Jurnal Scientia
Volume 13, Number 04, 2024, DOI 10.58471/ scientia.v13i04
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

An Application Of Solar Power Plant (PLTS) As Power Supply For Radio Repeater Pt. Icon Plus Pekan Baru

Khairunnisa Salsabila Purba[1], Amani Darma Tarigan[2], Ahmad Dani[3]
Universitas Pembangunan Panca Budi, Medan, North Sumatera, Indonesia

Article Info
Keywords:
Solar Power Plant (PLTS),
Power Supply,
Radio Repeater

ABSTRACT
In the utilization of Radio Repeater communication, electrical energy is needed to supply the radio so that communication can always run well. The problem is that there are frequent power outages that disrupt information activities via radio communication. Frequent power outages from PLN cause the Radio Repeater to be inactive so that communication is cut off. Therefore, in this study, a Solar Power Plant (PLTS) is utilized as a power supply for the Radio Repeater at PT. Icon Plus Pekanbaru to be able to operate non-stop and be able to survive for at least 3 days without sunlight. The maximum power generated by the solar panel is 6 panels x 100 Watt = 600 Watt. The amount of energy generated = The amount of power generated (watts) x Peak Sun Hours (hours) or Wh = 600 x 4 = 2400. The radio repeater operating time is 10 hours per day. Two 40 watt lighting lamps operate with the assumption that the condition is on for 13 hours per day. The lights are on from 6 pm to 7 am. Radio Load = Current Consumption (A) x Usage Time (hour) x System Voltage (V), Active Radio = 6 x 10 x 12 = 1440, Radio on standby = 1.5 x 12 = 864, Lighting = 13 x 40 = 520. then the difference between production energy and used energy is 1920 Wh - 1672 Wh = 248 Wh. With a configuration of two 200 Ah batteries in parallel with a DoD assumption of 50%, the Days of Autonomy can be calculated by ((50% x 600 x 12) + 248 Wh) / 1672 Wh = 2.3 days

This is an open access article under theCC BY-NClicense

Corresponding Author:
Khairunnisa Salsabila Purba
Universitas Pembangunan Panca Budi, Medan, North Sumatera, Indonesia
khsalsabila24@gmail.com

INTRODUCTION

PT. Icon Plus Pekan Baru utilizes radio communication to coordinate the internet network system and reports from field officers in carrying out repairs or field maintenance. Radio is considered very effective because it is cheap and easy to implement. In addition, this system is independent of other communication networks such as the internet or the Global System for Mobile Communication (GSM) network. In utilizing Radio Repeater communication, electrical energy is needed to supply the radio so that communication can always run well. The existing problem is that there are frequent power outages that disrupt information activities via radio communication.

Failure of the electricity network due to power outages by PLN due to maintenance or unexpected disturbances, often results in communication being cut off because the Radio

Jurnal Scientia
Volume 13, Number 04, 2024, DOI 10.58471/ scientia.v13i04
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

Repeater cannot be activated. One solution to this problem is the implementation of a Solar Power Plant (PLTS). A Solar Power Plant or (PLTS) is a system used to convert sunlight energy into electrical energy using the principle of the photovoltaic effect. Photovoltaic itself is a physical phenomenon that occurs on the surface of solar cells when receiving sunlight. Furthermore, the light received is converted into electrical energy.

Utilization of PLTS used as a power supply for Radio Repeater at PT.Icon Plus Pekanbaru to be able to operate non-stop and can survive for at least 3 days without sunlight. The operation of the PV system as a power supply requires the main components of photovoltaic (PV) panels, Solar Charge Controller (SCC), batteries, inverters and safety. In the modern era, the increasing demand for reliable and sustainable energy sources has driven the exploration and application of renewable energy technologies. One promising solution is the Solar Power Plant (PLTS), which utilizes solar energy as a clean and abundant power source. PLTS has become a preferred alternative for providing reliable power to various systems, particularly in remote or off-grid locations.

Radio repeaters, which are critical components in communication networks, require a stable and continuous power supply to ensure uninterrupted operation. For companies like PT. ICON Plus Pekanbaru, maintaining the reliability of radio repeaters is essential for effective communication and data transmission. However, relying solely on conventional power sources such as electricity from the grid presents challenges, including vulnerability to power outages and high operational costs.

