Instituto Nacional de Ciências e Tecnologia de Timor-Leste

Report of Scientific Research INCT 2024

Design and Implementation of Wind Turbines and Solar Panels Using Hybrid Methods Based on IoT Monitoring for the Church Building in Ponilala Village, Ermera Sub-District-Timor Leste

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Declaration

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Instituto Nacional de Ciências e Tecnologia, a 19 de November de 2024.

Signature of the Principal Investigator: ____________________________________.

Dezenha e Implementação de Aerogerador e Painéis Solares Utilizando Métodos Híbridos Baseados na Monitorização IoT para o Edifício da Igreja na Vila de Ponilala, Subdistrito de Ermera, Timor Leste

Abstrato: *A integração de turbinas eólicas e painéis solares está a tornar-se cada vez mais importante para superar os desafios de energia eléctrica enfrentados pela comunidade da aldeia de Ponilala. As suas atividades são muito movimentadas, como os grupos Joven ba Kristu, Sagrada Familya, Maria Auxiliadora e outros que costumam realizar atividades rotineiras. É, portanto, necessária uma corrente elétrica consistente e eficiente para acionar os equipamentos do sistema de som e iluminação. Esta investigação tem como objetivo projetar e implementar um sistema híbrido de células solares e turbinas eólicas baseado num controlador IoT. O estudo começa com uma análise das condições climáticas locais e das necessidades energéticas. Com a monitorização IoT, serão recolhidos dados de corrente e tensão elétrica. A análise de dados em tempo real controlou com precisão a distribuição de eletricidade para as necessidades da igreja e acendeu as luzes e o equipamento do sistema de som de forma consistente e eficiente. Uma corrente de 17 Ampere e 220 Volts da turbina eólica, uma corrente de 22 Ampere e 221 Volts da célula solar foi detetada consistentemente no painel de controlo que é informada pela monitorização IoT.*

Palavras-chave: *Turbinas Eólicas, Célula Solar, Monitorização IoT, Energia Elétrica*

Design and Implementation of Wind Turbines and Solar Panels Using Hybrid Methods Based on IoT Monitoring for the Church Building in Ponilala Village, Ermera Sub-District-Timor Leste

Abstract: *The integration of wind turbines and solar panels is becoming increasingly important to overcome the electrical energy challenges faced by the Ponilala village community. Their activities are very busy, such as the Joven ba Kristu, Sagrada Familya, Maria Auxiliadora groups and others who often carry out routine activities. Therefore, a consistent and efficient electric current is needed to activate the sound system equipment and lighting. This research aims to design and implement a hybrid system of solar cells and wind turbines based on IoT controller. The study begins with an analysis of local climate conditions and energy needs. With IoT monitoring, data on electric current and voltage will be collected. Real-time data analysis has precisely controlled the distribution of electricity to the church's needs and has turned on the lights and sound system equipment consistently and efficiently. A current of 17 Ampere and 220 Volt from the wind turbine, a current of 22 Ampere and 221 Volt from the solar cell has been consistently detected on the control panel which is informed by IoT monitoring.*

Keywords: *Wind Turbines, Solar cell, IoT Monitoring, Electrical Energy*

1. Introduction

1.1. Theory Context

Ponilala Village in Timor Leste, with an area of 8.50 km², is one of the villages in Ermera Sub-District and Ermera Municipality. In 2022, the population will reach 4,629 people, the majority are Catholic, and the majority of livelihoods come from coffee, sweet potato and corn plantations. Worship activities at church, as carried out every morning, Sunday and Friday, are an important part of the Ponilala community routine. To support the smooth running of worship, facilities such as a sound system and lighting are needed. However, the electrical energy source currently used comes from Timor Leste Diesel Power Generation/ EDTL and power plants in Hera and Betano, with a capacity of 250 MW, to support social and economic development in Timor-Leste (Ministry of Tourism Timor Leste, 2011). However, there were problems such as power outages due to cables breaking due to wind and landslides which caused electricity poles to fall. In this context, alternative solutions are needed to find more efficient sources of electrical energy as has been done by researchers (Badwawi et al., 2015), (Alnaimi et al., 2024), (C. H. Li et al., 2009), (Bayrak & Kabalci, 2016), they implement wind turbines and solar cells to meet community needs (Mehrjerdi, 2020), (Yang et al., 2009), (Elhadidy, 2002), (Reddy et al., 2012). The use of renewable energy, such as wind turbines and solar cells, is proposed as an alternative to support church activities and worship in Ponilala Village such as research that has been carried out and applied in the Malang area, Indonesia (Maulana and Ansori, 2020). Since 2008, the Timor Leste government has implemented 3000 solar cells for homes in several districts, together with the United Nations which has implemented solar cells for office buildings and households in Dili (United Nation, 2022). Wind turbines have proven effective in producing electrical energy, and several areas in Timor Leste, such as Bobonaro, Venilale, Quelicai, and Viqueque, have been identified as potential for the development of wind turbines (Ministry of Tourism Timor Leste, 2011). Ermera District also has potential with average wind speeds reaching 4-6 m/s. The potential for solar cells in the Ponilala-Ermera village is very large to be utilized, especially in high-lying churches with a radiation capacity of up to 4.4 Kwp/day so that they can be used to generate electricity, this solar radiation capacity compared to other areas can be used hybrid. However, both wind turbines and solar cells have their respective disadvantages. To overcome this, a hybrid approach is proposed. Hybrid systems combine two renewable energy technologies to create a more efficient and reliable system. Two devices will be combined, namely wind turbines and solar cells, to ensure a smooth supply of electrical energy, even when there is no wind or the sun is shining (C. Li et al., 2016). Based on the Hybrid Renewable Energy Sources (HRES) structural system, there are several energy sources that can be combined, such as wind+sollar, wind+sollar+diesel, wind+sollar+battery, wind+diesel, sollar+diesel and others (Bernal-Agustín & Dufo-López, 2009), (Roy et al., 2022). Based on the situation in Ponilala village, Wind+Solar+Diesel is the recommended hybrid for use because the electricity source currently used is a Diesel power plant. The hybrid wind-solar-diesel energy system is an attractive option, especially when a system is not directly connected to an electrical distribution or power grid, the same explanation as the research (Munuswamy et al., 2011). The diesel generating system, which is powered by non-conventional fuels, is employed as a backup electricity supply source. A diesel-generating system is deployed to ensure the continuity of the electricity supply in the HRES scheme (Khare et al., 2016), (Elaziz et al., 2022). By adding an engine generator to the HRES framework, the system becomes more complicated. However, modern controllers can operate these systems automatically. Moreover, the engine generator helps reduce the size of the power electronic converter needed for the system (Elhadidy, 2002), (Roy et al., 2022), (Al-falahi et al., 2017), (Patel, 2005). To monitor and optimize system operations, Internet of Things (IoT) monitoring is used. IoT monitoring will collect data on wind speed, solar radiation and electrical power output, which will be used to identify potential problems and improve operational efficiency, this system is very easy to operate so that a lot of research has gone into designing and implementing it (Pawar et al., 2020), (AL Hajri et al., 2024), (Srivastava et al., 2018), (Prasanna Rani et al., 2023), (Ha & Phung, 2019). Thus, this proposal proposes a hybrid method for designing wind turbines and solar panels to support Diesel power plant and using IoT monitoring to support the sound system and lighting at the Ponilala-Ermera Church. This hybrid method is expected to have advantages in efficiency, reliability, and cost reduction compared to traditional design methods.

1.2. Literature Theory

1.2.1. Renewable Energy

Renewable energy is an energy source that is available by nature and can be used continuously. This is in line with the statement from the International Energy Agency (IEA). Renewable energy is energy that comes from "sustainable natural processes", such as solar power, wind power, water flow, biological processes, and geothermal heat and others as seen in Figure 1.1 One study has implemented a hybrid solar–wind power generation system to supply power for a telecommunication relay station on a remote island, Dalajia Island in Guangdong Province, China (Yang et al., 2008), (Kabalci, 2013). Based on the results of a survey by the IEA, the hybrid solar cell and wind turbine system has been widely implemented in developing countries such as China, America, India and others. They utilize renewable energy in the form of a hybrid solar cell and wind turbine system in residential areas and buildings (International Energy Agency, 2020).

Figure 1.1 Renewable energy sources

The concept of renewable energy began to be known in the 1970s, as an effort to balance the development of nuclear and fossil fuel energy. The most common definition is an energy source that can be quickly restored naturally, and the process is sustainable. With this definition, nuclear and fossil fuels are not included in it. Renewable energy is an energy source that can be freely regenerated, and can be renewed and unlimited. Renewable energy can be created by utilizing increasingly sophisticated technological developments, so that it can become a reliable and efficient alternative energy source (Mehmood, 2024), (Dhakouani et al., 2019). In this study, the energy applied is energy from wind and solar radiation. The combination system between solar cells and wind turbines has been widely applied in Eastern Arab countries, including installed behind D-building at University of Buraimi, Oman (Almarshoud, 2016), and 32 of location in Saudi Arabia (Groissböck & Pickl, 2016), (Rehman et al., 2017), (Suliman, 2024).

1.2.2. Solar Radiation Energy

Solar radiation that occurs in the atmosphere experiences various deviations, so that its power towards the earth is smaller. Part of the solar radiation that is absorbed will change its nature. Changes in the angle of incidence of light can cause changes in the length of the path traveled by the light. The reception of solar radiation on the earth's surface varies greatly according to place and time. Solar radiation is the energy emitted from the thermonuclear process that occurs in the sun. Solar radiation energy has two forms, namely rays and electromagnetic waves. The spectrum of solar radiation itself consists of short-wave rays and long-wave rays. Rays with short wavelengths are X-rays, gamma rays, and ultraviolet rays, while rays with long wavelengths are infrared rays. There are three types of radiation received and reaching the earth's surface, namely direct radiation, diffuse radiation, and global radiation.

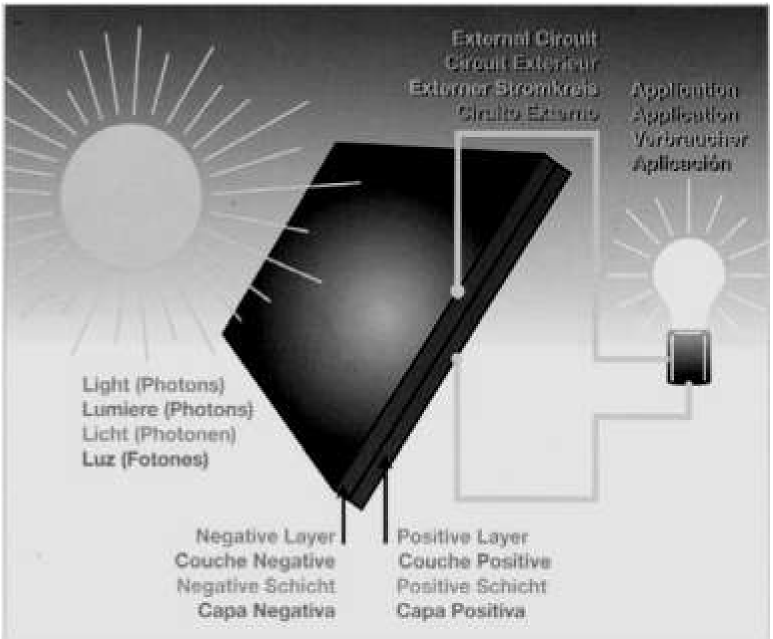


Figure 1.2 Sunlight radiation on solar cells (Patel, 2005).

Thus, the use of sunlight is important for use in renewable energy systems to generate electricity as show in Figure 1.2. Photovoltaic (PV) technology is better known as solar panels - generating electricity using devices that absorb energy from sunlight and convert it into electrical energy through semiconductor materials.

