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Solar Energy Potential In Regulating Pond Hydroelectric Power Plant Renun Using Helioscope

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Abstract

The availability of fossil fuels is increasingly depleting and environmental problems resulting from burning fossil fuels have an impact on environmental problems in the global region, so that efforts are needed to promote alternative energy sources called renewable energy. The Renun Hydroelectric Power Plant (PLTA) is one of the power plants located in Sidikalang which is very suitable for use as a Solar Power Plant (PLTS) which is located in a very large pool and because the Control Pool does not require excavation. for installation and more stable. By using the Helioscope software, the results were obtained in the form of solar panels used in floating PLTS on a pound controller totaling 20,441 solar panels with a Polycristaline model with a power of 300 Wp with the Blue Sun Solar Energy BSM270-300P-60 (300W) type, with the resulting power being 6.12 MWp , The batteries in the PLTS consist of 275 series and 3.5 parallel units so that the total battery required is 1,100 JYC batteries type OPzV3000, and 9 ABB brand inverters type PVI 500 TL CN with a power of 560 kW with a voltage of 360 and the value obtained is the calculation using BMKG data is 308,177 kWh while using Helioscope Software is 489,659 kWh for monthly.

Keywords : Regulating; Solar Power Plant; Renewable Energy; Helioscope

1. Introduction

Traditional energy fuels are decreasing at this same time and there are many people on this earth with overuse energy supply. The search for new energy has become an urgent issue facing humanity[1][2]. Government circles and social organizations both at home and abroad have tried to popularize alternative energy sources to to prevent excessive use of traditional energy, which is very important for the development of clean and sustainable energy known as renewable energy or often also called new and renewable energy [3].Based on the Electricity General Plan from 2009 to 2038 as stated in the Decree of the Minister of Energy and Mineral Resources of the Republic of Indonesia Number 060.Pers/04/SJI/2023 regarding the Bio-energy potential map, it can be 12.54 GW so that research is carried out related to the Renewable Energy is Sunlight. Sunlight is the largest source of energy and the potential to be cultivated is sunlight[4], considering that its potential is abundant in the territory of Indonesia at 4.8 kWh/m per day[5].

In addition, with solar cell technology, no greenhouse gases are produced when the process of solar energy is transformed into electricity so that the use of solar energy through solar cells is environmentally friendly and fairly easy to maintain[6][7]. By looking at this potential and environmental aspects, the concept of a backup power source is created by utilizing sunlight as an energy source. The system is conceptualized with the construction of backup solar panels (which can be used as energy to help reduce its main energy use), in

this concept planning of the area of solar panel fields and the ability of solar panels and the selection of the most appropriate solar panels is carried out. Although the potential is very large, the use of solar power plants is not widely use, due to the measurement of the intensity of solar radiation that has not been widely carried out so the output of solar panels can affect electrical power. Most measurements of solar radiation intensity in Indonesia are carried out at climatology stations[8].

Based on the Meteorology Climatology And Geophysics Council website accessed on 19 January 2023, the number of climatological stations in Indonesia itself is relatively limited, which is estimated to be more than 27 stations. For some areas that have hydropower plants in North Sumatra, there is no such measurement yet, but modeling can be done to obtain radiation intensity.One of the power plants located in Sidikalang North Sumatra and which has a water reservoir or called Regulating Pond with an area of 11.41 ha with a water storage capacity of 500,000 m3 is the Renun Hydroelectric Power Plant. The maximum water level is 1,370 m and the minimum water level is 1,365 m. It has a Regulating Pond with a large enough area which is very suitable for use in Solar Power Plants, because there are hidden from public view, have easier regulations for building over waters not used for recreation and does not require any dig for installation[9]. Based on recent background, analysis of the energy capacity of Solar Power Plants that can be generated in the Dairi Regency area, North Sumatra Province, to be used as electricity backup in the area around Renun Sidikalang. Next, the design of the floating PLTS will be carried out to determine the components needed in making solar panels and in particular to determine the energy capacity produced from installing solar panels in the Renun Hydropower Control Pool and analyzing the appropriate solar panels for PLTS in the Renun PLTA Control Pool. This can also help PLN in developing renewable energy, especially the design of floating PLTS.

