STUDY OF THE POTENTIAL OF NEW RENEWABLE ENERGY GENERATION (HIBRYD SOLAR AND WIND) AS AN ALTERNATIVE ENERGY SOURCE

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ABSTRACT

Indonesia is a country with a tropical climate where getting sunlight all year round is a gift that must be optimized, and wind energy that always blows which is emission-free and free. The development of these two renewable energies answers the energy problem that depends on fossil energy which causes environmental damage. Utilization of the season is very helpful in producing a combination of wind and solar energy, this combination is called hybrid power, these two energy sources aim to complement each other in optimizing the electrical energy produced. This hybrid power plant has been tested and obtained some data, namely a wind speed of 3.9 m/s can produce an output voltage on the vertical axis wind turbine of 3.20 Volts. The highest measured light intensity is 110, 094 W/m² which produces an input power of 74,907 Watt Pin, output power of 11,484 Watt Pout, with an efficiency of 15% on the solar module. Charging the battery from the initial condition of the 12.9 V/100 Ah battery to fully charged 13.64 V/100 Ah takes 25 hours with an average hourly VAWT energy of 28.61 W, and an average hourly energy of 32 solar modules. 66 Wp. And optimizing the performance of the hybrid generator system can operate for 5 hours with a load of 104 watts.

INTRODUCTION

Energy is a basic need that plays a very important role in all aspects of human life and must be managed in an efficient manner. The need for energy is increasing along with population growth and increasing community activities. So far, the need for energy is still dependent on energy sources from fossil fuels that rely on coal, oil, natural gas which will be dwindling and even running out. The use of fossil fuels will have an impact on environmental problems and encourage humans to utilize renewable energy sources.

Increasing energy needs have encouraged the Government to continue efforts to accelerate the development of renewable energy in Indonesia, especially to achieve the renewable energy mix target of 23% in 2025 and 31% in 2050 of the final energy mix in accordance with the national energy policy (Government Regulation No. 79 of 2014). Utilization of renewable energy sources has an active role in addressing energy problems in the future. Renewable energy is energy that comes from nature that is environmentally friendly and will not run out, such as solar, wind, water, biomass.

Solar energy is an environmentally friendly source of energy and its availability will never run out. Solar energy is a renewable energy source whose development is quite rapid in the world, including in Indonesia. Indonesia's position as a tropical country that gets sunshine all year round is a gift that must be optimized. Wind energy is a renewable energy source and has great potential. Wind energy is considered as one of the most practical and perfect energy sources because it is emission-free and free.

Utilization of the season is very helpful in producing a combination of wind and solar energy, this combination is called hybrid power, which during the dry season the sun will play a greater role, while during the rainy season the wind will play a greater role in producing a source of electrical energy. Both of these energy sources aim to complement each other in optimizing the electrical energy produced(Tharo, 2019). Hybrid Power Plant (PLTH) is a power plant consisting of two or more generators with different energy sources. For example, such as a Solar Power Plant (PLTS) combined with a Wind Power Plant (PLTB) or called Hybrid PV-Bayu(Hidayanti, Dewangga, MP, Sarita, Sumarno, & W, 2019).

Solar panels are devices that convert sunlight energy into electrical energy by means of the photovoltaic effect, therefore they are also called photovoltaic cells (Photovoltaic cell - abbreviated as PV). The electric voltage generated by a solar cell is very small, about 0.6 V without load or 0.45 V with load. To get a large electric voltage as you wish, several solar cells arranged in series are needed(Purwoto BH, Jatmiko, F, & Huda, 2018)

Vertical axis wind turbines(VAWT) is a wind turbine with a vertical or perpendicular axis and the rotor parallel to the direction of the wind, so that the rotor can rotate in all directions of the wind. (VAWT) also has several advantages and disadvantages. The advantages are that it has a high torque so it can rotate at low wind speeds, the generator can be placed at the bottom of the turbine so that it makes maintenance easier and the turbine work is not affected by the wind direction. The drawback is that the wind speed at the bottom is very low so that if you don't use a tower it will produce low rotation, and lower efficiency than the Horizontal Axis Wind Turbine (HAWT)(Tharo, 2019). By utilizing these two sources, it is hoped that the government's plan to create cheap, optimal, efficient and environmentally friendly energy will be realized.

LITERATURE REVIEWS

Renewable energy

Renewable energy is energy that comes from nature around us, some examples of renewable energy are wind, water, geothermal, biomass, and sun. It is called renewable energy because this energy can renew itself in a short period of time unlike fossil energy which takes years to form energy again. In Indonesia, the potential for renewable energy is very large because Indonesia's position as a country with a tropical climate that gets sunshine all year round is a gift that must be optimized. For Indonesian water, most of its territory is water, so it can be used to produce energy. Renewable energy is also very environmentally friendly because it does not produce waste that can pollute the environment.

