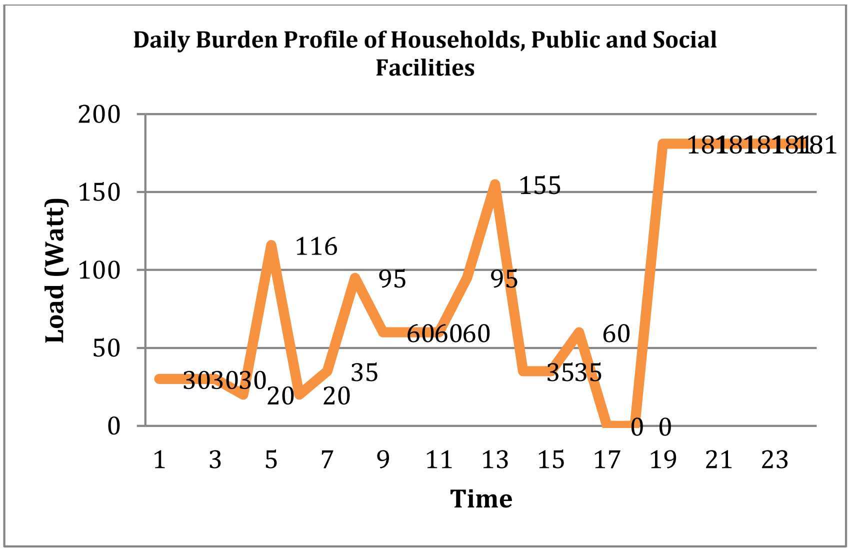

Figure 1. Daily Load Profile

B. Solar Power Peak Power

To determine the peak power of the solar power plant, daily average irradiation data is needed at the location. To obtain the data can be retrieved on a source available online for this planning used https://globalsolaratlas.info/. Berdasarkan the source the daily average irradiation is 5,211 kWh/m2 per day.

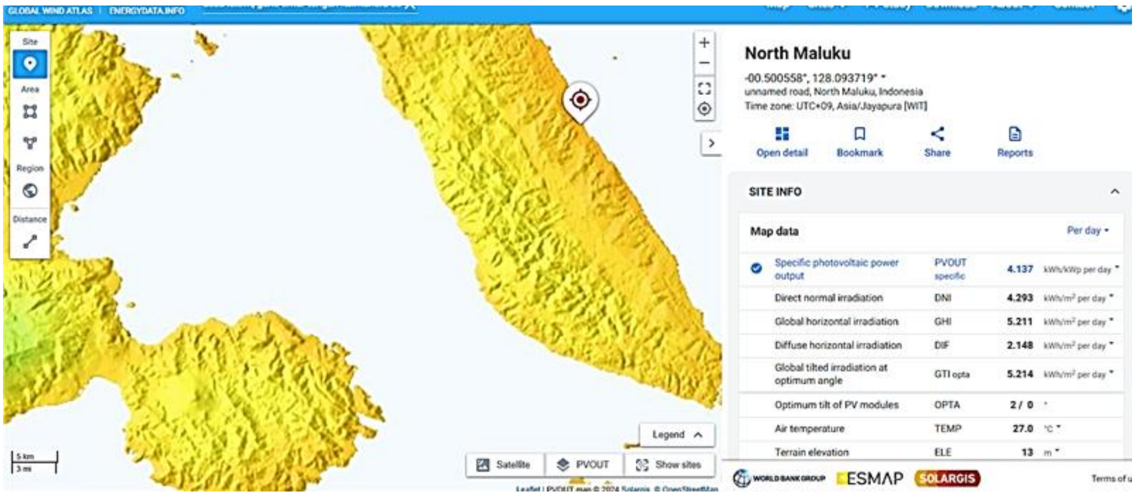

Figure 2. Daily average irradiation

3. RESULTS AND DISCUSSION

Integrated panel planning is only for a capacity of 80 households. The total amount of energy needs will be calculated based on the results of the survey for total energy consumption (ET) per day. In this solar PV planning, the solar panels used are monocrystalline solar panels so that the peak power of the solar PV is:

$$kW_{(peak)}PLTS = \frac{79}{5.211} = 15{,}16\ kWp$$

By considering the system losses of 25%, the peak power of the solar power plant is 11.37 kWp or rounded to 12 kWp.