Between 1992 and 2023, the worldwide usage of photovoltaics (PV) increased exponentially and being used globally in many countries for power generation as show in the Figure 1.3. The global PV cumulative installed capacity reached 229.3 GWp, an addition of 50.909 GWp (an increase of 29%) in 2015 compared to that in 2014, as shown in Figure 3 (Wikipedia. Retrieved October 17, 2024). From 2016-2022 it has seen an annual capacity and production growth rate of around 26%- doubling approximately every three years (Wikipedia. Retrieved October 17, 2024). Apart from that, there are also countries in the European Union that have implemented solar panel waste recycling, recycling technology, environmental protection, waste management, recycling policies and the economic aspects of recycling (Chowdhury et al., 2020).

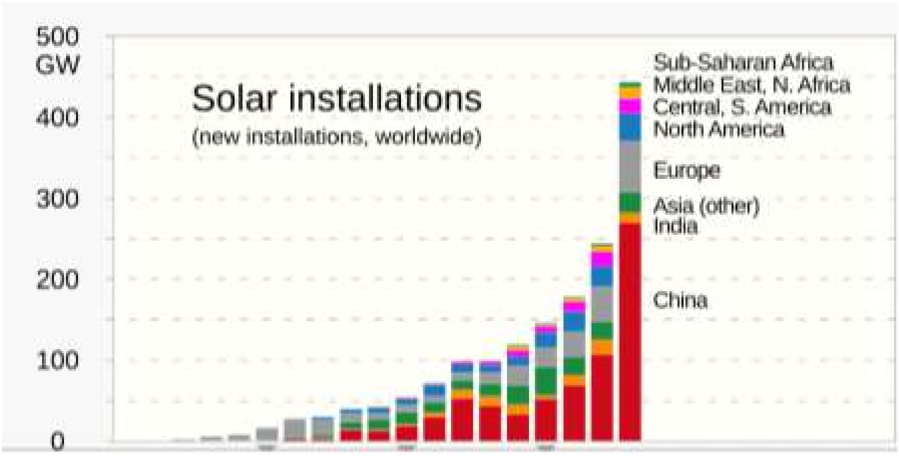


Figure 1.3 Utilization of solar cells in developed countries (Wikipedia. Retrieved October 17, 2024).

The intensity of sunlight in Timor Leste will be converted into electrical energy using Photovoltaic (PV). Photovoltaic is a system used to transfer solar radiation into electrical energy with the principle of the photovoltaic effect. The photovoltaic effect is defined as a phenomenon of the emergence of electrical voltage due to the contact of two electrodes connected to a solid or liquid system when exposed to light energy. In this proposed activity, a monocrystalline type PV is used (Patel, 2005, p. 42).

1.2.3. Energy from the Wind

Wind power is the collection of useful energy from the wind as show in Figure 1.4. Most modern wind power is generated in the form of electricity by converting the rotation of turbine blades into electric current using an electric generator. In windmills the wind speed is used to turn mechanical equipment to perform physical work, such as grinding grain or pumping water.

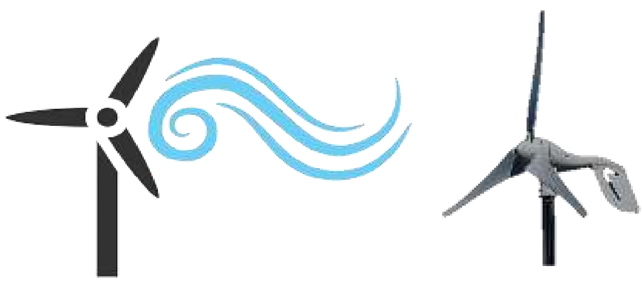


Figure1.4 Wind turbines generate electricity

Wind power is used in large-scale wind farms for national electricity generation and also in small individual turbines to provide electricity in isolated locations. Wind power has been widely applied in developing countries, one of which is the United Kingdom which produced 500MW for lighting needs. Several other countries have also implemented wind turbine systems from 1994 to 2000 as shown in Table 1.1 and Table 1.2 (Patel, 2005, p. 26-27).

Tabel 1.1 Installed Wind Capacity in Selected Countries, 1994, 1995 and 1997 (Patel, 2005, p. 26-27).

Country	1994 MW	1995 MW	1997 MW	Growth 1994-1995 Percent	Annual Growth Rate 1995-97 Percent
Germany	643	1136	2079	76.7	35.2
United States	1785	1828	2000	2.4	4.7
Denmark	540	614	1141	13.7	36.3
India	182	565	1000	210	33.0
Netherlands	153	259	325	69	12.0
United Kingdom	147	193	308	31	26.3
Spain	72	145	455	100	77.1
China	30	36	—	20	—
TOTAL	3552	4776	7308	35.4	23.7

Tabel 1.2 Projected Wind Capacity Addition in Megawatts Between 1994 and 2000 (Patel, 2005 p. 26-27).

Country	Addition planned Megawatts
United Kingdom	100–300
Spain	150–250
Germany	200–350
India	700–1200
China	350–600
Mexico	150–300
Argentina	100–150
Chile	100–200
Australia	50–75
New Zealand	50–100
Total	1950–3525

1.2.4. Horizontal Axis Wind Turbine (HAWT)

Horizontal Axis Wind Turbine (HAWT) is a turbine whose main axis rotates to adjust to the wind direction. In order for the rotor to rotate properly, the wind direction must be parallel to the turbine axis and perpendicular to the direction of rotor rotation. Usually, this type of turbine has an airfoil-shaped blade like the shape of a wing on an airplane. In this turbine, the rotor rotation occurs due to the lift force on the blade caused by the wind flow. This turbine is suitable for use in medium and high wind types, and is widely used as a large-scale power plant. The number of blades on HAWT varies, starting from one blade, two blades, three blades, six blades as show in Figure 1.5 and many blades (multi-blade) whose use is adjusted to the needs and wind conditions. In general, the more blades, the higher the turbine rotation.

Figure 1.5 Horizontal axis wind turbine.

1.2.5. Monitoring Real Time

Real time monitoring is a process where someone reviews, evaluates, and modifies the addition or deletion of existing databases or systems directly. Real time monitoring is also called live monitoring because it is done directly in 'real time'.

The ability of real-time monitoring to monitor live (see Figure 1.6), makes it easy for someone to see conditions in the field that often change rapidly so that they always need the most up-to-date data. This real-time monitoring is very useful in overcoming the inability of a division in a company to manage its resources. In addition, this real-time monitoring can also increase company productivity because there are the latest insights every time. This information then becomes a reference in increasing and accelerating productivity in order to excel in meeting consumer demand.

Figure 1.6 Monitoring real time solar power.

1.2.6. Internet of Things (IoT)

The Internet of Things is a concept where an object or thing is embedded with technologies such as sensors and software with the aim of communicating, controlling, connecting, and exchanging data through other devices as long as they are connected to the internet. The schematic can see in Figure 1.7.

Figure 1.7 Internet of things and renewable energy

IoT has a close relationship with the term machine-to-machine or M2M. All devices that have M2M communication capabilities are often referred to as smart devices. These smart devices are expected to help humans in completing various existing affairs or tasks.

1.2.7. Sensors

A sensor is a device that functions to detect symptoms or signals originating from changes in energy such as electrical energy, physical energy, chemical energy, biological energy, mechanical energy and so on.

(a). Anemometer Sensor

An anemometer is a device used to measure wind speed and direction as show in Figure 1.8. An anemometer is an instrument often used by weather stations such as the Meteorology, Climatology and Geophysics Agency (BMKG).

Figure 1.8 Sensor of anemometer

When blown by the wind, the propeller or bowl on the anemometer will move according to the direction of the wind. The greater the wind speed blowing the bowls, the faster the speed of rotation of the bowls. From the number of rotations in one second, the wind speed can be known.

(b). Irradiance Sensor

Solar Irradiance is the amount of electromagnetic radiation received from the sun per unit area (usually a square meter). It is the amount of solar power detected by a measuring instrument. When this data is integrated over time, the information is called solar irradiance, insolation, or solar exposure. The amount of solar irradiance varies depending on the distance of an object from the sun, the angle of the sun, and the solar cycle of changes in the appearance and activity of the sun every 11 years. Irradiance can be measured for the moon, stars, or other bright objects.

(c). Voltage Sensor

Voltage sensors (see Figure 1.9) are devices or modules used to measure, monitor and calculate the size of the voltage supply in an electronic circuit. This sensor can be used to detect and measure AC or DC voltage according to its features and capabilities. The input of this sensor is in the form of electrical voltage. While the output is in the form of a switch, analog signal or alarm module. Some of these types of sensors can even output signals in the form of sine waves or certain pulses, such as PWM, AM and FM signals.

Figure 1.9 Voltage sensor

In the type of DC voltage sensor, it generally consists of input pins and output pins. The input pin consists of 2 positive and negative pins that can be connected to the device or electronic circuit to be measured. While the output pin can be analog data that can be forwarded to other modules as needed.

(d). Current Sensor

Current sensor (see Figure 1.10) is a device or component or tool to detect current in electricity in a cable, and produce a signal proportional to the value of the current detected. The signal produced can be Analog Voltage or digital data voltage.

Figure 1.10. Current sensor

This signal can be used as a current measuring tool or current magnitude that can be stored in a storage such as a server for analysis or use as a control tool.

1.3. Problem Formulation

a). The village of Ponilala in Timor Leste faces challenges related to the reliability of its electricity supply, primarily provided by diesel power plants (EDTL and power plants in Hera and Betano). Due to frequent power outages caused by natural factors such as wind and landslides, there is an urgent need for alternative and more reliable energy sources. In particular, these outages disrupt the routine activities of the local church, where sound systems and lighting are essential for worship services.

b). Given the potential of renewable energy sources like wind and solar power, Ponilala village is identified as a suitable site for implementing a hybrid energy system. However, both wind turbines and solar panels have limitations, particularly during times of low wind or sunlight. Therefore, a hybrid system combining wind turbines, solar cells, and the existing diesel power infrastructure is proposed as a more efficient and reliable solution.

c). The core problem revolves around designing and implementing this hybrid energy system in Ponilala village, which can provide continuous and stable electricity for the church's needs while addressing the challenges of power interruptions. The system should incorporate Internet of Things (IoT) technology for monitoring and optimizing performance, thus ensuring both efficiency and cost-effectiveness in the long run.

1.4. Hypothesis

The implementation of a hybrid renewable energy system combining wind turbines, solar cells, and diesel generators, supported by Internet of Things (IoT) monitoring, will provide a more reliable, efficient, and cost-effective solution for powering the sound system and lighting at the Ponilala-Ermera Church. This hybrid system will significantly reduce power interruptions caused by the existing diesel-based energy supply, ensuring continuous support for church activities and worship services in Ponilala Village, Timor Leste.

1.5. Objective

1. To design and implement a hybrid renewable energy system that combines wind turbines, solar cells, and diesel generators to provide a reliable and continuous electricity supply for the Ponilala village church.

2. To analyse the potential of wind and solar energy resources in Ponilala village for integration into a hybrid energy system, ensuring a stable power supply during periods of low wind or sunlight.
3. To evaluate the effectiveness of using Internet of Things (IoT) technology for monitoring and optimizing the performance of the hybrid energy system, aiming to enhance operational efficiency and reduce costs.
4. To address the existing challenges of power outages in Ponilala village caused by natural factors such as wind and landslides, ensuring that church activities and worship services are not disrupted.

