Jurnal Scientia
Volume 13 , Number 03, 2024, DOI 10.58471/ scientia.v13i03
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

An Analysis Of The Potential Of Renewable Energy Solar Panels In Ecotourism Development Planning

Hagai Fernando Lumban Gaol[1], Zulkarnain Lubis[2], Muhammad Erpandi Dalimunthe[3]
[1,2,3]Universitas Pembangunan Panca Budi, Medan, North Sumatera, Indonesia

ArticleInfo

Keywords:
Renewable Energy,
Solar Panels,
Ecotourism,
Development Planning.

ABSTRACT

After the Covid pandemic, ecotourism is a tourism concept that prioritizes environmental sustainability and wise use of natural resources. One important aspect in ecotourism development is the use of renewable energy, such as solar panels, to meet energy needs without damaging the environment. This research aims to analyze the potential for renewable energy that can be produced by solar panels to support ecotourism development planning. This research includes collecting secondary data from relevant literature, measuring the intensity of sunlight at selected locations, as well as computer simulations to predict the energy output of solar panels. The analysis is carried out by considering factors such as weather conditions, orientation and tilt angle of the solar panels, and energy conversion efficiency. Please note: The research results show that the potential for renewable energy from solar panels in the selected locations is very significant. With optimal sunlight intensity and proper panel angle adjustment, ecotourism can produce most of its energy needs from this renewable energy source. The use of solar panels also has a positive impact in reducing carbon footprints and long-term operational costs. and the integration of solar panels in ecotourism development planning is a strategic step that can increase sustainability and energy efficiency. Recommendations from this research include wider implementation of solar panel technology, increased education about the benefits of renewable energy, as well as supporting policies from the government to encourage the adoption of green energy in the tourism sector.

Corresponding Author:
Hagai Fernando Lumban Gaol
Universitas Pembangunan Panca Budi, Medan, North Sumatera, Indonesia

INTRODUCTION

Indonesia as a tropical country has high solar energy potential with an average daily radiation of 4, 5 kWh/m2/day (Muhammad Bachtiar, 2006). The government through Ministerial Regulation (Permen) Number 53 of 2018 concerning the utilization of renewable energy sources for the supply of electricity. Public facilities that can be used as objects of application of renewable energy sources are canal rivers that will be planned to be used as tourist attractions. in accordance with PP No. 79 of 2014 concerning Energy Policy, the author initiated a Solar Power Plant (PLTS) as a renewable electrical energy source to supply electricity loads in canal ecotourism. The PLTS used will use an Off-Grid configuration.

Jurnal Scientia
Volume 13 , Number 03, 2024, DOI 10.58471/ scientia.v13i03
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

The analysis of solar energy-based renewable energy potential in the development planning of the Canal Ecotourism project is for energy efficiency and the environmental impact of the application of solar energy. The results of the research are expected to make a positive contribution to canal ecotourism and produce innovations related to reliable solar energy systems. The potential of canal ecotourism in North Sumatra is quite large, there are still several obstacles in its development. Some of them are the lack of public understanding of canal ecotourism and the lack of incentives from the government in the development of renewable energy development. Ecotourism development is currently growing along with increasing awareness of the importance of environmental conservation and sustainable use of resources. Ecotourism not only focuses on offering authentic nature tourism experiences, but also seeks to preserve the environment and provide economic benefits to local communities. In this context, the use of renewable energy such as solar panels becomes very relevant. Solar panels are able to provide a clean and sustainable source of energy, thus supporting ecotourism operations without harming the environment.

The use of solar panels in ecotourism not only helps reduce dependence on fossil fuels but also contributes to reducing greenhouse gas emissions. By harnessing the abundant potential of solar energy, solar panels can be a practical and economical solution to meet the energy needs of ecotourism sites that are often located in remote areas with limited access to conventional power grids.

Literature Review

Renewable Energy and Solar Energy

Renewable energy is energy that comes from natural sources that do not run out or can be renewed naturally within human time. Renewable energy sources include the sun (solar), wind, water (hydro), biomass and geothermal (geothermal). The main advantage of renewable energy is its ability to reduce greenhouse gas emissions and other environmental impacts resulting from the use of fossil fuels. Key examples of renewable energy include:

Energy obtained from solar radiation. The sun emits energy in the form of light and heat, which can be used for various energy needs on earth. Solar energy is one of the most potential and sustainable renewable energy sources, because the sun is an energy source that will not run out on a human time scale.