The integration of PLTS as a power supply for radio repeaters offers multiple advantages, including energy independence, cost efficiency, and reduced environmental impact. By harnessing solar energy, PLTS provides a sustainable solution that aligns with the growing emphasis on green technology and environmental sustainability.

Literature Review

Solar Power Plant (PLTS)

Solar Power Plant (PLTS) is a system that has the ability to convert solar energy into electricity. Sunlight is directly utilized as thermal energy (heat) or through the use of photovoltaic cells in solar panels and transparent photovoltaic glass. Solar-electric technology or commonly called photovoltaics (PV) converts sunlight directly into electricity. PV can provide electricity in DC current or converted using an inverter into DC current for residential and commercial buildings, including power for security lights and cooling systems

Solar cells are a set of modules for converting solar energy into electrical energy. Photovoltaic is a technology that functions to change or convert solar radiation into electrical energy directly. PV is usually packaged in a unit called a module. In a solar module consists of many solar cells that can be arranged in series or parallel. Meanwhile, what is meant by solar is a semi-conductor element that can convert solar energy into electrical energy based on the photovoltaic effect. Solar cells have started to become popular lately, in addition to the dwindling fossil energy reserves and the issue of global warming. The energy produced is also very cheap because the energy source (sun) can be obtained for free

Jurnal Scientia
Volume 13, Number 04, 2024, DOI 10.58471/ scientia.v13i04
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

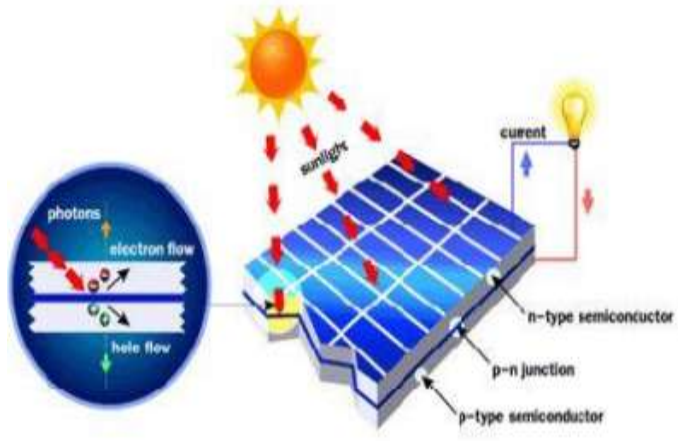

Figure 1. Solar cell schematic

New and renewable energy has a very important role in meeting energy needs. This is because the use of fuel for conventional power plants in the long term will drain the increasingly depleting sources of oil, gas and coal and can also cause environmental pollution. One of the efforts that has been developed is the Solar Power Plant (PLTS). PLTS or better known as solar cells (photovoltaic cells) will be more in demand because it can be used for various relevant purposes and in various places such as offices, factories, housing, and others. In Indonesia, which is a tropical area, it has very large solar energy potential with an average daily insolation of 4.5 - 4.8 KWh / m² / day. However, the electrical energy produced by solar cells is greatly influenced by the intensity of sunlight received by the system. In planning the construction of PLTS, the load of the PLTS is first calculated so that we can calculate the capacity of solar power to be built. The following is an example of a simple calculation of the power requirements used, panel capacity and the number of panels used and the need for batteries with their storage capacity. Electric power formula:

Electrical Power = Voltage x Current,

Or

Watt = Volt x Ampere..... (1)

Solar power plant installation requires planning regarding power requirements

a. Number of Usage

b. Number of Solar Panels/solar cells

c. Number of batteries

Here is the calculation of the amount of power usage, the number of solar panels and the number of batteries used, namely the calculation of power requirements (the calculation of the device's electrical power can be seen on the label behind the device, or read from the manual) and the calculation of the number of modules used

Solar Charge Controller (SCC)

Solar Charge Controller (SSC) is one of the components of PLTS that is useful for setting the electric current (current regulator) that enters from the PV panel or the outgoing/used load current and functions to protect the battery from overcharging, and from