2. Research method

Research method is scientific method used in an effort to find or obtain data for a specific goal or use. The methods used in this study can be seen in Figure 1

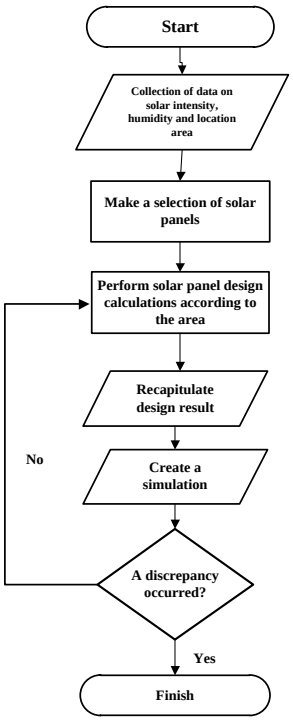

Figure 1. Planning research process for the floating PLTS design

In this method, the researcher determines the equipment needed in planning the floating solar panel design, performs calculations to find out which solar panels can be used at that location, then the researcher calculates the number of solar panels according to the area and performs simulations to ensure suitability using helioscope software.

3. Results and discussion

To be able to build a floating Solar Power Plant , there are devices that support those used in Solar Power Plant. The various types of devices are as follows:

A Solar Panels

Tools that use sunlight to generate electricity are solar panels[10]. Solar cells will rust and break easily if exposed to water[11]. Therefore this cell is made in the form of panels of a certain size covered with clear water-resistant plastic or glass[12][13]. These panels are known as solar panels. The solar panels used contain many modules and most of the crystalline solar PV modules are used for these floating systems[14][15]. To find out the area of a solar panel using length and width units, the following calculations can be used Equation (1)

$$N\ Modul\ Solar = \frac{P\ area}{P\ module} \quad (1)$$

B Inverters

Electronic equipment that functions to convert direct current energy into alternative current energy is called an inverter[16][17]. DC current is energy generated by solar panels, that's why an inverter is needed in a Solar Power Plant system .The inverter capacity calculation is calculated according to the peak load that must be supplied and calculated by adding the future margin factor, error margin and capacity factor. The number of inverters required is in accordance with the energy produced and the specifications of inverters on the market with the brand ABB type PVI 500 TL CN with a power of 560 kW with a voltage of 360 V, with Equation (2) as follows

$$\text{Inverter} = \frac{\text{WP Solar Panel x Efficiency}}{\text{Power of inverter}} \quad (2)$$

C The battery

Baterry is a Solar Power Plant element whose function is to store the electrical energy generated by solar panels during the day[18], then use it at night and during cloudy weather[19]. To calculate the battery capacity used, it can be formulated using Equation (3)

$$Battery\ Capacity\ (Ah) = \frac{Total\ daily\ energy}{Dc\ Voltage\ Inverter} \quad (3)$$

We can find out how many batteries are needed to produce the appropriate voltage by connecting a series of battery voltages on the market, following a series and parallel calculation are calculated by the Equation (4) and (5)

$$Series\ Arrangement\ = \frac{Total\ Battery\ Output\ Voltage}{Rated\ Battery\ Voltage} \quad (4)$$

$$Series\ Arrangement\ = \frac{Total\ Battery\ Output\ Voltage}{Rated\ Battery\ Voltage} \quad (5)$$

D Floaters

The buoy functions as a place for solar panels and media that makes solar panels stand above water[20]. The structure is designed so that it can accommodate many solar panels.

E. Wiring

Due to its use outdoors, specifically designed solar cables withstand UV and very high temperature fluctuations and are generally unaffected by the weather[21][22].

F Helioscope

HelioScope is program based web Which launched by Folsom Labs which possible para engineer for operate simulation design complete in form appearance 3D [23], possible user for know potency shadow or effectiveness every panel for placed from location which different. The helioscope is used to simulate energy production and describe the potential for solar energy in the Renun regulating pond.

Renun on the regulating pond which is shaded by State Electricity Company Pandan Generation Control Unit which has the address Silalahi III, Silahisabung, Dairi Regency, North Sumatra.Based on the floor plan of the Regulating Pond for the Renun Hydroelectric Power Plant, it is known that the area of the Regulating Pond is 11.41 ha, for the location of the Regulating Pond for the Renun Hydroelectric Power Plant is not covered or obstructed by other buildings or trees so that the area is suitable for installing solar panels with the following location Figure 2.