Energy is produced from wind through wind turbines. When the wind blows it can move the turbine blades connected to the rotor. This rotor then spins a main shaft connected to a generator, producing electricity. This process is based on the principle of converting wind kinetic energy into mechanical energy, and then this mechanical energy is converted into electrical energy by a generator.

Energy obtained from flowing water, such as a river or dam. Hydro energy works by utilizing falling or flowing water to rotate a turbine connected to a generator. The potential energy of water stored at a height is converted into kinetic energy as the water flows, and this kinetic energy is then converted into electrical energy by a generator.

Energy is produced from organic materials such as plants and waste. Biomass contains energy that initially comes from the sun through the process of photosynthesis.

Jurnal Scientia
Volume 13 , Number 03, 2024, DOI 10.58471/ scientia.v13i03
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

When biomass is burned or processed, the chemical energy stored in the organic material is released and converted into usable energy, such as electricity or heat.

Energy obtained from geothermal heat. Geothermal energy is extracted from hot reservoirs located beneath the earth's surface. This heat can be used directly for heating or converted into electricity using turbines and generators. There are three main types of geothermal power plants, namely dry steam generators, flash steam generators, and binary cycle generators.

Solar energy is energy obtained from solar radiation. The main technologies for harnessing solar energy are photovoltaic (PV) cells, which convert sunlight directly into electricity, and solar thermal technology, which uses the sun's heat to produce electricity or heat. The efficiency of a PV system is influenced by factors such as sunlight intensity, environmental temperature, and the quality of the solar panel material.

The working principle of a solar power plant is quite simple and environmentally friendly because the solar power plant itself only utilizes light energy sources from the sun without using any fuel that can damage the environment. When compared with fossil fuel power plants which use generators to produce electrical energy by converting mechanical energy into electrical energy. Converting mechanical energy into electrical energy using a generator requires something called fuel. The results of the combustion will produce exhaust gases which can pollute the air and the environment. Apart from exhaust gases which can pollute the environment, the sound from noisy generators can also disturb us and the community.

Currently, the use of new renewable energy is developing very rapidly in our country. Solar power generation is also a new form of renewable energy that is very suitable for use at this time, with the aim of reducing the use of conventional electrical energy which is increasingly decreasing due to fewer and fewer fossil energy sources. Solar energy is also unlimited energy which can be used for a long time.

Renewable energy is energy that comes from natural resources that can be renewed and will not run out, such as sunlight, wind, water and biomass. Renewable energy is considered more environmentally friendly than fossil energy because it does not produce significant greenhouse gas emissions. In the context of ecotourism, the use of renewable energy, especially solar energy, is the right choice to reduce environmental impacts and promote sustainability.

Figure 1. Solar Cell

Jurnal Scientia
Volume 13 , Number 03, 2024, DOI 10.58471/ scientia.v13i03
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

Battery

Batteries are components used as energy storage which have the ability to convert chemical energy directly into electrical energy or vice versa. This battery consists of several electrochemical cells and these cells work by using a positive electrode and a negative electrode. The electrical output from this battery is DC electricity. The PLTS system functions to store the electric current produced by the solar panels before being used to operate the load. Loads that can be used directly from battery current are loads that use DC electricity such as DC lights and other electronic equipment. The type of battery that is suitable for use in PLTS systems is a VRLA (Valve Regulated Lead Acid) battery which is generally called a dry battery because it has a density on the electrode plates so that it can produce a high current discharge and perform better than batteries in general.