Effective Area It is necessary to know in advance the area to be used and to know the size of the solar panel that will be used. It can be calculated by the following equation:

$$Area\ (m^2) = \frac{Peak\ Power\ PLTS}{Solar\ Module\ Efficiency}$$

$$Area\ (m^2) = \frac{12\ kWp}{0{,}14} = 85.71m^2$$

So that the effective area required is as large as:

$Effective\ \ Area\ (m^2) =\ 85{,}71\ x\ 2 = 171{,}42\ m^2$ So the land area needed is 172 m2

The number of modules required is:

$$Number\ of\ Modules = \frac{Module\ Peak\ Power}{Module\ Capacity} = \frac{12\ kWp}{250\ Wp} = \frac{12.000\ Wp}{250\ Wp} = 48\ bh$$

The number of modules needed is 48.

The energy from the battery required is:

$$Battery\ Energy\ Requirements = Total\ daily\ energy\ x\ \text{Autonomy Day}$$

$$Battery\ Energy\ Requirements = 79\ kWh\ x\ 2 = 158\ kWh$$

So the energy requirement from the battery is 158 kWh.

Maximum Load Power Capacity (Wmax) Based on the calculation table of electricity needs, the total maximum load occurs at night of 181 Watts.

The selection of the inverter is carried out by considering the power required. So:

$$Watt\ (VA) = Wmaks + (25\%\ x\ Wmaks) = 181 + (25\%\ x\ 181) = 226.25\ Watt$$

This value adjusts to the capacity of the inverter on the market. In this tension, an inverter with a capacity of 1500 VA, 1200 W and a voltage of 24 Vdc is used.

Battery Working Voltage and AH Determination

Determined:

1. Battery
   - 12 Vdc
   - 200 Ah
   - DoD 80%
2. Inverter
   - 1200 Watt
   - 1500 VA
   - 24Vdc
3. System Voltage is 24 Vdc

Then the number of series and parallel batteries is:

$$Number\ of\ Series\ Batteries = \frac{24\ Vdc}{12\ Vdc} = 2\ Seri$$

$$Number\ of\ Parallel\ Batteries = \frac{158.000\ Wh}{24\ Vdc\ x\ 200\ AH\ x\ 0{,}8} = \frac{158.000}{3.840} = 41{,}145 \approx 41\ paralel$$

The number of batteries required is

$$Number\ of\ Batteries\ =\ 2\ Series\ x\ 41\ Parallel = 82\ pcs$$

So the total number of batteries needed is 82 batteries

Power Capacity and SCC Calculation

Determined:

1. Peak Power
   - 12 kWp or 12.000Wp
2. System Working Voltage
   - 24Vdc
3. SCC current capacity

   The total current of SCC is:

$$I_{SCC} = \frac{Peak\ Power}{System\ Voltage} = \frac{12.000}{24} = 500\ \ Ampere$$

4. The number of SCCs required is:

$$Number\ of\ SCCs = \frac{SCC\ Current}{Selected\ current\ capacity} = \frac{500}{100} = 5\ pcs$$

5. SCC power is:

$$\text{power}\ SCC = \frac{12.000}{5} = 2400\ Watt$$

4. CONCLUSION

The results of the research on Solar Power Plant Planning as an Alternative Energy Source can be concluded, namely the Solar Power Plant System Planning in Lelewi Village, South Halmahera Regency aims to utilize alternative energy that has not been maximized in the area, solar power energy is calculated at 50% of the daily load during the day, total electrical energy that can be generated from solar power plants is 12 Wh. The solar components used after accounting for the need for electrical power backup are 48 100 wp solar panels, 48 units of 12V voltage batteries with a capacity of 100 Ah which are expected to be charged in about 10.05 hours, 2 units of solar charger controllers, and 1 unit of inverter with a capacity of 226.25 Watts.

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