Jurnal Scientia
Volume 13, Number 04, 2024, DOI 10.58471/ scientia.v13i04
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

the solar panel to the battery the voltage and current can be adjusted according to needs. The functions and features of the solar charge controller are as follows:

a. When the battery is fully charged, the electric current entering the battery will be stopped by the controller so that overcharging does not occur, this aims to make the battery last much longer. And the electric power generated by the solar panel will be directly distributed to the load/electrical equipment according to the power consumption of the electrical equipment in a certain amount
b. The controller functions to stop the taking of electric current from the battery by the load/electrical equipment when the battery is almost empty (generally around 10% of the remaining voltage in the battery), then the load current will be disconnected by the controller to protect the battery so that the battery cells are not damaged. Of the several types of controllers, the one that notifies the battery in the charging process is an indicator light that is generally red or yellow. When the condition of taking electric current in the battery will be stopped by the controller if the battery current is empty (below 10%), therefore the electrical equipment / load cannot operate, because the load can accommodate quite a large condition, this condition is called over discharge
c. Some types of certain controllers are usually equipped with complete indicators and digital meters, so that they can observe and detect everything that happens in the PLTS system properly. A solar charge controller (SCC) that can detect battery capacity is a good SCC to use. If a battery is fully charged, the current that automatically charges from the solar panel will stop. Through the battery voltage level monitor on the SCC, this can be detected. The battery will be charged to a certain voltage level by the solar charge controller if the voltage level drops, the battery will be recharged

Power Supply

Batteries are a medium for storing electrical energy obtained from PV panels. The types of batteries that can be used for PV systems vary, for example acid batteries (flooded or valve regulated type) and lithium batteries. The amount of energy stored in the battery is expressed in Ampere Hour (Ah). Ah is calculated based on the current released (discharged) by the battery for 1 hour. However, during discharge, the battery is prohibited from being discharged up to 100%, because it affects the battery life cycle.

The battery discharge limit is called the Depth of Discharge (DoD). DoD is expressed in percent. The greater the DoD given to the battery, the shorter its life cycle will be. The inverter is responsible for converting DC current and voltage to AC. There are two types of inverters, namely on grid inverters (connected to the grid / PLN) and off grid inverters. The power supply used in remote areas uses the off grid inverter type. There are 2 inverter output waveforms, namely Modified Sine Wave (MSW) and Pure Sine Wave (PSW). The power unit used by the inverter is Volt Ampere (VA).

METHOD

The research period began in November 2024. This research was conducted at the PT. Icon Plus Pekan Baru Office. The steps taken in this research were to measure and calculate directly for data collection and to adjust the PLTS components to be able to supply the load,

Jurnal Scientia
Volume 13, Number 04, 2024, DOI 10.58471/ scientia.v13i04
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

especially for the Radio Repeater to facilitate communication. The radio repeater used is the Motorola brand which consists of two radios that function as receivers and transmitters. When operating, this radio repeater uses a DC voltage supply and a current of 6 A, and when on standby the measured current is 1.5 A. Other equipment at the repeater location is two lighting lamps with a power of 20 watts per lamp. This lamp load only works at night until morning which is regulated by a light sensor. The load calculation is carried out by manual measurement using a Tang Ampere Measuring Tool. The equipment prepared is a radio repeater device and a power supply device. The repeater device uses two radios that function as receivers and transmitters which are connected to a duplexer before entering the omnidirectional antenna. To reduce the risk of damage due to lightning strikes, a lightning arrester (LA) is installed on the cable connecting the antenna to the radio. The power supply device utilizes solar panels, inverters, SCCs and batteries as a medium for storing electrical energy. In general, energy from sunlight is captured by solar panels and forwarded to the SCC which functions as an energy regulator between the solar panels and batteries. The SCC regulates the voltage and current received from the solar panels to carry out the charging process to the battery according to the battery voltage rating. The battery will be the source of energy for the radio repeater and other loads. The radio repeater requires a DC power supply, so it does not require an inverter. The inverter is only used to power AC loads. The configuration of the radio and power supply devices is as shown in the block diagram below.