Figure 2. Baterray source

Inverter

The electronic equipment that is generally used is not only direct electricity (DC), many electronic equipment requires alternating electricity (AC). In the PLTS system, the tool used to change DC current from the battery into AC current is an inverter. An inverter is an electrical device used to convert direct electric current (DC) into alternating electric current (AC). The function of an inverter is to convert the DC input voltage into a symmetrical AC output voltage with the desired magnitude and frequency. The output voltage can be fixed or variable at a fixed or variable frequency. The wave forms that can be produced by a Power Inverter include square waves, sine waves, modified sine waves and pulse width modulated waves depending on the design. the inverter circuit in question. However, currently, the wave forms generally used in PLTS systems are sine waves and modified sine waves

Figure 3. Inverter

Jurnal Scientia
Volume 13 , Number 03, 2024, DOI 10.58471/ scientia.v13i03
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

Solar Charge Controller

Solar charge controller is a component used to regulate current. The solar charge controller also protects the battery from damage when the battery is almost empty, this tool will cut off the current to the load and will be reconnected when the voltage on the battery has started to charge depending on the minimum limit. The solar charge controller also has the ability to convert the voltage value issued by the solar panel to match the voltage value on the battery.

There are two types of SCC that are commonly used, namely the Pulse Width Modulation (PWM) controller and the Maximum Power Point Tracking (MPPT) controller. SCC PWM regulates the energy flow to the battery by gradually reducing the current, which is called "pulse width modulation". PWM is an abbreviation for Pulse Width Modulation which indicates that the charging controller works by emitting electrical pulses to the battery with varying wavelengths. When the battery is full, the PWM charge controller continues to supply a small amount of power to keep the battery full. PWM controllers are suitable for small-scale solar PV applications because the solar panel and battery systems must have appropriate voltages. Solar charge controller MPPT or Maximum Power Point Tracking is an algorithm included in a power controller that is used to extract the maximum power available from a PV module under certain conditions. The MPPT type SCC has better efficiency than the PWM type, MPPT is able to fully utilize the power of the solar panels to charge the battery. MPPT limits its output to ensure the battery is not overcharged. The MPPT controller will monitor and adjust the incoming energy to regulate the PLTS system flow. The MPPT controller is able to reduce voltage and increase current, because MPPT is a DC to DC converter that operates by taking DC input from the PV module, converting it to AC and converting it back to a different DC voltage and current to precisely match the PV module to the battery.

(a) (b)

Figure 4. Solar Charge Controller a. SCC Tipe PWM b. SCC Tipe MPPT

Internet of Things (IoT) in Energy Systems

Internet of Things (IoT) refers to a network of physical devices that are connected and can communicate and exchange data over the internet. In energy systems, IoT enables real-time monitoring and control of energy devices, which can improve the efficiency and performance of the system. IoT implementation in solar panels can help in:

a. Performance Monitoring: Enables real-time monitoring of solar panel performance, including energy output and operational conditions.

Jurnal Scientia
Volume 13 , Number 03, 2024, DOI 10.58471/ scientia.v13i03
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

b. Automatic Adjustment: Automatically adjusts the orientation and tilt angle of the solar panels to maximize sunlight absorption.
c. Diagnostics and Maintenance: Obtain diagnostic data for predictive maintenance and preventing breakdowns.

Energy efficiency is the ratio between the energy output produced and the energy input used. For solar panels, energy efficiency is influenced by several factors, including: Type and Quality of Solar Panels: The materials and technology used in manufacturing solar panels affect their conversion efficiency. Environmental Conditions: Weather conditions, temperature, and air pollution can affect solar panel performance.

Maintenance: Solar panels that are well maintained will function more efficiently than those that are not maintained. Ecotourism is a form of tourism that is responsible for preserving nature and the welfare of local communities. The main principles of ecotourism include:

a. Environmental Sustainability: Ensuring that tourism activities do not damage the natural environment.
b. Social and Economic Benefits: Provide economic and social benefits for local communities.
c. Education and Awareness: Increase awareness about preserving nature and local culture.

In planning ecotourism development, the use of renewable energy such as solar panels is in line with environmental sustainability principles and can be an additional attraction for tourists who care about the environment. Through case studies and best practices from various ecotourism projects that have successfully integrated solar panels, insight can be gained into effective methods and strategies in implementing this technology. Analysis of the successes and challenges faced in these projects can provide valuable guidance for better ecotourism development. This theoretical basis provides a scientific basis for understanding the importance of using renewable energy in ecotourism and the factors that influence the efficiency of solar panels. Thus, this research can make a significant contribution in supporting sustainable ecotourism development.