1.6. Importance of the Research/Justification of the Study

1. The proposed hybrid renewable energy system will reduce dependence on diesel-generated electricity and minimize power outages in Ponilala Village, ensuring continuous power supply for essential church activities and worship services.
2. By combining wind turbines, solar cells, and diesel generators, the hybrid system is expected to optimize energy generation and usage, making it more efficient compared to using a single energy source.
3. The use of wind and solar energy will reduce the village's carbon footprint, contributing to cleaner energy practices and reducing environmental pollution caused by diesel power generation.
4. The reliable energy supply will support not only church services but also improve the village’s overall socio-economic activities, allowing for smoother day-to-day operations in the community.
5. The integration of Internet of Things (IoT) monitoring will enhance the system’s performance by enabling real-time data collection and optimization, leading to improved operational efficiency and early detection of any issues.
6. By diversifying the energy sources, the village will have greater energy security, reducing the risk of complete power failure due to natural events or grid disruptions.

1.7. Work Organization

In this study, the research implementation process is based on the research flowchart as shown in Figure 1.12 In addition, the research implementation time and items that have been worked on are based on the research Road Map as shown in Figure 1.11.

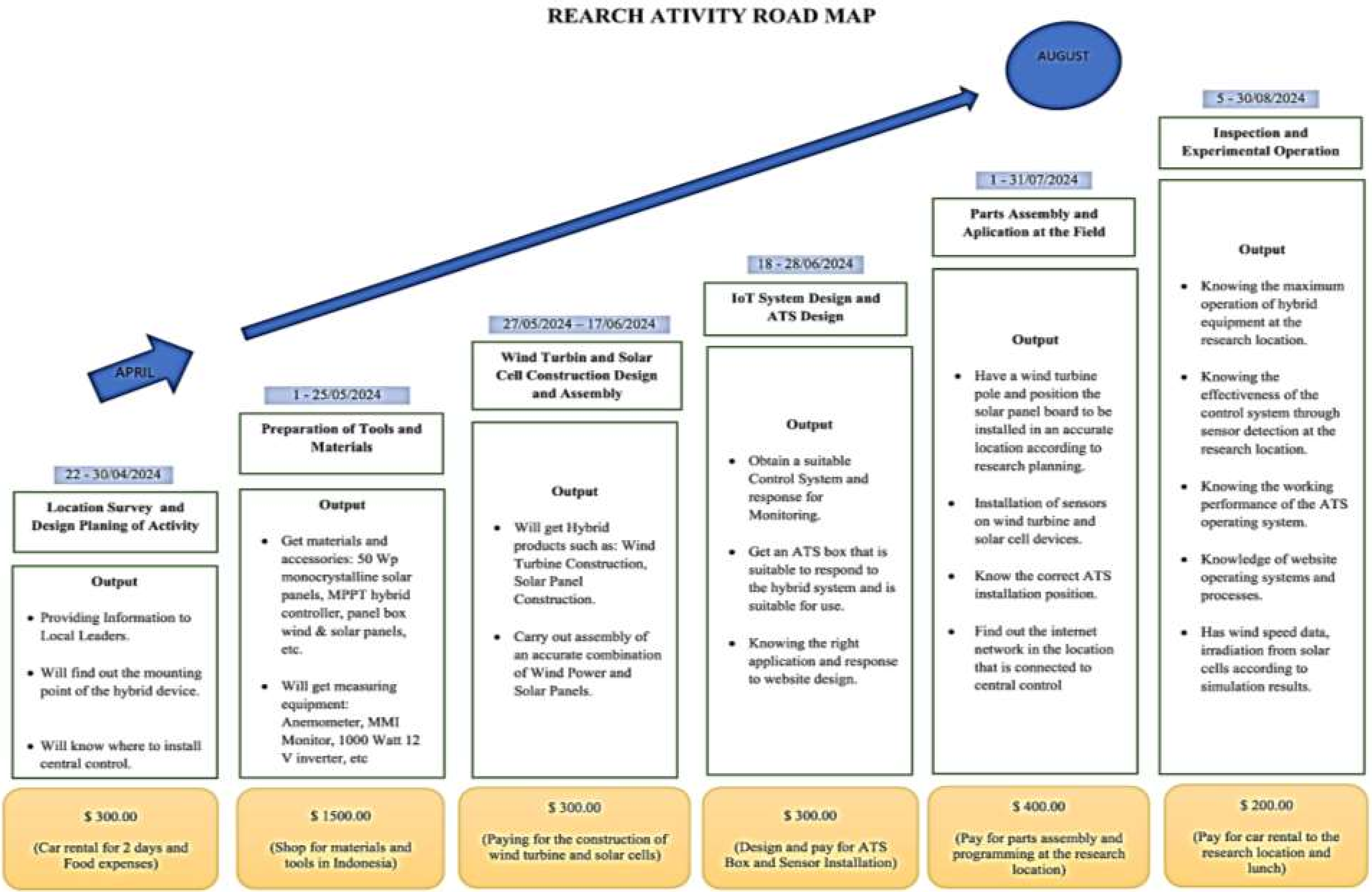


Figure 1.11 Research road map

Research flowchart

This research flowchart discusses the process and stages of research based on the objectives and variables of research data.

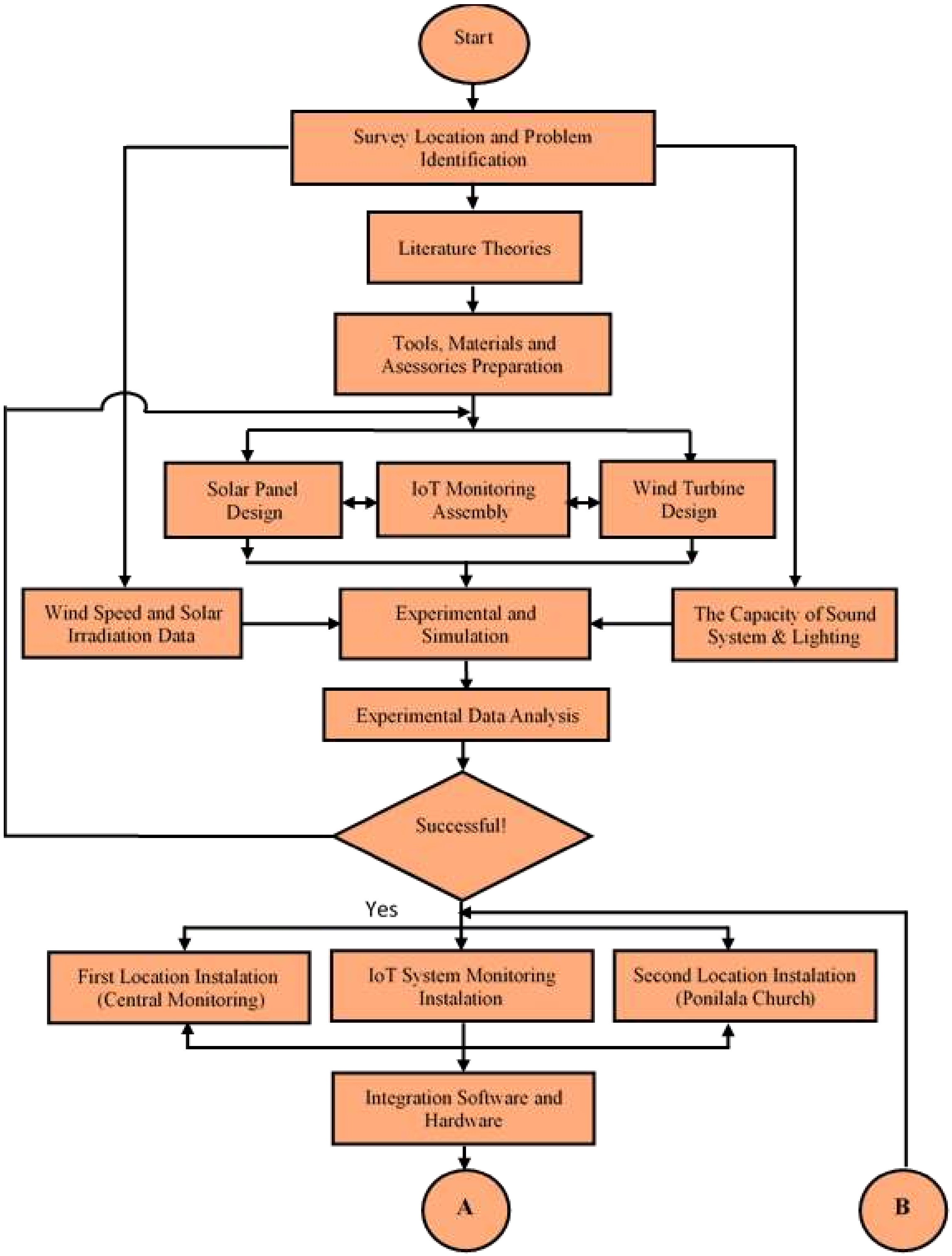


Figure 1.12 Research flowchart

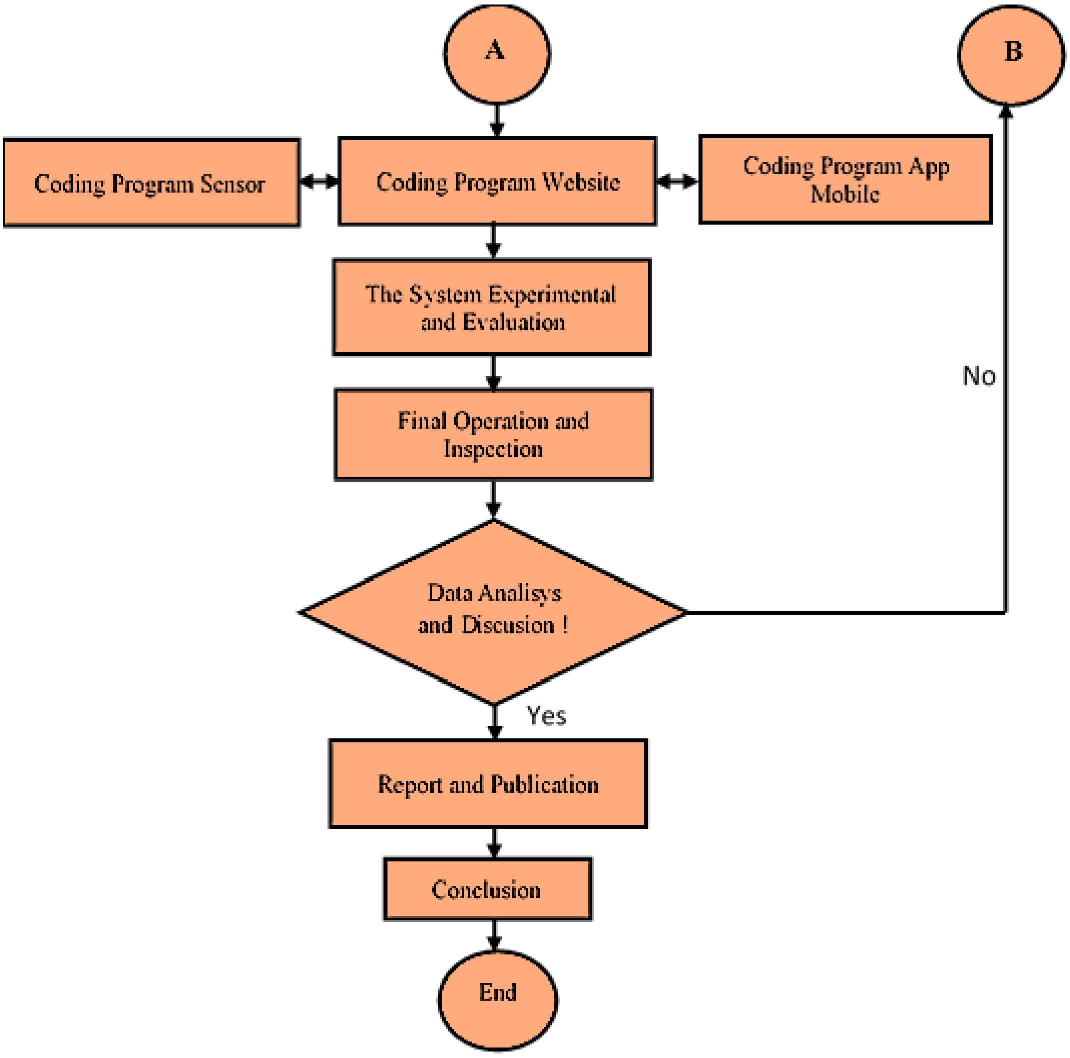


Figure 1.12 Research flowchart **(continued)**

1.8. Geographic Location (Location/places where the study was carried out)

The research will take place in Ponilala Village, located in the Ermera Sub-District within Ermera Municipality, Timor Leste as shown in the Google map in Figure 1.4a. The village spans an area of 8.50 km^2 and, as of 2022, has a population of 4,629 people. The majority of the population is Catholic, and the primary sources of livelihood are coffee, sweet potato, and corn plantations. Worship activities at the local church are an integral part of the community's routine, occurring every morning, Sunday, and Friday. The research will focus on the church in Ponilala Village as shown in Figure 1.13b, where sound systems and lighting are necessary for worship services. The village's current electricity supply relies on diesel power from Timor Leste's Diesel Power Generation (EDTL) and power plants located in Hera and Betano, which face frequent outages due to natural causes, making Ponilala an ideal location to implement and study a hybrid renewable energy system.