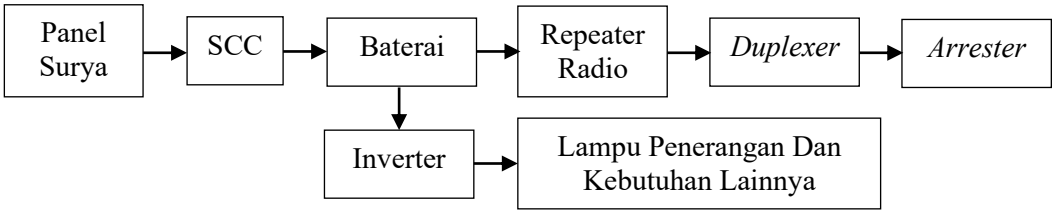

Figure 2. Block Diagram of Radio Device and Power Supply Configuration

The equipment and devices are installed in the radio repeater shelter at the PT.Icon Plus Pekan Baru office. The total area of the shelter is 36 m2. The area of the special room for radio equipment and the PLTS system reaches 9 m2. Solar panels are installed on the roof of the shelter with an additional frame (Light Steel) so that they are not easily blown away by the wind. The Solar Charger Controller (SCC), Inverter and MCB components as safety are installed in a transparent junction box for easy monitoring, while the battery is installed on a special rack.

RESULT

Analysed

The power supply in the radio repeater utilizes 6 pieces of polycrystalline solar panels. Each piece of solar panel is capable of producing a maximum power of 100 Watt Peak with parameters Isc = 6.33A, Voc = 22V V. To calculate the amount of energy produced, it is

Jurnal Scientia
Volume 13, Number 04, 2024, DOI 10.58471/ scientia.v13i04
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

necessary to know the parameters of the maximum duration of sunlight per day or Peak Sun Hours (PSH) in the area. The production of the solar panel system can be calculated using the following equation:

Amount of Power Generated = Number of Panels x Panel Power Rating (watts) (1)

Amount of Energy Generated = Amount of Power Generated (watts) x Peak Sun Hours (hours) (2)

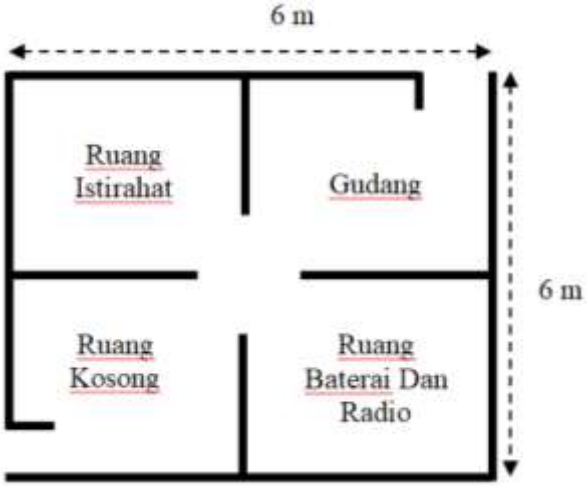

Figure 3. Radio Repeater Shelter Room Size

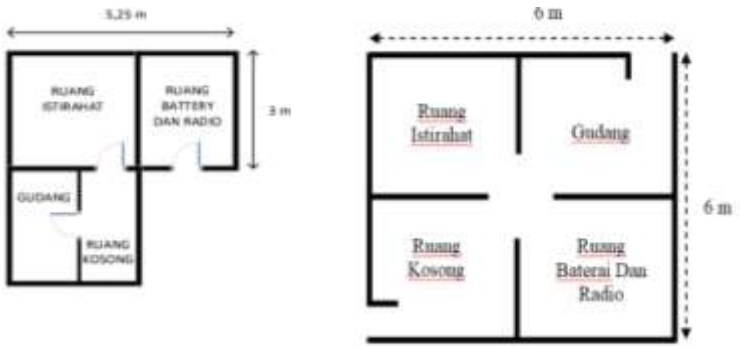

Figure 4. Radio Repeater Power Supply Schematic

The number of batteries used is 2 units with a voltage rating of 12 volts and a capacity of 200 Ah. All batteries are installed in a parallel configuration so that the current that can be stored becomes greater. In order to last, the battery discharge rate or Depth of Discharge (DoD) must be considered and usually the energy used or the discharge rate is between 50% and 70%. The amount of capacity stored in batteries with a parallel configuration and the amount of energy that can be used by considering DoD can be calculated using the following formula:

Jurnal Scientia
Volume 13, Number 04, 2024, DOI 10.58471/ scientia.v13i04
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

Parallel Battery Capacity = Capacity (Battery 1 + Battery 2 + Battery n) (Ah) (2)

Energy Used by Battery = % DoD x Battery Capacity (Ah) x System Voltage (V) (3)

The installed SCC is 1 unit, with a voltage rating of 24 volts and a current of 100 amps. The SCC type is the PWM type. The SCC current rating must be above the nominal short circuit current of the solar panel. The inverter uses a PSW output type with a power rating of 2000 VA. Additional equipment required for installation is diode, fuse, ampere meter, MCB DC, MCB AC, contactor, light sensor, panel box, cable for installation and grounding cable. Radio repeater directly takes electrical energy from the battery, while AC load for lights and maintenance tools takes from inverter output. Maintenance tool load for daily conditions is absent, while the lamp load is regulated by the light sensor as a switch, where the lamp will turn on automatically when there is no light or at night. Calculation of radio load (DC) and lamp (AC) is done with the following equation.