Figure 2: Regulating pond renun hydropower

For planning the implementation of a floating solar power plant in hydropower regulating pounds, the entire regulatory pond is used according to the area of the area, then planning for solar panels to regulate pounds is carried out in accordance with Meteorology Climatology And Geophysics Council data. In this study what is said to be the population is the sun intensity data and temperature humidity in Sidikalang every day. From the climate population data, only the daily average is taken every month which will be used as a sample. The data to be collected is from March 2022 – February 2023 shown in Table 1

Tabel 1. Average solar radiation intensity value

Month	Daily Radiation Intensity (Wh/m2)
March 2022	273,33
April 2022	151,46
May 2022	118,16
June 2022	288,10
July 2022	89,39
August 2022	148,51
September 2022	129,18
October 2022	124,96
November 2022	203,78
Desember 2022	90,42
January 2023	131,42
February 2023	90,10

To be able to build a floating Solar Power Plant, supporting devices used in are needed Solar Power Plant, such as:

I. Solar Module.

The solar module used in this simulation is Blue Sun Solar Energy BSM270-300P-60 (300W). Solar module specifications are listed in Table 2

Table 2. Blue sun solar energy solar module specification

Specifications	Information
Nominal Max. Power(Pmax)	300W
Opt. Operating Voltage(Vmp)	3,4V
Opt. Operating Current (Imp)	9,3 A
Open Circuit Voltage (Voc)	40,41V
Short Circuit Current (Isc)	9,7A
Efficiency Modules	18,37 %
power tolerance	+3%
Area (L xl) mm	1640 x 991

1) The Bouys

In accordance with the description of the buoy, 2 wide buoys are used so that the width used is 80.2 cm. For the media for installing solar panels, use the SP-102 Solar Main Float II type buoy with dimensions of 120,2 cm long and 80,4 cm wide, with a design installation as in Figure 3.The buoy functions as a place for the solar panels and a medium that allows the solar panels to stand on the water buoy. The number of solar panel floats with the SP-102 Solar main float II type corresponds to the number of solar panels, namely 21,488 floats. For walking floats, each solar panel requires 2 road floats so the number of road floats needed is 2 x 21.488 = 42.976 float.

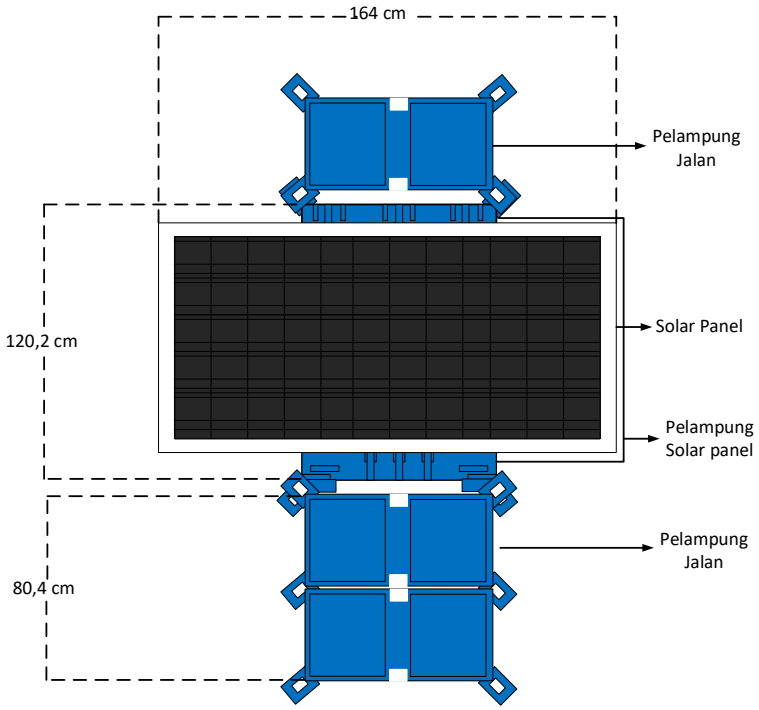

Figure 3. Installation of solar panel

2) Solar Panel

The number of solar panels can be calculated after installing the floats. The length of the solar panels still uses the original length of the solar panels, for the width of the solar panels, use the width of the floats holding the solar panels plus the width of the road using a walkway float with a value of 200.4 cm according to the installation design in Figure 3 is used using Equation (1)

$$N\ Solar\ Module = \frac{384,17}{1,64} x \frac{183,46}{2}$$
$$= 20.441$$

Next, the power that can be generated from the entire solar panel is calculated using the following calculations:

Solar panel power = 20.441 x 300 Watt power
= 6, 2 MWatt power

For the number of solar panel floats with type SP-102 Solar Main Float II, the number corresponds to the number of solar panels, namely 20,441 pcs of floats. For running floats, each solar panel requires 2 road floats so the number of road floats needed is 4x 20.441 = 40.882 pcs of buoys

3) Inverters

From the results of calculating the number of solar panels, the need for batteries as an energy storage medium is then calculated if the electrical energy produced is not directly according to Equation 2.

$$\text{Inverter} = \frac{6.446\ x\ 85\%}{560}$$
$$= 10 \text{ pieces}$$

4) The Battery

The battery is used as energy storage medium if electrical energy produced is not directly used according to Equation (3)

$$\text{Battery Capacity (Ah)} = \frac{288,10 \text{ Wh x } 21488}{550}$$
$$= 11.25 \text{ kAh}$$

5) Power Generated by Solar Panels

The amount of production resulting from calculating kwh production per month with the panel area used along with the monthly production can be calculated as follows

Solar Panels watt power = 21,488 x 300 Watt power
= 6.44 MWp

6) Series-Parallel Arrangement Configuration

By doing calculations that refer to battery voltage, we can find out how many batteries are needed to produce the appropriate voltage by connecting the series of battery voltages and parallel calculations to find out how many batteries are needed to achieve the expected current according to the battery current in market are calculate by Equation 4 and 5

$$\text{Series arrangement} = \frac{550 \text{ v}}{2 \text{ v}}$$
$$= 275$$
$$\text{Parallel arrangement} = \frac{11,25 \text{ kAh}}{3000\ Ah}$$
$$= 4$$
$$Total\ batteries\ are = batteries\ x\ parallel\ arrangement$$
$$= 275 \text{ x } 4$$
$$= 1100 \text{ Batteries}$$

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7) Solar Panel Production Result

Based on the total number of panels, the amount of production produced can be seen from the results of calculating monthly production kwh with the panel area used along with the monthly production results as in Table 3

Tabel 3. Monthly table of Kwh production of Solar panels

Month	Production(kWh)
March 2022	494.082
April 2022	314.342
May 2022	237.316
June 2022	597.922
July 2022	179.541
August 2022	308.216
September 2022	259.452
October 2022	259.353
November 2022	409.286
Desember 2022	187.665
January 2023	263.958
February 2023	186.994
Average	308.177

8) Helioscope Software

After the arrangement of the solar panels has been carried out, it is necessary to ensure that the wiring has been carried out and then the software can be run so that the energy results in the solar power plant design are obtained, along with the Helioscope design which can be seen in Figure 4. In the helioscope software, it is possible to recap the energy that can be produced by PLTS every month within a period of one year, shown in Table 4