(a) **(b)**

Figure 1.13 Research location (a) Location Map, (b) The position of the church in Ponilala Village

2. Research Methodology

The type of this research is product design and implementation. The research process will be based on a flowchart as shown in Figure 1.12 which can describe the steps in designing a Solar cell and Wind Turbine power generation system design with IoT Monitoring. This hybrid system will be implemented in selected locations so that the community can immediately use it. For remote data monitoring based on IoT which can be monitored via Android applications such as Haiwell Cloud Device as show in Figure 2.1.

Figure 2.1 Android applications such as Haiwell Cloud Device

2.1. Design Methods and Strategies

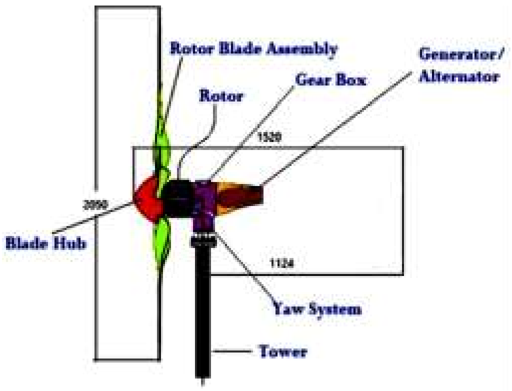
In this study, the design of the hybrid system will be carried out in the laboratory of the Dili Institute of Technology (DIT). In the design process, lecturers have involved students to design, assemble and experiment. The next step is that the hybrid device will be taken to the location for installation at the Ponilala church. The next step will be data collection consisting of:

1. Power generated in a hybrid solar cell and wind turbine,
2. The efficiency generated in hybrid solar cell and wind turbine.
3. Monitoring data from the Internet of Things (IoT) on hybrid systems..

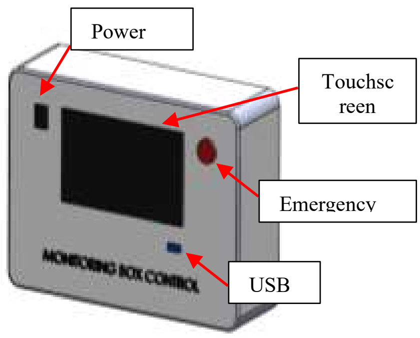
2.2 Materials dan equipments fo design

The main components of a hybrid solar cell and wind turbine power plant are:

- Support Pole
- Wind Turbine model HY-1500 (Blade 3) (See Figure 2.2a)
- Solar Cell 400 WP (See Figure 2.2c)
- Control Box / Control IoT System (See Figure 2.2b)
- Lithium Battery and Control System Circuit



(a)



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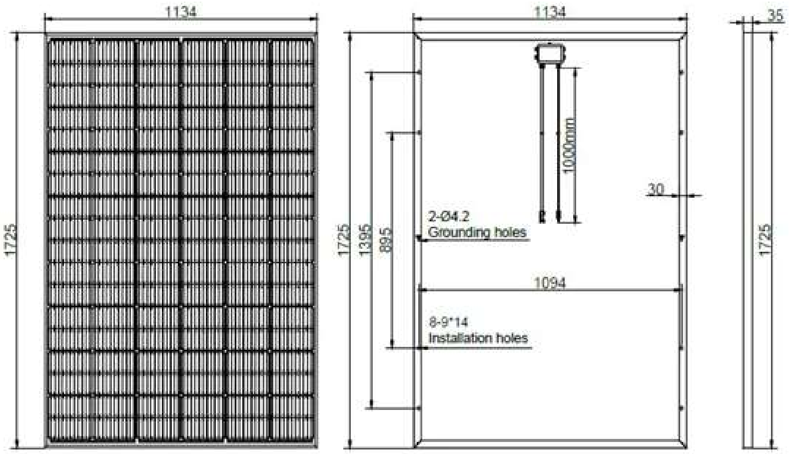

(c)

Figure 2.2 (a) Turbin Angin model HY-1500 (Blade 3), (b) data monitor screen for IoT Technology, (c) Solar Cell 400 WP.

Table 2.1 The specification of Wind turbine HY-1500

Technical Specification	
Model	HY-1500
Rated Power	1500W
Max Power	1800W
Rated Rotation Speed	750rpm
Starr-up Wind Speed	2.0 m/s
Cut-in Wind Speed	2.5 m/s
Rate Wind Speed	12 m/s
Rotor Diameter	2 m
Blade Quantity	4
Swept Area	3.3 m^3
Strong Wind Protection Mode	Electromagnetic brake, blades Aerodynamic Brake
Wind Turbine Type	Upwind
Net Weight	20 Kg

The research instrument for generating hybrid solar cell and wind turbine power systems, model HY-1500, consists of: Control System Circuit / Control Box, Inverter, Solar Charger, Controller, Lamp, Lithium Battery, Cable Circuit, Digital Multimeter, Data Logger, Multimeter, Anemometer, Solar Power Meter.

2.3 Research Procedures

2.3.1 Preparation Stage

- Design of hybrid solar cell and wind turbine power generation system model HY-1500.
- Survey of location that will be used to establish hybrid power generation.
- Purchase of equipment and tools used.
- Prepare instruments and measuring tools.

2.3.2 Data Collection Stage

- Data collection was carried out at 07.00 – 16.00 (Timor Leste time).
- When starting to run, the solar power meter will capture the position of the greatest light energy intensity.
- Measure the current, output voltage, and solar energy intensity using a Monitoring Box Control which is a Touchscreen Monitor. In addition, remote data monitoring can be done using the Haiwell Cloude application on an Android cellphone. For the solar power meter every 10 minutes from 07.00 – 16.00 (Timor Leste time).

- When starting to run, the wind turbine will catch the wind and will rotate.
- Measure the current, output voltage, wind speed, wind temperature using a multimeter and anemometer every 10 minutes from 07.00 – 16.00 (Timor Leste time).

2.3.3 Data Collection Techniques

The types of data that need to be known in this research are data of wind power, efficiency performance of wind turbines and the data of Solar Cell Efficiency Performance.

a). Power Electrical Produced by Wind Turbine. This data is known from the calculation results using equation 1(Patel, 2005 p. 54).

$Pe = V \, x \, I$ .... Eq. 1.

Where, Pe is power of electrical, V is Voltage, I is current.

b). Data of the efficiency performance of wind turbines is known through calculation results using equation 3 (Maulana and Ansori, 2020).

$$\eta = \frac{Output}{Input} x100\%$$

$\eta = \frac{Pe}{Pw} x100\%$ .... Eq. 2.

Where, Pe is Power electricity generator (Watt), Pw is Wind Power (Watt).

c). Data of Solar energy is known through calculation results using equation 3.

Psc = V x I x FF .... Eq. 3.

Where, Psc is power of solar cell, V is the voltage (V), I is Current (I) and FF is the filling factor. To get the FF value, can use the following equation:

$$FF = \frac{V - \ln{(V + 0{,}72)}}{V + 1}$$

d). Data on Solar Cell Efficiency Performance is known through calculation results using equation 4 (Maulana and Ansori, 2020).

$$\eta = \frac{Output}{Input} x100\%$$

$$\eta = \frac{Psc}{G\,x\,A} x100\% \quad \text{.......} \quad \text{Eq. 4.}$$

Where, Psc is Solar Cell Power (Watt), G is Light Intensity (Watt/m²) and A is Cross-sectional area (m²)

3. Results and Discussion

After the hybrid system design was carried out based on the research plan, an experiment was carried out in the Dili Institute of Technology testing laboratory. The next step is the installation of the hybrid system device at the location, namely the Ponilala church. The hybrid system product has been installed at the location as show in Figure 3.1, so the researcher entered the data collection in the form of electrical power from the wind turbine and solar panels, then data collection on the efficiency of the hybrid system's operational performance.

Figure 3.1 Instalation hybrid system at the location (a) Solar Cell (b) Electrical Control panel box and IoT panel box (c) Position control box in the Church (d) Anemometer position (e) Wind Turbine Position (f) IoT system monitoring use Haiwell Cloud

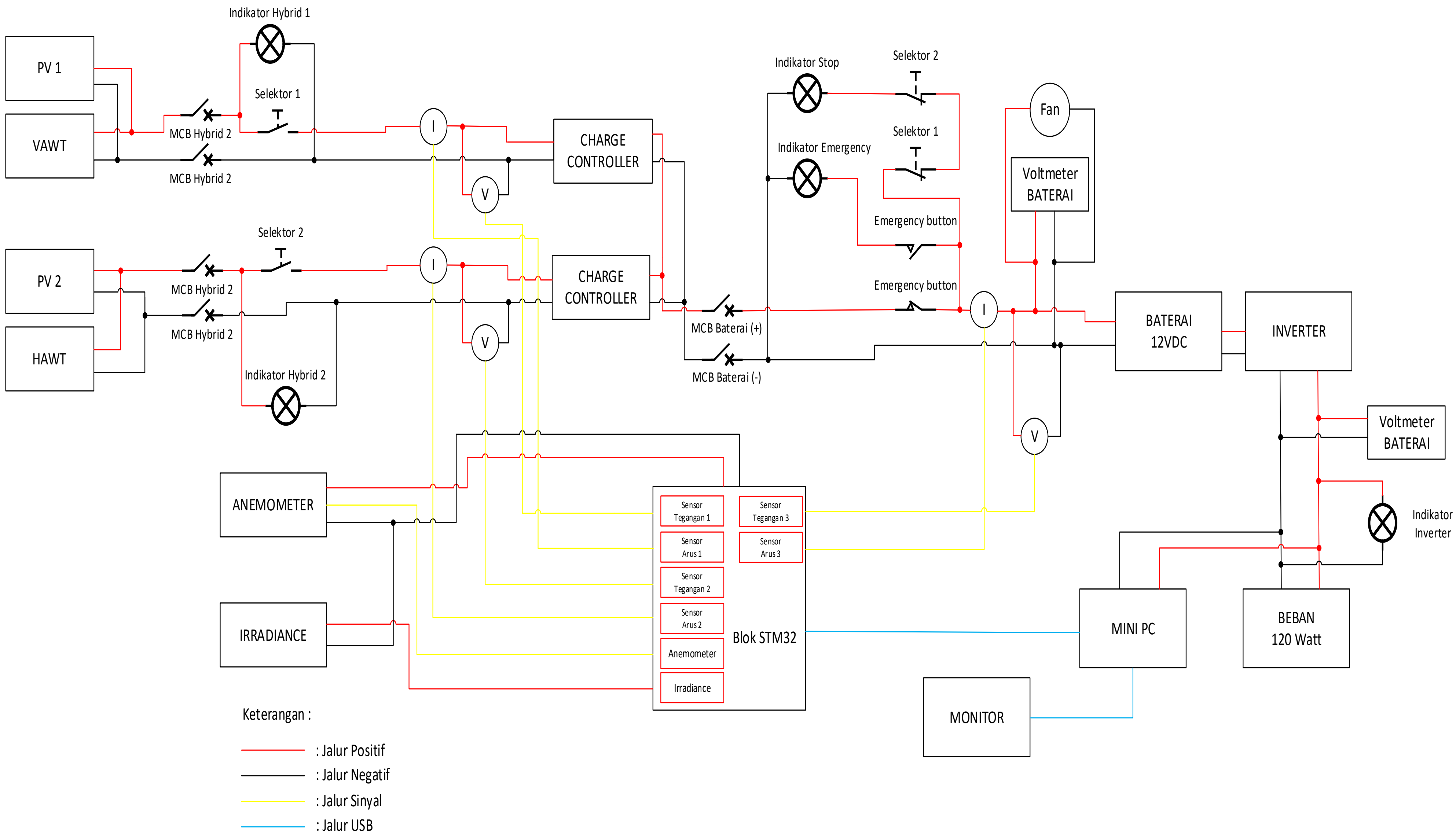

Figure 3.2 Schematic diagram of hybrid system device.

