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An Utilization Of Sunlight As An Alternative Energy To Support Energy Independence In Pematang Serai Village

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ABSTRACT

The utilization of renewable energy (RE) is a crucial solution to reduce dependence on depleting fossil fuels that negatively impact the environment. One of the most promising RE sources is solar energy, given Indonesia's tropical climate and abundant sunlight. This study aims to educate and raise awareness among the community of Pematang Serai Village, Langkat Regency, about using solar energy as an environmentally friendly alternative to support energy independence. The methods applied include field observation, public education through lectures and discussions, and a simulation of a simple solar power plant (PLTS) installation. The findings indicate high community enthusiasm for understanding the concept of solar energy and its technological applications. The simulation suggested the need for three 100 Wp solar panels, four 12V 75 Ah batteries, a 1500 Watt inverter, and a 20 Ampere solar charge controller to power a 286-Watt water pump for five hours. This program successfully raised community awareness of the importance of transitioning to cleaner and more sustainable energy sources. Additionally, it aligns with the government's effort to achieve a 23% national energy mix target by 2025. With abundant solar energy potential, Pematang Serai Village has significant opportunities to become an energy-independent village through the implementation of solar power technology.

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INTRODUCTION

Fossil fuels, such as oil, natural gas, and coal, have become the mainstay of meeting global energy needs. However, the resulting environmental impacts, including carbon emissions that trigger climate change, are a serious challenge. In addition, fossil fuel reserves are increasingly depleting, so there is a need for diversification of energy sources to ensure the sustainability of future energy needs. Renewable Energy (EBT) has emerged as a solution to replace conventional energy. One type of EBT that has great potential in Indonesia is solar energy. Indonesia's geographical location on the equator provides high sunlight intensity throughout the year, making solar energy an abundant resource with great potential to be utilized.

Pematang Serai Village, located in Tanjung Pura District, Langkat Regency, North Sumatra, has geographical and weather conditions that support the use of solar energy.

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With the majority of the population working as farmers, fishermen, and traders, the need for stable and economical energy is very important to improve community welfare. However, most people still rely on fossil fuels, so innovation is needed to introduce renewable energy technology, especially Solar Power Plants (PLTS). This study aims to provide socialization regarding the use of solar energy to the people of Pematang Serai Village, as well as provide technical insight into the simple installation of PLTS as an initial step in supporting energy independence in the village.

METHOD

This activity is carried out through a participatory approach, which actively involves the community in every stage of implementation. The methods used consist of: An initial survey was conducted to identify the geographical conditions of the village, the potential for solar energy, and the energy needs of the community. Data was obtained through interviews with village officials and direct observation at the location.

Counseling and Socialization.

Socialization is carried out using lecture and discussion methods. The materials presented include:

a. Solar energy basics.
b. The main components of a solar power plant are: solar panels, inverter, battery, and solar charge controller.
c. Example of calculating energy requirements for simple applications, such as water pumps.

Simulation Calculation and Demonstration

The team provided a simulation on how to calculate the need for PLTS components according to the energy load. In addition, a simple PLTS model was introduced with the prepared components.

Evaluation and Monitoring

An assessment of community understanding is carried out through discussion and Q&A sessions. Furthermore, an evaluation of the sustainability of the program is carried out through a return visit to see the implementation in the field. The procedures or research steps can be seen in the following flowchart:

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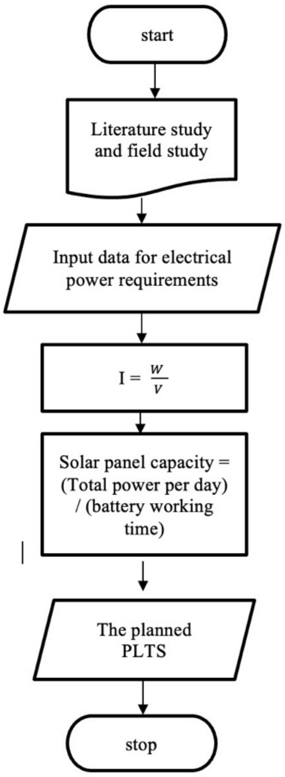

Figure 1. Research Flowchart

The research stage first by conducting field observations and literature studies related to the problem to be studied. Then collect the necessary data. The data is then analyzed by performing mathematical calculations to obtain how much current is needed and how many solar panels are needed in this study.

RESULTS AND DISCUSSION

This activity successfully involved village officials and the community of Pematang Serai Village. The enthusiasm of the community was seen during the counseling and discussion sessions, which showed a high interest in renewable energy innovations. The following are the main results of the activity:

Basic Understanding of Solar Energy

Participants understand that solar energy is a clean and environmentally friendly alternative. By utilizing the abundant sunlight in their area, communities can reduce their dependence on fossil fuels.