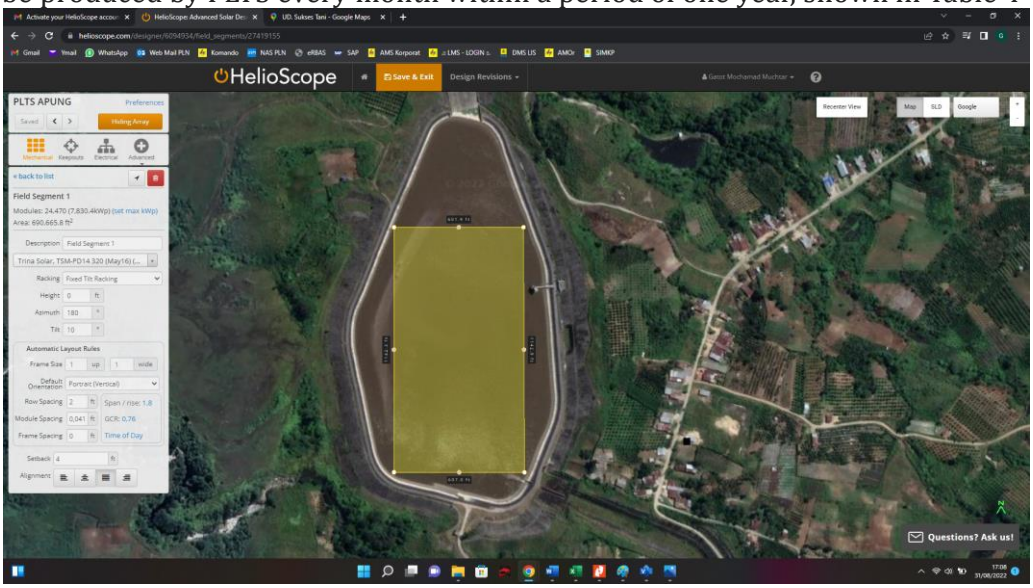

Figure 4 Solar panel design regulating pond renun hydropower with a helioscope

Table 4 Production of kwh according to the helioscope simulation

Month	kWh production
March 2022	429.827
April 2022	483.307
May 2022	547.314
June 2022	533.935
July 2022	538.282
August 2022	489.335
September 2022	518.819
October 2022	542.273
November 2022	488.328
Desember 2022	507.852
January 2023	437.419
February 2023	467.212
Average	498.659

9) Losses in Solar Power Plants

In the helioscope software, we can also find out other factors that influence so that solar panels are not optimal in producing energy, several factors that affect the non-optimal absorption of energy are commonly called losses or energy wasted on solar panels, in this study losses caused by parameters can be seen in Figure 6

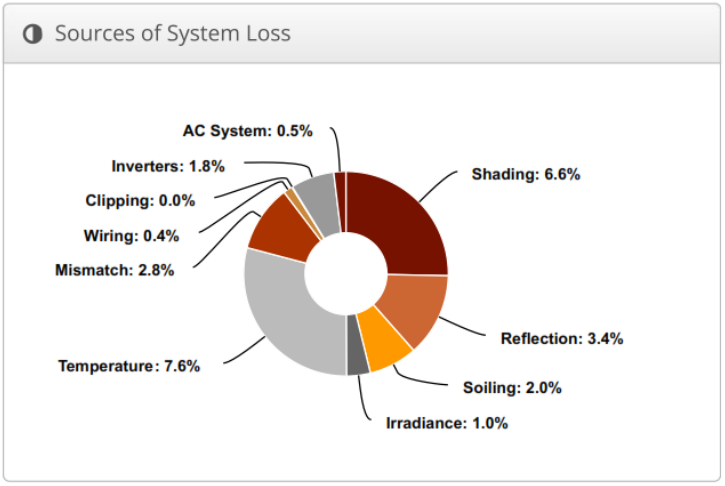

Figure 6 . Causes of losses in the solar power plant system

4. Conclusion

The conclusions obtained from research on the design of floating solar power plants in the Renun Hydropower Control Pool are as follows; The number of solar panels used in the floating PLTS in the Regulator Pool is 21,488 solar panels with a 300 Wp Polycristaline model with a generated power of 6.44 MWp. The solar float uses the SP-102 Solar Main Float II type with the same number as the number of solar panels installed, namely 21,488 pcs of floats and the walking float uses the SP-202 Walkway Float horizontal II type using 2 times the number of solar panels installed with the total requirement 42,976 buoys. The number of batteries in the Solar Power Plant is 275 in series and 4 in parallel so the number of batteries needed is 1,100 and 10 inverters. The potential results of the solar power plant planning carried out at the Pound Renun Regulatory Hydroelectric Power Plant, based on

data from the North Sumatra Meteorology, Climatology and Geophysics Agency and simulations using helioscope software, obtained a calculated value using data from the Meteorology, Climatology and Geophysics Agency of 308,177 kWh and monthly simulations using Helioscope Software of 489,659 kWh, can fulfill the electricity shortage in the Renun Sidikalang area and it is necessary to analyze the impacts produced after installing PLTS using the Floating method on the conditions of the installation site, whether there is silting or sedimentation or shallowing caused by faster growing aquatic plants, when not exposed to the sun.

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