Radio Load = Current Consumption (A) x Usage Time (hour) x System Voltage (V) (4)

The reliability of the power supply of the Solar Power Plant (PLTS) system is determined by the ability to operate without sunlight. This is called Days of Autonomy. Days of Autonomy can be calculated using the following formula:

Days of Autonomy = Amount of Available Energy / Amount of Load Consumption per Day (5)

For safety, before and after the ampere meter and SCC, a fuse is added as a safety measure. A fuse is also installed before entering the radio. For the inverter, a DC MCB is installed at the input and an AC MCB at the output. The battery output to the load is equipped with a diode so that there is no back current to the battery circuit. The installation of solar panels and indoor installations for junction boxes and batteries are described in the figure below:

The reliability of the power supply of the Solar Power Plant (PLTS) system is determined by the ability to operate without sunlight. This is called Days of Autonomy. Days of Autonomy can be calculated using the following formula:

Days of Autonomy = Amount of Available Energy / Amount of Load Consumption per Day (6)

For safety, before and after the ampere meter and SCC, a fuse is added as a safety measure. Before entering the radio, a fuse is also installed. For the inverter, a DC MCB is installed at the input and an AC MCB at the output. The battery output to the load is equipped with a diode so that there is no back current to the battery circuit. The installation of solar panels and indoor installation for junction boxes and batteries are described in the image below:

Jurnal Scientia
Volume 13, Number 04, 2024, DOI 10.58471/ scientia.v13i04
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

Figure 5. Solar Panels Installed

Figure 6. Battery and PV Junction Box

Power maximum Which produced by panel solar is 6 panel x 100 Watt = 600 Watt. W ith assumption PSH in peak Mattirowalie is 4 O'clock, capacity production system Generator Electricity Power Sun (PLTS) shown on table below This:

Table 1 Calculation Production Energy Panel Sun (System 24 volt)

Condition	Power Panel (W)	Long PSH (hour)	Energy Production (Wh)
Production maximum	600	4	2400
Assumptions Losses 20%	120	4	(480)
Total Production per Day (Efficiency 80%)			1920

From the table above, it can be calculated using the following equation:

Amount of Energy Generated = Amount of Power Generated (watts) x Peak Sun Hours (hours)

Wh = 600 x 4

= 2400

PT. Icon Plus Pekan Baru Office provides information that the radio repeater operating time is 10 hours per day. Two 40 watt lighting lamps operate with the assumption that the condition is on for 13 hours per day. The lights are on from 6 pm to 7 am. The consumption of radio repeaters and lighting lamps is shown in the table below:

Jurnal Scientia
Volume 13, Number 04, 2024, DOI 10.58471/ scientia.v13i04
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

Table 2 Consumption Operation Radio And Light Lighting

Equipment	Consumption Current (A)	Long Time (Hour)	Power used (Watt)	Capacity Usage (Ah)	Energy Used (Wh)
Radio moment active	6	10		60	720
Radio moment standby	1.5	24		36	432
Light lighting		13	40		520
Total Consumption per Day					1672

From table above can counted with equality following:

Burden Radio = Consumption Current (A) x Long Usage (hour) x Voltage System (V)

Radio Active = 6 x 10 x 12
= 1440

Radio moment standby = 1.5 x 12
= 864

Light Lighting = 13 x 40 = 520

CONCLUSION

The Mattirowalie radio repeater requires a special power supply for radio equipment and lighting. From the calculation results, it was obtained that by utilizing the Solar Power Plant (PLTS), the PLTS power supply system was able to obtain a Days of Autonomy value of 2.3 days. With the results obtained, the radio repeater can operate optimally without having to worry about a lack of power supply. To increase reliability, power capacity can be increased by adding solar panels. For the battery charging regulator, the Solar Charge Controller (SCC) can be upgraded using the MPPT model to increase the efficiency of better electrical energy production.