PLTS Calculation Simulation

In the simulation, the load that will be used is the Shimizu PS-128 BIT Water Pump Machine with Voltage (V) = 220 Volts, Frequency (f) = 50 Hz and Current (I) = 1.3 Amps. So the load of the water pump is: 220 x 1.3 = 286 Watts

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Time required for pump operation = 5 hours

So the total power in 5 hours is:

286 Watts x 5 hours = 1430 Watts.

Next, the total water pump current in 5 hours is:

$I = \frac{W}{V} = \frac{(1430\ Watt)}{12\ Volt} = 119{,}167A$

In 5 hours the pump requires a current of 119.167 Amperes, so in 1 hour the current required is 23.84 Amperes. Then, to determine the need for solar panels, the following formula is used:

Solar panel capacity = (Total power per day) / (battery working time)

$= \frac{1430}{5} = 286$ Wp

So to meet the required power, a 286 Watt Peak solar panel is required, but in this case the solar panels used are generally only 50 Wp or 100 Wp, so just take the 100 Wp one, so the solar panels needed are 286: 100 = 2.86 rounded up to 3 pieces of 100 Wp. For battery requirements, it can be calculated by seeing that the electrical energy in the battery cannot be used 100%, the potential loss in the inverter can reach 5%, so there needs to be a reserve of 5% that must be added.

So the total reserve power is: 1430 : 95 % = 1505 Watts.

Next, select the battery specifications, here the selected battery is 12 Volt, 75 Ah, then recalculate the battery requirements to be used.

Number of batteries = Electric power : battery capacity

Number of batteries = 1505 : (12 x 75)

Number of batteries = 1.67 units, rounded up to 2 12 V 75 Ah batteries, but because the battery usage should not be completely discharged, which will quickly damage the battery, in this case the battery requirement is multiplied by 2 so that 4 batteries are needed with the specification 12V 75Ah.

To determine the capacity of the inverter with a maximum power to be used of 1430 Watts, the inverter used must have an output greater than the maximum power, namely 1500 Watts.

The size of the Solar Charge Controller (SCC) required is 6 x 3 = 18 Amps, so the SCC used is 20 A.

From the calculations above, it is obtained that to install a PLTS with a load of 286/300 Watts, the following is required:

a. 100 Wp Solar Panel 3 pieces
b. 4 12V 75 Ah batteries
c. 1500 Watt Inverter
d. SCC 20 Ampere

Figure 2. PLTS Installation Circuit

In general, the planned installation is as seen in the image above, but in this case the AC Load will be replaced with a Shimizu Water Machine, so in addition to being used for Water Machines that have alternating current, this energy source can also be used for direct current electrical loads that do not need to use an inverter.

Introduction to PLTS Components.

The team introduced the physical components of the PLTS, namely solar panels, inverters, batteries, and solar charge controllers. The community was given a basic installation guide for household use.

Figure 3. Explanation of PLTS

These components are:

1. Solar Cell

   Photovoltaic is the main component which is a medium for converting light energy into electrical energy which will then be stored in a battery. Based on its manufacture, solar panels (solar cells) are divided into 3 types, namely:

a. Monocrystal
b. Polycrystal
c. Thin Film

The three technologies are distinguished by their efficiency levels. Monocrystal is the photovoltaic with the highest efficiency level today, but in terms of economy it is still very expensive compared to polycrystal.

2. Solar Charge Controller (SCC)

   Solar charge controller (SCC) is a control device that functions to regulate the voltage and current released from solar cells, in charging the battery from overcharging, also controlling the discharge process. What needs to be considered in using this charge controller is the amount of voltage and power released by the solar cell and which can be received by the battery.

3. Battery

   The battery functions to temporarily store electricity produced by solar cells, so that it can be used when there is no solar energy (night or cloudy weather). The amount of capacity to store electric current in the battery is measured in watt hours (watthour/wh). The amount of capacity to store electric current is determined by how much electricity is needed and the ability of the solar cell to charge the battery.

4. Inverter

   An inverter is an electronic device that functions as a converter of direct current (DC) from solar cells or batteries into alternating current (AC) which will be used to supply voltage to the load. The output waveform of the inverter is ideally a sine wave. But in reality it is not so because of the presence of harmonics or currents that have multiple frequencies and fundamental frequencies caused by the use of nonlinear loads in the power system which cause distortion in the sine waveform so that the waveform is no longer sine.

Immediate Benefits

People realize that implementing solar energy can reduce long-term electricity costs and increase energy access in areas that have not been reached by conventional electricity.

Recommended Apps

Pematang Serai Village has great potential for the development of small-scale PLTS, especially for household and agricultural needs. The application of this technology is expected to support the government's program in achieving the national energy mix target of 23% by 2025.

CONCLUSION

This program has succeeded in providing new insights to the people of Pematang Serai Village about the importance of solar energy as an alternative energy source. The socialization and simulation of PLTS that were carried out can encourage the community to start switching to renewable energy technology to support village energy independence. And from the calculations carried out, the following conditions were obtained: Utilization of Renewable Energy, namely Solar Energy in Water Machines, is produced through the sun and then enters the solar module (solar panel), then the solar module will produce a DC current which is controlled by the charger controller to be stored in the battery, then the DC current that enters the battery can be used as a power source in the Water Machine. The 300 Wp Solar Panel can produce 3000 Wh of energy during a working time of 10 hours. This shows that the 300 Wp Solar Panel can be an alternative energy source. Pematang Serai Village, Tanjung Pura District, Langkat Regency has the potential for sunlight which can be used as an alternative energy source to increase community energy independence.

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