METHOD

This research uses a qualitative approach to investigate the analysis of the potential for solar energy-based renewable energy in planning the development of canal ecotourism projects. A qualitative approach was used to understand subjective views on solar energy development in canal ecotourism. To create a solar energy-based renewable energy potential analysis design for canal ecotourism project development planning, we can first determine the concepts of the solar energy-based renewable energy potential analysis design for canal ecotourism project development planning that we want to create from start to finish. with the end that the planning analysis can be neatly organized and work well. The purpose of this block diagram is to make it easier for researchers to create and arrange the necessary components. Each part of the block diagram is connected to one another and has its own function and use to form a system of renewable energy potential based on solar

Jurnal Scientia
Volume 13 , Number 03, 2024, DOI 10.58471/ scientia.v13i03
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

energy that researchers will create in this research. We can see the design of the analysis of the potential for renewable energy based on solar energy in planning the development of canal ecotourism projects in the block

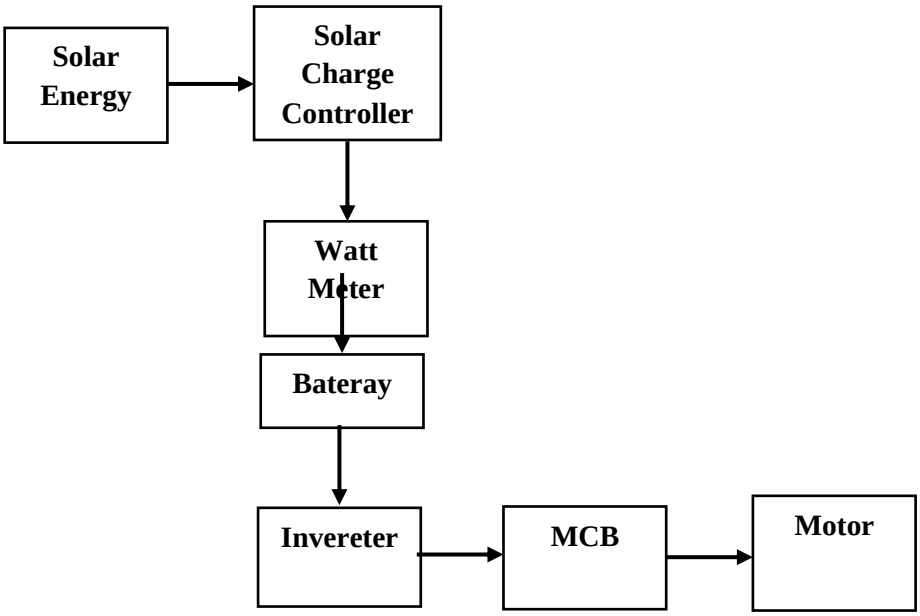

Figure 5. Block Diagram

Based on the block diagram image above, we can see that solar energy is a renewable energy source that we use in planning the development of canal ecotourism projects. The explanation of each block diagram above is as follows:

a. Solar energy
   Solar energy is the main source of electrical energy that we will use. In solar panels, a photovoltaic process occurs, namely changing light energy from the sun into electrical energy. However, the electrical energy produced by solar panels is still DC electrical energy. After calculating, the overall power required is 5000 Watts. Analysis of the potential for solar energy in this canal ecotourism project uses 50 solar energy units, where 1 solar energy capacity is 100 wp. The estimated power that will be generated is 5000 wp.
b. Solar charge controller
   The electrical energy produced from the solar panel will be channeled to the solar charge controller so that the solar charge controller can control the electrical energy produced by the solar panel for charging the battery so that there is no such thing as an over charge and adjust the energy used from the battery so that the battery does not go down and can causes the battery to quickly fail. In this potential solar energy analysis, it is more advisable to use SCC with the MPPT type because it is ideal for large energy production.