Figure 3.2 show about the circuit diagram of a hybrid system combining solar cells, wind turbines, diesel generators, and batteries serves to illustrate the configuration and connections between these components. Its circuit shows how energy is generated, stored, and distributed to the load. Displays the interconnection of various power sources and their controllers to ensure efficient operation and also represents monitoring and control systems to optimize energy use and switch between sources as needed.

3.1. The Results of Wind Speed

To optimize system performance, the proposed hybrid system is equipped with internet of things (IoT) technology which is used to monitor wind speed, irradiance (solar radiation), power source, current source, and voltage source with the diagram shown in Figure 3.3.
All the resulting data for wind speed detected from IoT monitoring via the Waiwell Cloud application on the mobile application (see Figure 3.3) starting from 07:00 to 16:00 Timor Leste Time can be displayed in Table 3.1.

Figure 3.3 Data display model on haiwell cloud on mobile phone.

Tabel 3.1. Wind Speed (18/11/2024 07:00-16:00 Timor Leste Time)

Times (Hours)	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30	12:00
Wind Speed (m/sec)	4.1	4.2	4.8	5.2	5.4	5.9	5.8	5.7	4.1	3.4	2.7

Table 3.1. **(Continuation)**

Times (Hours)	12:30	00:13	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30
Wind Speed (m/sec)	2.2	2.1	2.5	3.5	3.3	3.9	5.9	11.4	12.2	12.1	12.5

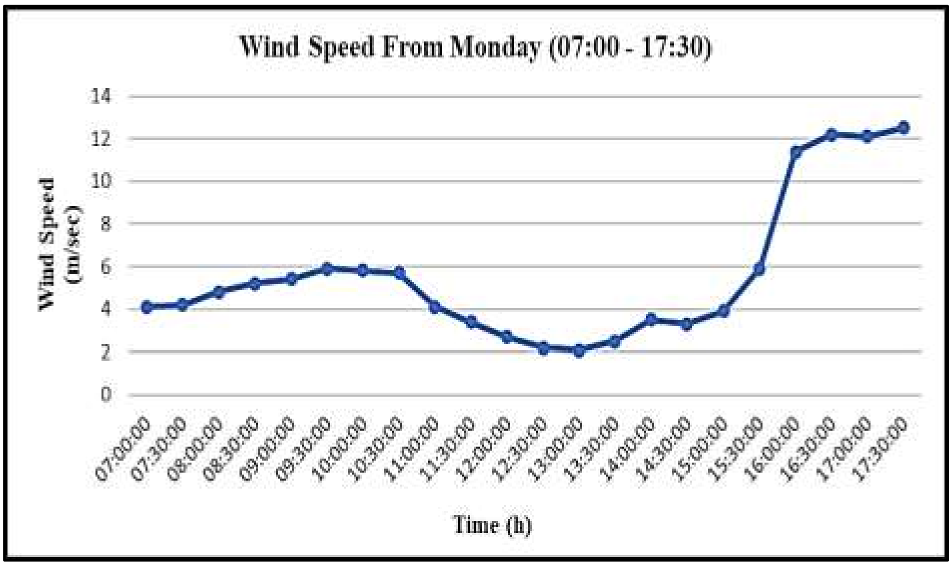

Figure 3.4 Result of the Wind Speed from the one day (18/11/2024 07:00-16:00 Timor Leste Time).

Based on the wind speed data detected from IoT monitoring, which started from 7:00 to 17:30 as shown in the graph in Figure 3.4. The line on the graph shows that the wind speed from 09:30 began to increase until 10:30 reached 5.7 m/s. Furthermore, the wind speed began to decrease at 11:00 to 13:00. Furthermore, at 13:30 the wind speed began to increase until 17:30 reached 12 m/s. The results of this wind speed data are not much different from the research data from (Alnaimi et al., 2024). In relation to his research (Akpinar & Akpinar, 2005) that wind speed between 7 m/s to 25 m/s can produce power of 300 kW, this power value is very good to be used for wind turbines so that they produce electricity.

3.2. Power Electrical Produced by Wind Turbine

After getting the voltage (V) and current (I) data from IoT monitoring via Haiwell Cloud on an Android phone, equation 1 is used. The electrical power data is taken every 30 minutes starting from 07:00 to 5:00. The calculation results can be displayed in Table 3.2 and the data can be analyzed through the graph in Figure 3.5.

Tabel 3.2. Power Electrical Produced by Wind Turbine (18/11/2024 07:00-17:30 Timor Leste Time)

Times (Hours)	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30	12:00
Electrical Power by Wind Speed (Watt)	51.3	52.8	75.48	83.16	84.24	92.4	94.35	94.35	46.41	33.21	18.24

Table 3.2. **(Continuation)**

Times (Hours)	12:30	00:13	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30
Electrical Power by Wind Speed (Watt)	17.0	14.7	17.6	29.5	32.5	37.3	82.3	221.7	236.9	230.5	283.1

Based on the electrical power data generated from the wind turbine which was measured manually, which started from 7:00 to 17:30 as shown in the graph in Figure 3.4. The line on the graph shows that the electrical power from 09:30 began to increase until 10:30 reached 94.35 Watts. Furthermore, at 11:00 to 13:00 the electrical power began to decrease with a value of 14.7 Watts. Furthermore, at 13:30 the wind speed began to increase until 17:30 reached 283.1 Watts. The results of this electrical power data run according to the wind speed, the higher the wind speed produced by the wind turbine, the higher the electrical voltage value.

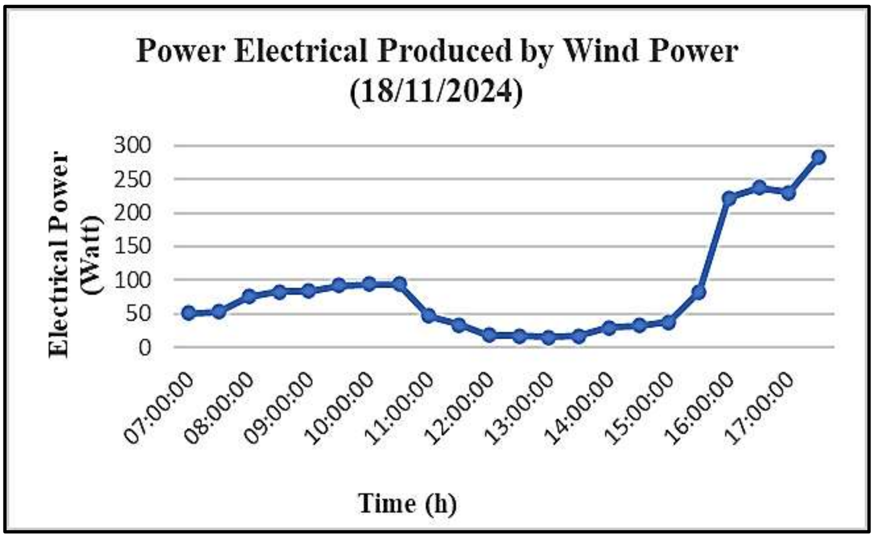

Figure 3.5 Power Electrical Produced by Wind Turbine (18/11/2024 07:00-17:30).

3.3. The current efficiency of Wind Turbine

The current efficiency of wind power reflects how well wind energy is harnessed and converted into electricity. While modern 3 blade of turbines are highly effective, achieving nearly half the theoretical maximum efficiency, factors such as turbine design, wind conditions, and operational practices significantly influence real-world performance.

Next, the wind power efficiency data is calculated using equation 2 and the calculation results can be seen in Table 3.3.

Tabel 3.3. The current efficiency of Wind Turbine (18/11/2024 07:00-17:30 Timor Leste Time)

Times (Hours)	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30	12:00
Efficiency of Wind Power (%)	7.99	7.95	6.36	6.25	6.41	6.39	6.15	6.04	8.83	10.24	14.80

Table 3.3. **(Continuation)**

Times (Hours)	12:30	00:13	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30
Efficiency of Wind Power (%)	12.90	14.20	14.20	11.86	10.14	10.44	7.16	5.14	5.15	5.25	4.41

The variations in wind turbine efficiency throughout the day—such as decreasing to 6.4% in the morning, increasing to 14.8% during the day, and dropping to 4.41% in the afternoon—can be attributed to several environmental and operational factors.

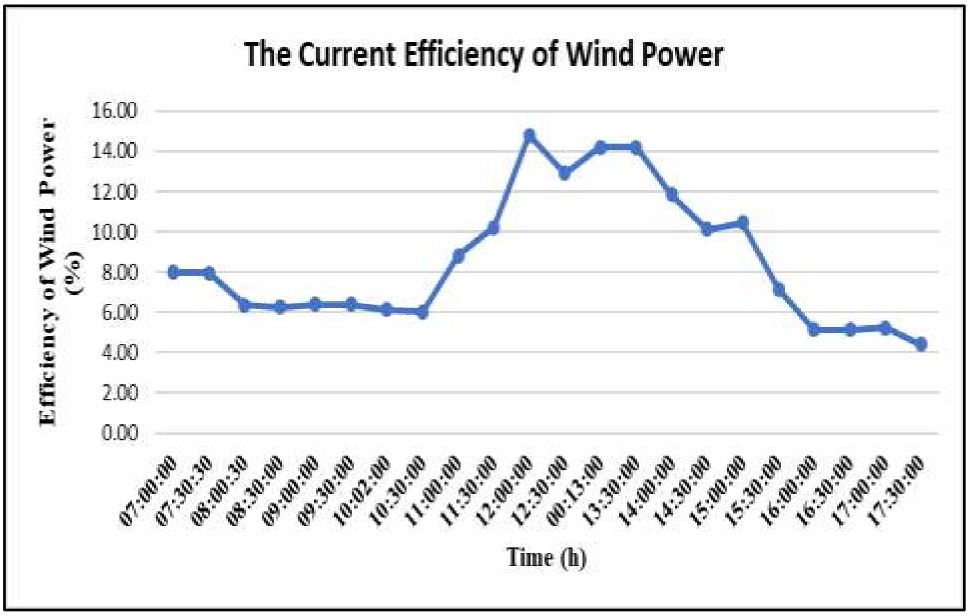

Figure 3.6 The efficiency of Wind Power (18/11/2024 07:00-17:30 Timor Leste Time).