REFERENCES

Amani Darma Tarigan, Pristisal Wibowo, Adi Sastra Tarigan, 2022 "Perancangan Otoped Listrik Menggunakan Panel Surya Sebagai Media Transportasi "R E L E (Rekayasa Elektrikal dan Energi) : Jurnal Teknik Elektro) Vol. 2, No. 2, Januari 2022, ISSN 2622 – 7002

Aryza S et al, (2024) A ROBUST OPTIMIZATION TO DYNAMIC SUPPLIER DECISIONS AND SUPPLY ALLOCATION PROBLEMS IN THE MULTI-RETAIL INDUSTRY. *Eastern-European Journal of Enterprise Technologies*, (3).

Anisah, Siti, Amani Darma Tarigan, and Dwi Putri Wardhani. "Study And Potential Utilization Of Solar Power Plant As A Source Of Energy At University Of Pembangunan Panca Budi." *Proceeding International Conference of Science Technology and Social Humanities*. Vol. 1. 2022.

Dani, A., & Erivianto, D. (2022). Studi Sistem Pembangkit Listrik Tenaga Surya Off Grid Skala Rumah Tangga pada Daerah Bagan Deli Menggunakan Pvsyst. *Jurnal Indonesia Sosial Teknologi*, *3*(09), 961–972. https://doi.org/10.59141/jist.v3i09.496

Zuraidah Taro1, Hamdani, 2020 "Analisis Biaya Pembangkit Listrik Tenaga Surya (PLTS) Atap Skala Rumah Tangga" (Journal of Electrical and System Control Engineering) JESCE,3(2) Februari2020ISSN2549-628X(Print)ISSN2549-6298(Online)

Romi Masmur Pasaribu, Zuraidah Tharo, 2023 "Mekanisme Perencanaan Plts Off-Grid Untuk Daya 1300va Pada Rumah Tinggal" Jurnal Teknik Elektro dan Informatika, Volume 18 Nomor 2 (2023) 52-58E –Link P-ISSN 1858-2109 E-ISSN 2656-5676

Zuraidah Tharo, Hamdani, Melly Andriana, Siti Anisah, 2022 "(Journal of Electrical and System Control Engineering)" JESCE, 6 (1) Agustus 2022 ISSN 2549-628 X (Print) ISSN 2549-6298 (Online)10.31289/jesce.v6i1.7563

Hamdani, Zuraidah Tharo, and Siti Anisah. "Perbandingan performansi pembangkit listrik tenaga surya antara daerah pegunungan dengan daerah pesisir." *Prosiding Seminar Nasional Teknik UISU (SEMNASTEK)*. Vol. 2. No. 1. 2019.

Suhardhika Sih Sudewanto,Erwin S. Kalatiku, 2021 "Pemanfaatan Sistem Photovoltaic untuk Catu Daya Repeater Radio PLN" Energi dan Kelistrikan: Jurnal Ilmiah Vol. 13, No. 2, Juli - Desember 2021, P-ISSN 1979-0783, E-ISSN 2655-5042 https://doi.org/10.33322/energi.v13i2.1543

K. B. Kusuma, C. G. I. Partha, and I. W. Sukerayasa, "Perancangan Sistem Pompa Air Dc Dengan Plts 20 kWp Tianyar Tengah Sebagai Suplai Daya Untuk Memenuhi Kebutuhan Air," J. SPEKTRUM, vol. 7, no. 2, 2020

H. A. S, "Studi Pemanfaatan Energi Matahari Sebagai Sumber Energi Alternatif Terbarukan Berbasis Sel Fotovoltaik Untuk Mengatasi Kebutuhan Listrik Rumah Sederhana Di Daerah Terpencil," ALJAZARI J. Ilm. Tek. MESIN, vol. 3, no. 2, 2018, doi: 10.31602/al-jazari.v3i2.1624

R. T. Jurnal, "Studi Penyimpanan Energi Pada Baterai Plts," Energi & Kelistrikan, vol. 9, no. 2, pp. 120–125, 2018, doi: 10.33322/energi.v9i2.48

T. Abuzairi, W. W. A. Ramadhan, and K. Devara, "Solar Charge Controller with Maximum Power Point Tracking for Low-Power Solar Applications," Int. J. Photoenergy, vol. 2019, 2019, doi: 10.1155/2019/5026464