Jurnal Scientia
Volume 13 , Number 03, 2024, DOI 10.58471/ scientia.v13i03
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

c. Watt meters
The watt meter functions as a monitor that can monitor how much current, voltage and power flows from the solar charge controller when charging the battery.

d. Battery
The battery functions as a storage place for electrical energy produced from solar panels before being used to power electrical loads. The electrical energy stored in the battery will be used when the solar panels cannot provide enough energy for the load. In other words, when the solar panel does not receive sunlight, the energy stored in the battery will be used to help meet the required load. After calculation, the battery capacity required for the Canal ecotourism solar energy potential is a battery with a capacity of 12 v 500 Ah.

e. Inverters
The voltage that comes from the solar panel and also that stored from the battery is still DC electrical voltage, while the voltage from the load that we will use is Ac. To adjust the voltage required by the load, we need a device that can convert the DC voltage into Ac voltage so that it can turn on the load we are using. The name of the tool we use is inverter. The inverter functions as a voltage converter from DC voltage to Ac voltage. In the solar power plant itself, the inverter can not be used, but we just have to adjust it to the load we want to use or turn it on. inverter requirements For power around 5000 watts, an inverter with a capacity of around 5500 watts can be a suitable choice.

f. MCB
Because the voltage from the solar panel and battery has been converted to AC voltage, we need an additional safety device, namely an MCB. The function of the MCB itself is to protect against overloads and short circuits which can damage all existing components. The MCB will disconnect automatically if these two things happen.

g. Motorcycle
The motor functions as a load which will be turned on using a solar power generator to pull and move the flying fox sling wire. After calculation, the motor capacity required for the Canal ecotourism solar energy potential is a motor with a capacity of 4000 Watts.

RESULT

Smart Garden Energy Concept and Design

The problem of the still dominant use of energy originating from fossils shows that there is an imbalance with the use of EBT which has not yet experienced optimal development in Indonesia. In response to this condition, the author plans to design the formation of ecotourism called Smart Garden Energy as a first step to introduce more EBT to the community , especially for solar energy in order to achieve the final target of achieving the energy trilemma and carrying out further development of EBT. The Smart Garden Energy concept can be a means of education based on science and technology. This ecotourism is

Jurnal Scientia
Volume 13 , Number 03, 2024, DOI 10.58471/ scientia.v13i03
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

designed to display rides that can provide education through presenting concepts and material regarding EBT and current environmental conditions, as well as providing an understanding of the tools, materials and processes in creating energy that comes from sunlight (solar) which are presented in an interactive manner. audio-visual and also through simulation.

The author's goal in this design is to make Smart Garden Energy an ecotourism object that can reach the wider community, but also has a specific target to be able to focus more on education on the younger generation and students, both for students and university students so that they can learn more deeply about energy and form a sustainable ecosystem. care and encourage the development of solar energy. Furthermore, the concept of presenting education from SmartGarden Energy can be carried out through the following educational vehicles.

Science Education

The plan to establish this vehicle is intended to provide scientific education conducted indoors in a building called the Solar Simulation Observatory. At this observatory, a simulation of the process and steps to utilize or convert sunlight (solar) into electrical energy will be shown. In this simulation, we will show a series of tools and materials needed, the components of the tools and materials used, as well as provide education regarding technology and the use of science in the formation of solar energy. Through this vehicle, the public can increase their insight and knowledge in the field of energy and science related to the use of solar energy.

This research is about monitoring solar current controllers that use solar thermal energy to produce electricity which is integrated into solar panels. The electricity produced then goes into the battery to store electrical voltage. In solar cell design, the use of a solar charge controller is usually rare, so the battery is quickly damaged due to overcharging. Therefore, a solar charge controller is needed to create a better battery charging system. This concept functions to reduce the risk of the battery being damaged quickly due to overcharging. This design uses electronic components such as current and voltage sensors and Arduino.

Figure 6. Solar Cell Moduls

Jurnal Scientia
Volume 13 , Number 03, 2024, DOI 10.58471/ scientia.v13i03
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

Technology Education

The plan to establish this vehicle is intended to provide real education about solar panel technology used to produce EBT. This solar panel technology ride is carried out outdoors. The solar panels that will be presented in this vehicle will not only be an array of solar panels but also solar panels designed to be a solar tree. Solar tree is a solar panel designed in the shape of a tree. It is hoped that the existence of various forms of solar panels will become an attraction in increasing knowledge in the field of solar panel technology which will become a new, environmentally friendly energy. Not only that, in this solar panel technology vehicle, visitors can see the use of solar panels which are used for lighting, electric vehicles and even for charging cellphones.