As seen from the graph line in Figure 3.6, in the early morning, wind speeds might be moderate, resulting in partial turbine performance. Efficiency decreases if the wind speed is lower than the optimal range for the turbine's operation (cut-in to rated speed range). Wind speeds tend to increase due to thermal effects. As the sun heats the ground, warm air rises, causing convection and stronger winds, which can improve turbine efficiency. In the late afternoon, wind speeds may drop again as the thermal activity subsides, reducing turbine performance. Additionally,

if wind turbulence increases (caused by changes in temperature gradients or local obstacles), it can further impact efficiency, as explained by scientists (Patel, 2005).
Efficiency is highest when the wind blows steadily and directly toward the turbine's rotor. Variations in wind direction or increased turbulence during certain times of the day can cause inefficiencies due to delays in the turbine's yaw system aligning with the wind direction and Aerodynamic losses due to unsteady flow.

Air density is influenced by temperature, pressure, and humidity, which fluctuate throughout the day shas as (1) In the morning, cooler temperatures result in higher air density, which can increase potential energy but may coincide with low wind speeds. (2) In the midday warmer air has lower density, but higher wind speeds can offset this effect, improving efficiency. And (3) In the afternoon, If the temperature and pressure changes create unfavorable conditions, efficiency may drop further (Patel, 2005).

The efficiency of your wind turbine varies due to diurnal wind speed patterns, thermal effects, and site-specific environmental conditions. To optimize efficiency, consider ensuring the turbine is properly maintained to minimize downtime, selecting a site with consistent and strong wind patterns and using advanced control systems to adapt to changing wind conditions effectively.

3.4. Power of solar radiation

The measurement data for solar energy can be seen in Table 3.4 and the solar cell value data will be obtained from the calculation results of the filling factor value can be seen in Table 3.4. Data is taken every 30 minutes. The data collection process starts from 7:00 to 15:30 in the afternoon Timor Leste time. The type of initial data to be taken is Electrical voltage (V) and Electrical current, then it will use equation 3. The filling factor equation is used to calculate the FF value. Furthermore, it will be multiplied by the voltage data and electric current data to get the power of solar energy value.

Tabel 3.4. Value of filling factor (18/11/2024 07:00-17:30 Timor Leste Time)

Times (Hours)	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30	12:00
Filling Factor (FF)	0.56	0.58	0.64	0.65	0.74	0.67	0.67	0.67	0.57	0.53	0.48

Table 3.4. **(Continuation)**

Times (Hours)	12:30	00:13	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30
Filling Factor FF)	0.48	0.47	0.48	0.53	0.54	0.54	0.65	0.72	0.72	0.72	0.73

Tabel 3.5. Power of Solar Energy (18/11/2024 07:00-17:30 Timor Leste Time)

Times (Hours)	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30	12:00
Filling Factor (FF)	0.56	0.58	0.64	0.65	0.74	0.67	0.67	0.67	0.57	0.53	0.48

Table 3.5. **(Continuation)**

Times (Hours)	12:30	00:13	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30
Filling Factor FF)	0.48	0.47	0.48	0.53	0.54	0.54	0.65	0.72	0.72	0.72	0.73

The graph illustrates in Figure 3.6, the power output of solar energy over the course of a day, from 7:00 AM to 5:30 PM. Let’s break down the events and trends in the graph and explain why the solar energy output behaves.

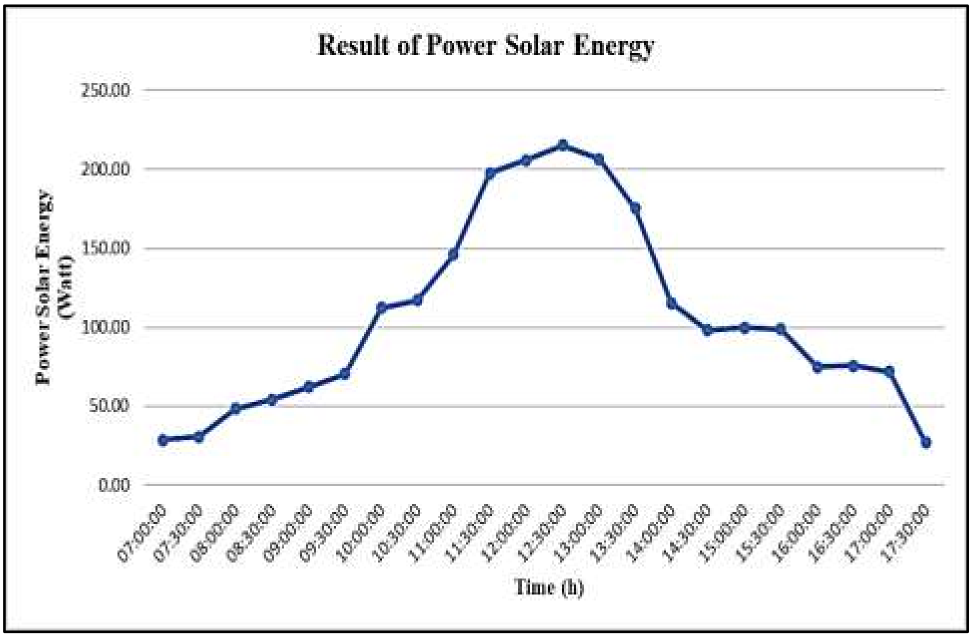

Figure 3.7 The power of solar energy (18/11/2024 07:00-17:30 Timor Leste Time).

In the early morning, the power output is low and increases gradually as time progresses because the sun's angle (solar altitude) is low, resulting in less direct sunlight hitting the solar panels. Atmospheric scattering and absorption reduce the intensity of sunlight. As the sun rises higher, the intensity of solar radiation increases, leading to a gradual rise in power generation.

Then the power output peaks during this period, reaching the maximum value of 215.23 Watts around midday. This happens because of the sun is at its highest point in the sky, reducing the path length of sunlight through the atmosphere and minimizing energy losses. Besides that, solar panels receive maximum direct sunlight, aligned with their optimal tilt and orientation and clear skies and minimal obstructions allow the panels to capture the most energy.

After the peak, the power output starts to decrease, the sun's altitude lowers as the afternoon progresses, reducing the angle and intensity of sunlight. Shadows from nearby objects or terrain may begin to affect the solar panels and increased atmospheric scattering in the afternoon can further reduce sunlight intensity.

The graph reflects a typical solar energy generation pattern driven by the sun's position and atmospheric conditions. The midday peak occurs due to maximum sunlight intensity and optimal panel alignment, while the morning and evening declines are due to lower solar angles and reduced irradiance.

3.5. The Efficiency of Solar Cell

Solar cell efficiency data is obtained from the calculation results using equation 4. However, the initial data that needs to be taken is Voltage (V) and electric current (I). Thus, the calculation results for solar cell efficiency can be input into Table 3.6 and the analysis process results can be shown in the graph Figure 3.8.

Tabel 3.6. Power of Solar Energy (18/11/2024 07:00-17:30 Timor Leste Time)

Times (Hours)	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30	12:00
Solar cell Efficiency	0.30	0.24	0.31	0.24	0.30	0.31	0.41	0.40	0.46	0.48	0.63

Table 3.6. **(Continuation)**

Times (Hours)	12:30	00:13	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30
Solar cell Efficiency	0.64	0.57	0.61	0.61	0.59	0.43	0.43	0.38	0.35	0.23	0.27

To analyse the efficiency value based on time starting from 7:00 in the morning to 17:30 in the afternoon, it will be displayed through the direction of the line on the graph in Figure 3.8.

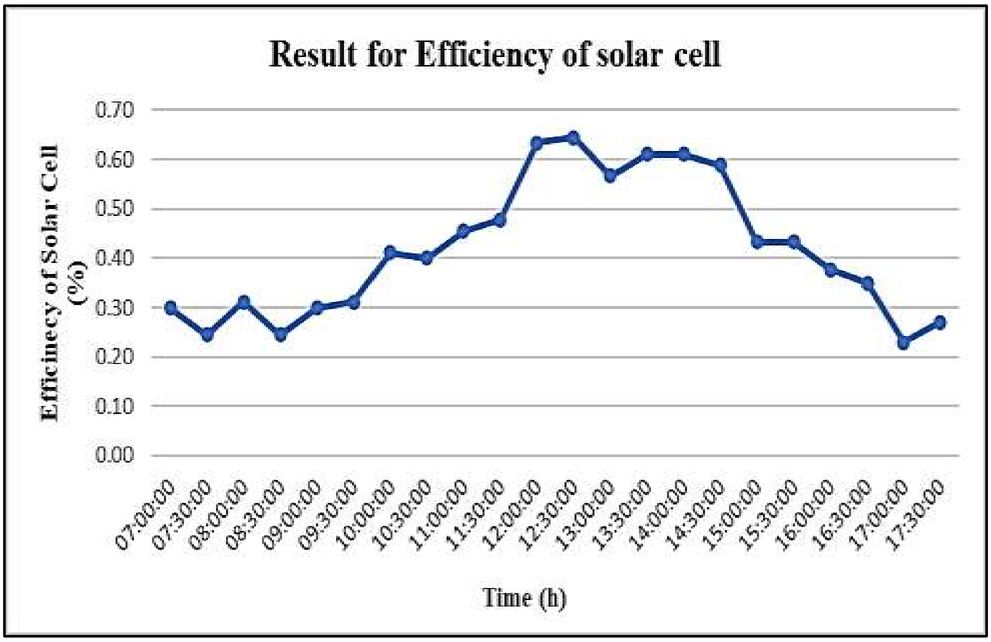

Figure 3.8 The efficiency of solar energy (18/11/2024 07:00-17:30 Timor Leste Time).

It can be seen from Figure 3.8 that the variation in solar cell efficiency throughout the day, with lower efficiency in the morning and afternoon and a peak during midday, can be explained by several factors related to the environment, solar irradiance, and the behaviour of solar cells. In the morning at the 7:00 to 9:30 the efficiency is low because the solar cells generate weak electric current due to low sunlight intensity. In this case that the sun is at a low angle (solar altitude), and sunlight passes through a longer atmospheric path, causing scattering and absorption and Lower irradiance results in reduced photon energy, weakening the solar cell's output. Then the midday at the time of 10:00 to 13:30 efficiency peak 0.64% as solar irradiance is at its highest, this happens because the electrical current generation is significantly stronger. This condition proves that the sun is at its highest position, and solar irradiance is maximized due to minimal atmospheric scattering and Solar panels receive direct sunlight at near-optimal angles, boosting current generation and efficiency. For the afternoon at the time of 3:30 to the 5:30 is that the efficiency drops again to 0.23% because the solar irradiance decreases and current generation weakens drastically. the logic is that as the sun sets, the irradiance decreases again due to the longer atmospheric path and lower solar altitude. Thus, it is analysed that to improving efficiency in the morning and afternoon can involve strategies like optimizing the tilt angle of panels, using tracking systems, or employing more advanced solar cell materials less sensitive to irradiance and temperature changes.

4. Conclusion and Recomendation

4.1. Conclusions

1. The proposed hybrid system, integrated with IoT technology for real-time monitoring of wind speed, solar irradiance, and power parameters, demonstrates significant potential for optimizing performance. Data from the Waiwell Cloud application reveals fluctuations in wind speed, with notable increases from 5.7 m/s at 10:30 to 12 m/s at 17:30, aligning closely with prior research. These findings suggest that wind speeds in the range of 7 m/s to 25 m/s are ideal for generating up to 300 kW of power, making the system highly effective for wind turbine electricity production.
2. The IoT-based monitoring system, utilizing Haiwell Cloud on an Android device, effectively tracks voltage and current data, enabling accurate power calculations at 30-minute intervals. Analysis of the data reveals a direct correlation between wind speed and electrical power output, with power peaking at 283.1 Watts at 17:30 as wind speeds increased. This relationship demonstrates that higher wind speeds lead to greater electrical voltage and power output, validating the efficiency of the wind turbine in harnessing wind energy for electricity generation.
3. The efficiency of wind turbines is influenced by a complex interplay of environmental and operational factors, including wind speed, air density, turbulence, and thermal effects. Variations throughout the day, such as efficiency decreasing to 6.4% in the morning, peaking at 14.8% midday, and dropping to 4.41% in the afternoon, are largely tied to diurnal wind patterns and site-specific conditions. Key factors like steady wind direction, air density changes due to temperature and pressure, and the turbine's ability to align with wind direction directly impact performance. To optimize turbine efficiency, proper maintenance, strategic site selection with consistent wind patterns, and advanced control systems are essential for adapting to dynamic wind conditions and minimizing energy losses.
4. The solar energy generation pattern is directly influenced by the sun's position and atmospheric conditions, as reflected in data collected from 7:00 to 15:30. Power output starts low in the morning due to low solar altitude and atmospheric scattering, gradually increasing as the sun rises higher. The peak output of 215.23 Watts occurs around midday when solar panels receive maximum direct sunlight under optimal alignment and clear skies. After

midday, power generation declines as the sun's angle decreases, shadows may form, and atmospheric scattering increases. This typical diurnal pattern underscores the importance of optimizing solar panel orientation and minimizing obstructions to maximize energy capture throughout the day.

5. Solar cell efficiency varies throughout the day, with low efficiency in the morning and afternoon due to reduced sunlight intensity and higher atmospheric scattering, and a peak of 0.64% at midday when solar irradiance is maximized. This pattern highlights the influence of solar altitude and irradiance on performance. To enhance efficiency during lower irradiance periods, strategies such as optimizing panel tilt, using tracking systems, and adopting advanced solar cell materials can be employed.

4.2. Recommendations

To optimize the performance and efficiency of hybrid renewable energy systems, it is crucial to integrate IoT-based monitoring for real-time data collection and analysis, enabling precise adjustments to wind turbines and solar panels. Wind turbine sites should be selected based on consistent wind patterns within the optimal speed range of 7 m/s to 25 m/s, paired with proper maintenance and advanced control systems. Solar panel efficiency can be enhanced by optimizing tilt angles, implementing tracking systems, and using advanced materials less sensitive to irradiance and temperature changes. These measures will ensure maximum energy generation throughout the day while minimizing losses due to environmental and operational factors.

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Attachments

Research authorization letter

Hatoo ba : Instituto Nacional Ciência e Tecnologia (INCT)
Sra. Onelia Mendes do Santos

Assunto : Informasaun Suvey Lokasi Peskiza

Ho Respeitu,

Hanesan assuntu nebee mensiona, ami hakarak relata ba INCT liu husi Sra. Onelia katak, bajeia ba ami nia mapa azenda atividades nebee ami submete ona ba INCT maka atividades primeiru kona ba survey lokasi. Survey lokasi nebee mak ami halao sei survey igreija iha Munisipiu Ermera, Postu Ermera, Suco Ponilala. Data ba terenu ami sei halao iha loron Sexta Feira, 17/05/2024, oras sai husi Dili tuku 5.00 OTL dader no fila mai Dili lokraik.

Mak ne'e deit ami nia pedidu hatoo ba ita boot, ba atensaun no colaborasaun diak la haluha hato'o obrigadu wa'in.

Dili, 15 de Maiu de 2024

Investigador Responsável

Dr. Natalino Fonseca Da Silva Guterres, ST., M.T.

Assinatura dos membros da equipa de investigação:

(1) Agostinho Pinto, ST., M.T.____.

(2) Marcelo Fernandes Xavier Cham, B.Sc., M. Cs.______________________________.

(3) Justino Martins Salsinha, B. Eng., M.T. _________________________________.

(4) Gilberto Soares, ST.____.

Detail of financial report.

Table 1: Distribution of funds from March 17 to June 26, 2024

No.	Data	Item	Total cost ($)
1	17/5/24	Aluga kareta	100
2	17/5/24	Combustivel ba kareta	100
Fee ba survey lokasi			
3	17/5/24	Marcelo fernandes X. cham	50
4	17/5/24	Gilberto Soares	50
5	17/5/24	Natalino Fonseca	50
6	17/5/24	Justino martinz	50
7	17/5/24	Zebre benigno	50
8	17/5/24	Agostinho Pinto	50
9	17/5/24	Han	10
10	26/5/24	Cash hola material iha Dili	974
Total			**1484**
11	12/6/24	Cash ba order materiall no equipamentu	505
12	12/6/24	Cash ba order MPPT	405
13	12/6/24	cash ba organiza procesu order (Justino)	15
14	12/6/24	cash ba organiza procesu order (Godrius Ciprian D jahimu)	20
Transport ba preparasaun inspesaun iha terenu 26 june 2024			
15	26/6 24	Zebre benigno	5
16	26/6 24	Gilberto Soares	5
17	26/6 24	Octavio Agus dos santos	5
18	26/6 24	Dircio Exposto	5
17	26/6 24	Justino Martins Salsinha	10
18	26/6 24	Combustivel ba kareta ba	90
19	26/6 24	Aluga kareta ba preparasaun visita avaliador sira	50
20	26/6 24	Kustu haruka MPPT no sasan seluk husi kupang - Dili	150
Sub total			**1265**
Total			**2749**

ATTACHMENT OF PROOF OF PAYMENT

No: D 0078

PERTAMINA INTERNATIONAL TIMOR

PERTAMINA INTERNATIONAL TIMOR

SPBU COCO PITSA

KWITANSI

Product	Volume	Price	Amount
Pertamax	: .... Liter	$	$ ....
Solar	: 77.52 Liter	$ 1.29	$ 100.00
Pertamax (Non Cash)	: .... Liter	$	$ ....
Solar (Non Cash)	: .... Liter	$	$ ....
		Total Amont	$ ....

17 / 05 20 24

Tuan
Toko

NOTA NO. ....

Tgl: 17/05/2024

BANYAKNYA	NAMA BARANG	HARGA	JUMLAH
1	Sup tulang	$ 2.00	$ 2.00
1	Ayam goreng	$ 2.00	$ 2.00
1	Nasi Rendang	$ 2.00	$ 2.00
1	ikan Pateng	$ 2.00	$ 2.00
1	Nasi telur	$ 1.50	$ 1.50
2	Agua sedang	$ 0.25	$ 0.50
		Jumlah Rp.	$ 10.00

Tanda Terima

Hormat kami,

No. 01

Telah terima dari Natalino F. da Silva Guterres

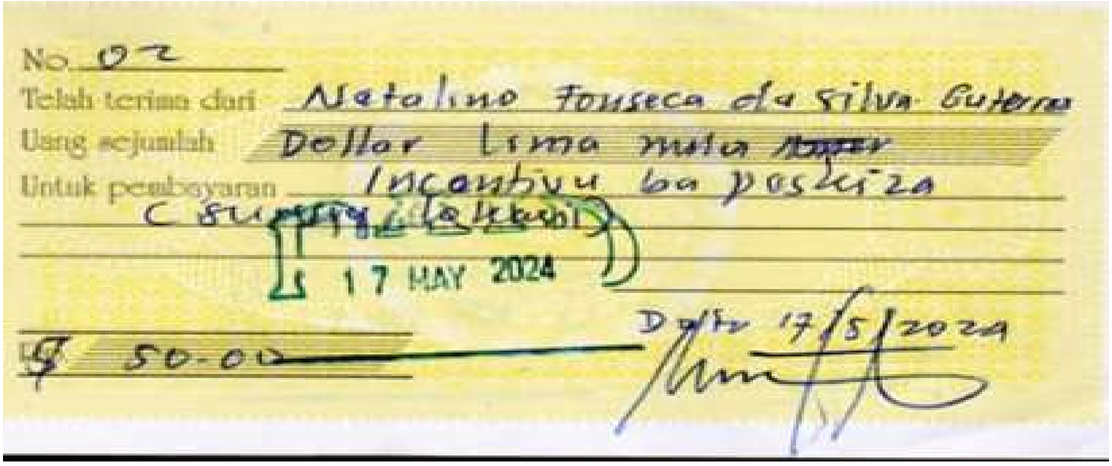
Uang sejumlah Dollar Americanu atus ida

Untuk pembayaran Aluga Kareta ba sito survey

17 MAY 2024

Dili 17 May 2024

$ 100.00



No. 02

Telah terima dari Natalino Fonseca da Silva Guterres

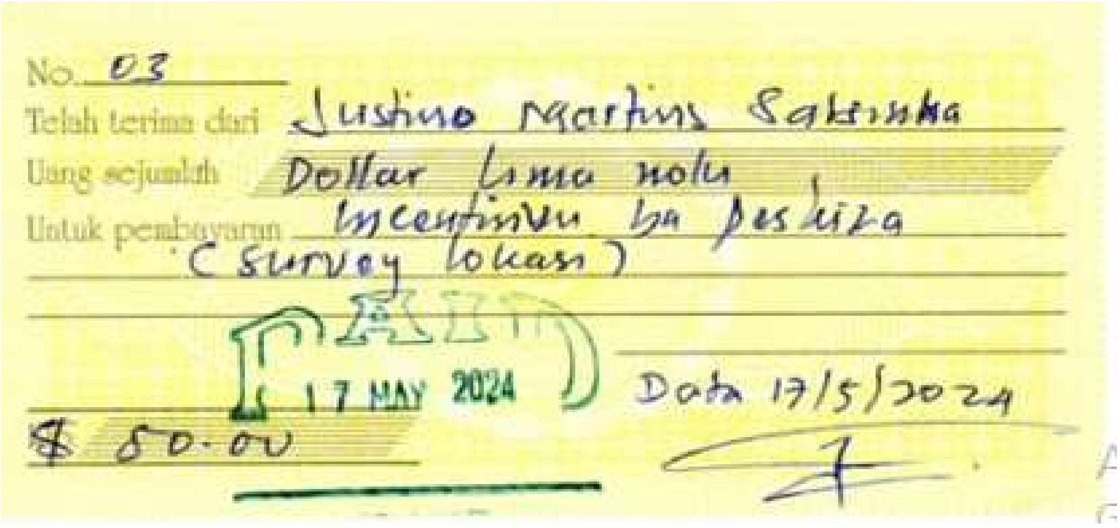
Uang sejumlah Dollar lima nolu ~~[illegible]~~

Untuk pembayaran Incentivu ba peskiza (survey lokasi)

17 MAY 2024

Data 17/5/2024

$ 50.00



No. 03

Telah terima dari Justino Martins Sakirinha

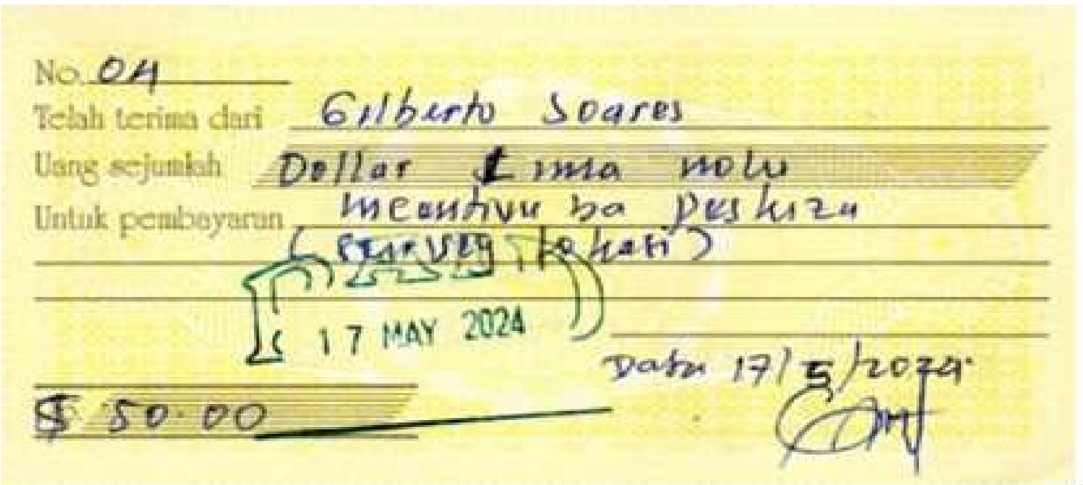
Uang sejumlah Dollar lima nolu

Untuk pembayaran Incentivu ba peskiza (survey lokasi)

PAID 17 MAY 2024

Data 17/5/2024

$ 50.00



No. 04

Telah terima dari Gilberto Soares

Uang sejumlah Dollar Lima nolu

Untuk pembayaran incentivu ba peskiza (survey lokasi)

17 MAY 2024

Data 17/5/2024

$ 50.00

No. 05
Telah terima dari Marcelo Fernandes Xavier Chum
Uang sejumlah Dollar ~~[illegible]~~ lima nulu
Untuk pembayaran incentivu ba peskiza (survey lokasi)

PAID 17 MAY 2024

Data 17/5/2024.