Figure 7. Location of research

Audiovisual Education

This audiovisual vehicle offers the experience of watching three-dimensional works, which makes visitors feel as if the images on the screen are real. This vehicle will be a simulator that invites visitors to learn the entire process involved in obtaining EBT. This 3-dimensional cinema makes visitors feel like they are directly involved in every process.

Sharing Education

This vehicle is a forum to provide more in-depth education about the use of renewable energy. In this vehicle, there will be a Sharing Session in the form of a class with the delivery of material which can be done using an interesting and fun method but also remains focused on elaborating on topics regarding EBT. Providing this class can collaborate with the government, the private sector, experts, as well as influencers to be able to share knowledge and the latest issues about renewable energy, practical knowledge, as well as share experiences regarding using solar energy, both the benefits and drawbacks.

Smart Garden Prospects

This smart garden project is a combination of information technology and renewable resources. Of course, as explained at the beginning of this paper, Indonesia is heading towards a transition towards new and renewable energy, of course this can be a promising thing. From a business perspective, Smart Garden Energy will bring many benefits. This is because the Smart Garden Energy concept does not yet exist in Indonesia, only the Yogyakarta smart garden has an almost similar concept. Of course, if this project is realized

Jurnal Scientia
Volume 13 , Number 03, 2024, DOI 10.58471/ scientia.v13i03
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

it will be a bright prospect for the business world in the future, especially the sustainable business sector.

It is hoped that in the future Smart Garden Energy will be able to improve the business ecosystem based on a green economy, where entrepreneurs compete with each other in realizing innovations, especially in the field of renewable energy and the use of the latest energy. If that happens, of course the goals of the energy trilemma will be achieved well in the future and will make it easier for people to undergo the energy transition in everyday life.

Testing and Analysis of Electricity Quantity Monitoring Tools on Power Electronics-Based Solar Charge Controller Devices.

Testing the tool without load and using a load of (40) and (4) watts, by comparing the results of the monitoring tool measurements and the results of reading electrical quantities using a multimeter for 10 minutes and carrying out 5 tests.

Testing using no load

The test results using no load can be seen in the following table:

Table 1. No-load testing

Number of Testing	V_{uk} (V)	V_a (V)	I_a (A)	P_a (W)	VAC_{uk}	VAC_a
1	12.45	12.5	0.03	0.40	192.9	194.2
2	12.44	12.4	0.03	0.40	193.3	194.4
3	12.43	12.3	0.03	0.40	193.4	194.5
4	12.39	12.2	0.03	0.40	193.5	194,4
5	12.46	12.6	0.03	0.40	193.9	194.6
Averages	12.43	12.4	0.03	0.40	193.4	194.4

Information:

Vbuk = battery voltage value read on the measuring instrument
Vba = battery voltage value that is read on the device that is made
Ia = current value that is read on the device that is made
Pa = power read on the device being made
Vacuk = AC voltage value read on the measuring instrument
Vaca = AC voltage value that is read on the device being made

Based on the table above, the average battery voltage value obtained from the monitoring tool measurement results is (12.4V) and the results of reading electrical quantities using a multimeter are (12.43V).

Voltage accuracy percentage:

$$= \frac{Averages\ Voltage\ (Va)}{Averages\ voltage\ on\ device\ (Vuk)} \times 100\%$$

$$= \frac{12.4}{12.43} \times 100\ \%$$

= 99,7%

Jurnal Scientia
Volume 13 , Number 03, 2024, DOI 10.58471/ scientia.v13i03
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

From the calculation above, it can be seen that the percentage error in the voltage of the tool being made is (0.3)%.. The average value of power produced on the device is (0.40 W), so the calculation results are as follows: Average energy calculation results:

$$= \frac{Averaaverage\ power\ x\ usage\ timeges\ Voltage\ (Va)}{3600}$$

$$= \frac{0.40\ x\ (10\ x\ 60)}{3600}$$

$$= \frac{0.40\ x\ 600}{3600}$$

= 0.06 Wh.

Based on the table above, the average AC voltage value obtained from the monitoring tool measurement results is (194.4V) and the results of reading electrical quantities using a multimeter are (193.4V).

Table 2. Tests on the Solar Charge Controller

No	Times	Input SCC	Output SCC with out Load
1	08:12	13.80 V	12.97 V
2	08:22	14.73 V	13.03 V
3	08:32	15.72 V	13.63 V
4	08:38	15.77 V	14.88 V
5	08:52	17.77 V	15.45 V

In testing the Solar Charge Controller, the SCC input and output output will exceed the battery limit because when the SCC is on the battery has started to charge and the voltage in the battery will increase.

CONCLUSION

The design of a small-scale power consumption PLTS with photovoltaic technology in an Agro-Tourism area with a load of 3,500 Watts at an agro-tourism location requires the following equipment: 30 solar panels (Wp = 35 Wp); 74 batteries; Inventor of 700 watts, and (iv) SCC of 30 units (10 A). Considering the quite large costs that must be invested in solar energy, especially in agro-tourism areas, the author suggests that maintenance and upkeep of PLTS components be carried out regularly, so that the attraction of agro education and tourist activities with the use of photovoltaic technology

REFERENCES

AL Hakim,R.R.(2020).Model energi Indonesia,tinjauan potensi energi terbarukan untuk ketahanan energi di Indonesia: sebuah ulasan.ANDASIH Jurnal Pengabdian Kepada Masyarakat,1(1).

H Bayu, J windarta.(2021). Jurnal energi baru terbarukan program studi magister energi,sekolah pancasarjana,universitas diponogoro Indonesia, 2(3),123-132

Salahududin salahudin,(2022).Inovasi perencanaan Pembangunan berbasisekowisata,universitas Muhammadiyah malang,vol.6.no.1

S. Aryza, Lubis, Z., Indrawan, M. I., Efendi, S., & Sihombing, P. (2021). Analyzed New Design Data Driven Modelling of Piezoelectric Power Generating System. *Budapest International Research and Critics Institute-Journal (BIRCI-Journal)*, *4*(3), 5537-5547.

S. Aryza, Wibowo, P., & Saputra, D. (2022, July). Rancang Bangun Alat Pengontrolan Proses Pemanasan Produksi Biodisel Dari Minyak Jelantah Berbasis Arduino Mega. In *Prosiding Seminar Nasional Sosial, Humaniora, dan Teknologi* (pp. 121-127).

Teguh afrianto(2021).jurnal optimasi perencanaan pembangkit listrik tenaga surya(PLTS) terpusat wilayah pulau luar Universitas teknologi mesin nasional,info mesin 12(2).

Teten Haryanto,Henry Charles,Hadi Pranoto.(2021).Perencanaan energi terbarukan solar panel essential load dengan system switch,Jurnal Tehnik Mesin:vol.10,no.1

Garg, H. P., & Agarwal, R. K. (2017). Solar Energy: Fundamentals, Economic and Energy Analysis. Springer.

Farhan, A., & Muis, Z. (2019). Analisis Potensi Energi Surya sebagai Alternatif Pembangkit Listrik di Pulau Sulawesi. Jurnal Teknologi Energi, 3(1), 12-19.

Suryadi, D., & Mardiansjah, F. H. (2017). Analisis Potensi Energi Matahari untuk Pembangkit Listrik Tenaga Surya di Provinsi Jawa Tengah. Jurnal Rekayasa Energi, 4(1), 11-18.

Siregar, F. R., & Suhartana. (2017). Analisis Potensi Energi Surya untuk Pembangkit Listrik Tenaga Surya di Wilayah Kota Medan. Jurnal Energi dan Manufaktur, 5(1), 32-39.

Rahayu, D., & Sari, N. P. (2018). Analisis Potensi Energi Surya untuk Pembangkit Listrik Tenaga Surya di Pulau Bali. Jurnal Teknik Elektro dan Komputer, 7(2), 63-68.

Dalimunthe, M. E., & Lesmana, D. (2024). Analysis of Aquaponics Solar Panel Innovation in Building C of Pembangunan Panca Budi University. Fidelity: Jurnal Teknik Elektro, 6(1), 60-63.