$ 50-00

No. 06.
Telah terima dari Agostinho Pinto
Uang sejumlah Dollar lima nulu
Untuk pembayaran incentivu ba peskiza (survey lokasi)

PAID 17 MAY 2024

Data 17/5/2024

$ 50-00

No. 07
Telah terima dari Jebre Benigno
Uang sejumlah Dollar Lima nulu
Untuk pembayaran incentivu ba peskiza (survey lokasi)

PAID 17 MAY 2024

Data 17/5/2024

$ 50-00

No. 08
Telah terima dari Justino Martins Saldanha
Uang sejumlah Dollar atus sia hitu nolu resin hitu
Untuk pembayaran atu sosa equipamentus no material Sistema Hibrido (solo iha Dili)

PAID 26 MAY 2024

Dili 26/5/2024

$ 974.00

No. 09

Telah terima dari Justino martins Salsinha

Uang sejumlah Dollar Americanu atus lima no lima

Untuk pembayaran sosa material ba IOT no Turbina anin iha Indonesia

PAID 12 JUN 2024

Dili 12/6/2024

$ 505.00

No. 10

Telah terima dari Justino martins Salsinha

Uang sejumlah Dollar americanu ~~rua nulu~~ sanulu resin lima

Untuk pembayaran transportasi procesu kompra online

PAID 12 JUN 2024

12/6/2024

$ ~~20.00~~ $15.00

No. 11

Telah terima dari Godrisus Cyrian de Jalismo

Uang sejumlah Dollar americanu rua nulu

Untuk pembayaran transportasi compra online

PAID 12 JUN 2024

12/6/2024

$ 20.00

No. 12

Telah terima dari Justino Martins Salsinha.

Uang sejumlah Dollar americanu atus hat lima

Untuk pembayaran [illegible] sosa [illegible]PPT. Cordu on line ?

PAID 12 JUN 2024

12/6/2024

Rp. $ 405.00

ESTAÇÃO CONVESTIVEL

Mekar Fuel

AV. Presidente Nicolau Lobato-Luru-Mata
Dili Timor-Leste
Phone : 77621521/ 76620457

Dili, 24 / 06 /2024

To...

No Nota:

ITEM	DESCRIPTION	UNIT PRICE US$	TOTAL PRICE US$
DIESEL	72 LT	1.25	$ 90.00
PERTAMAX	PAID		
	GRAND TOTAL	US$.	$ 90.00

Nota: Item was broughtcan not be refundor re change!!!

Yours Faithfully

No. 13

Telah terima dari Justino Martins Salsinhi

Uang sejumlah ~~Transporte~~ Dolar sanulu

Untuk pembayaran Transportes para Procesu Sumi Sasan

PAID 24 JUN 2024

24/06/2024

Rp. $ 10.00

Atinh.

No. 14
Telah terima dari Zelora Benigno
Uang sejumlah Dollar lima americano
Untuk pembayaran Transportasi ba Posilalo

PAID 26 JUN 2024

26/6/2024

$. 5.00

No. 15
Telah terima dari Gilberto Soares
Uang sejumlah Dollar americano lima
Untuk pembayaran Transportasi ba Posilalo

PAID 26 JUN 2024

26/6/2024

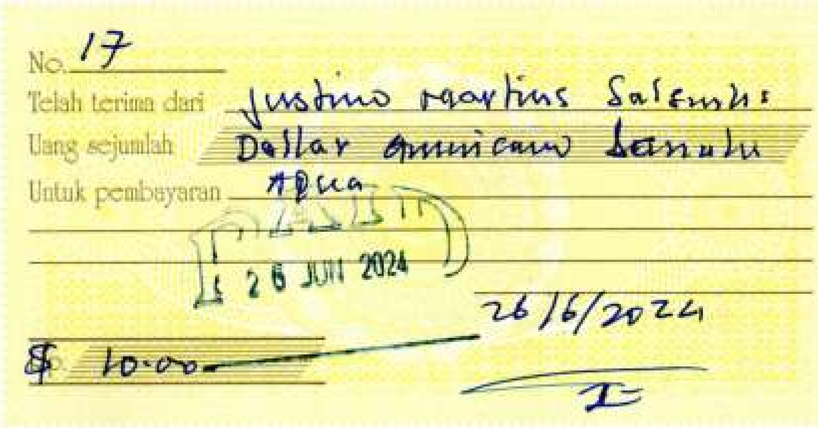
$. 5.00

No. 16
Telah terima dari Octavio Agus. dos-santos. Soares
Uang sejumlah Dollar Americano lima
Untuk pembayaran Transportasi ba posilala

26 JUN 2024

26/6/2024

$. 5.00



No. 17
Telah terima dari Justino Martins Salsinha
Uang sejumlah Dollar Americano Sanulu
Untuk pembayaran Apica

26 JUN 2024

26/6/2024

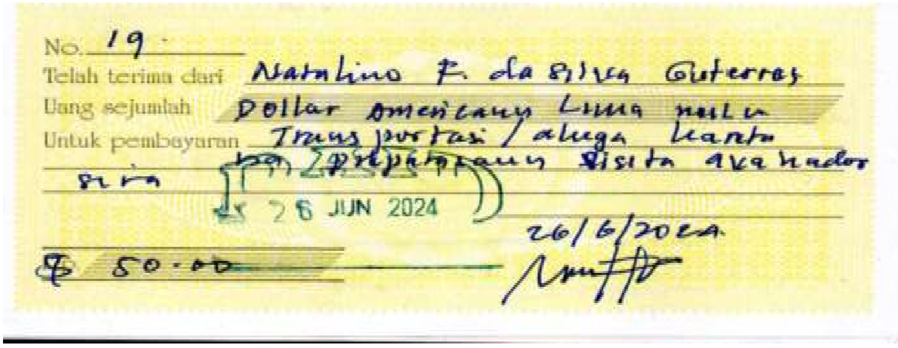
$ 10.00

No. 18
Telah terima dari Direio Exposto
Uang sejumlah Dolar Americano Lima
Untuk pembayaran Transportasi

26 JUN 2024

26/6/2024

$ 5.00



No. 19
Telah terima dari Natalino F. da Silva Guterres
Uang sejumlah Dollar Americano Lima nulu
Untuk pembayaran Transportasi / aluga karta ba preparasaun visita avaliador sira

26 JUN 2024

26/6/2024

$ 50.00

No. 20
Telah terima dari Devan
Uang sejumlah Dollar Americano atus ida lima nulu
Untuk pembayaran Custo karka sasan husi Kupang - DILI

JUN 2024

28/6/2024

$ 150.00

IoT payment proof

redesma technologies

CV. REKAYASA DESAIN MANUFAKTUR

Jl. Bulusan VI No. 37
Tembalang, Semarang
Indonesia
www.redesma.tech

KWITANSI
RECEIPT

Nomor *Number*	KWI/XI/24/025

Telah terima dari *Received From*	:	**Dr Natalino Fonseca**
Sejumlah uang *Amount Received*	:	*Dua Puluh Juta Rupiah*
Untuk Pembayaran *In payment of*	:	**Desain Sistem IoT**

Semarang, 21 November 2024

Rp 20.000.000

Informasi Rekening Pembayaran
Bank Mandiri
CV. REKAYASA DESAIN MANUFAKTUR (REDESMA)
136-00-1850330-7

Yogi Reza Ramadhan, S.T.
Direktur

SURVEY ACTIVITY


Equipa peskizador hasoru malu ho chefe


Entrega karta autorizasaun ba Chefe do Suku Ponilala


Diskusaun spontan ho autoridade iha igreja


Observa posizaun solar panel nian


Posizaun solar panel hare husi norte


Posizaun solar panel hare husi leste


Posizaun solar panel hare husi sul

Posizaun turbin anin iha igreja observa husi parte leste.

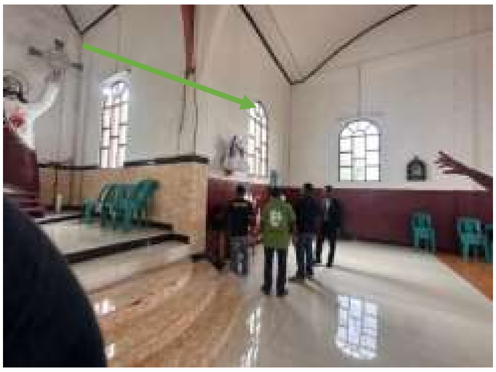
Posizaun turbin anin iha igreja observa husi parte leste

Observa hela lokal control panel nian

Identifika ona local control panel nian

Sound system

Organ



Lampu neon

SHOPPING FOR MATERIALS AND TOOLS

MPPT 2in 1 no dump load

Turbin anin ho ninia asesories

Solar panel ho ninia asesories

Verifika solar panel no turbin anin

Inspesaun equipmentus no materiai husi Equipa INCT iha terenu (ponilala)

Observa ba qualidade rai henek iha mota Ponilala-Gleno

FRAME DESIGN ON LOCATION


Fabrikasaun frame suporta solar sell nian no koko atu monta temporaria


Ajusta frame bajeia ba medidas papan solar panel

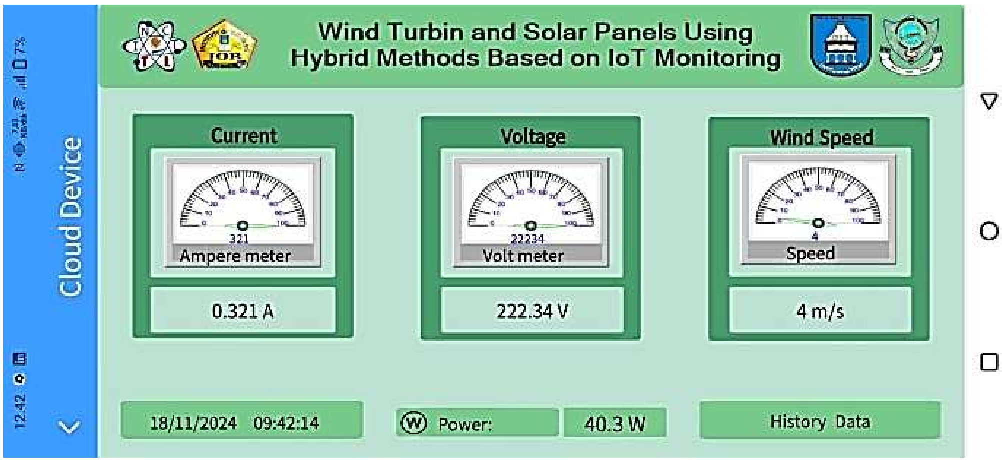


Monta solar panel iha igreija nia leten no hari tiang wind turbin

IoT OPERATION PROCESS


Instala panel box ATS no IoT iha Igreija Ponilala


Monta anemometer no blade wind turbin



Operasaun informasaun dadus liu husi Telemovel uza aplikasaun Haiwell Cloud.