Solar Energy

Solar energy is energy that is currently being actively developed by the Indonesian government because as a tropical country, Indonesia has quite large potential for solar energy. Solar energy is extraordinary because it is non-polluting, inexhaustible and free.

Indonesia is located in the equatorial region. The average sunlight is 4000-5000 Wj/m², while the average amount of sunshine is 4 to 8 hours. Indonesia experiences approximately 170 rainy days per year with an average temperature of 26 to 32ºC and an average relative humidity of 80 to 90% and never drops below 60%.(Manab, 2016).

The use of solar energy has the potential to be further managed and developed as a source of energy reserves, especially for countries located on the equator, including Indonesia. There are several ways to use solar thermal energy, namely:

1. Room heating
2. Room lighting
3. Sun stove
4. Drying of agricultural products
5. dirty water distillation
6. Water heating
7. Power plants

As a tropical country, Indonesia has a high solar energy potential. Based on data on solar radiation in Indonesia, it can be classified successively as follows: in the Western Region of Indonesia (KBI) it is around 4.5 kWh/m²/day and in the Eastern Region of Indonesia (KTI) it is around 5.1 kWh/m²/day. Thus the potential for solar radiation in Indonesia is an average of 4.8 kWh/m²/day. With the abundance of solar energy, the development of solar power plants as a pollution-free and natural source of electricity is the right choice to be implemented in Indonesia.(Manab, 2016).

Solar Power Plant

A solar power plant or often called a solar cell is a power generation technology that converts photon energy from the sun into electrical energy. This conversion is carried out on a solar panel consisting of photovoltaic solar cells. These cells are layers of pure silicon (Si) or other semiconductor materials that are processed in such a way that when the material gets photon energy it will excite electrons from their atomic bonds to become electrons that move freely, and will produce a direct current electric voltage (DCs).(Herki Desrizal, 2018).

The concept of a solar power plant is simple, namely converting sunlight into electrical energy. The sun's natural resources have been widely used to supply electrical power in communication satellites through solar cells. This solar cell can generate an unlimited amount of electrical energy directly taken from the sun and can be designed to supply small and large electricity needs, either independently or hybrid (combined with other energy sources) either by the Decentralization method (one house one generator)) or with the Centralization method (electricity is distributed by cable network)(Hafid, Abidin, Husain, & Umar, 2017).

Solar panels or solar modules are a collection of solar cells arranged in such a way (series or parallel) as needed to convert sunlight into direct current (DC) electrical energy. The modular form of the solar module makes it easy to meet electricity needs for various scales of needs. Small needs can be met with one or two modules, and large needs can be supplied by thousands of solar modules strung together into one solar module which generally consists of 36 solar cells.

Wind Power

Wind is air that moves from a place with higher air pressure to a place with lower air pressure. In a hot area the air pressure is lower because in that area it expands and becomes lighter. The light air moves up towards the colder area so that the air becomes cold and becomes heavy again, then the cold air will move downwards, thus a cycle of air circulation and air movement or wind. The ability of the air is called energy. wind.

Indonesia has great potential in developing renewable energy, such as 950 megawatts of wind energy, 11 gigawatts of solar energy, 75 gigawatts of water energy, 32 megawatts of biomass energy, 32 megawatts of biofuel energy, 60 megawatts of marine energy potential and around 29 gigawatts of potential gas energy (Ditjen EBTKE , 2016). Wind energy is the main source of environmentally friendly energy resources and has become one of the most commonly used renewable energy sources recently and is free for all. Therefore, the Indonesian government with policies and regulations related to renewable energy is a very good sign for the development and utilization of wind energy in Indonesia.(Muthar, 2019)

When the wind blows, the wind is accompanied by kinetic energy (movement) that can do some work. Kinetic energy is the energy due to which a mass has a relative velocity, for example a moving car or a rotating power wheel. Wind energy resulting from the movement of the wind can be converted into mechanical energy by using a windmill or into electrical energy by using a wind turbine which is also called the Wind Energy Conversion System (SKEA).

The amount of energy that can be transferred to the rotor depends on the density of the air, the area and the wind speed. Kinetic energy for a mass of wind m moving with speed v which will later be converted into shaft energy can
formulated as follows:

$$E = \frac{1}{2}mv^2$$

where :
m = moving air mass (Kg)
v = wind speed (m/s)
Wind Power Plant

Wind Power Plant (PLTB) is a power generation technology that converts wind energy into electrical energy. Wind is moving air, so it has speed, power and direction. The cause of this movement is the heating of the earth by solar radiation. Wind power plants convert wind kinetic energy into mechanical energy by turbines and converted into electrical energy by generators by utilizing the wind speed that drives the turbines.

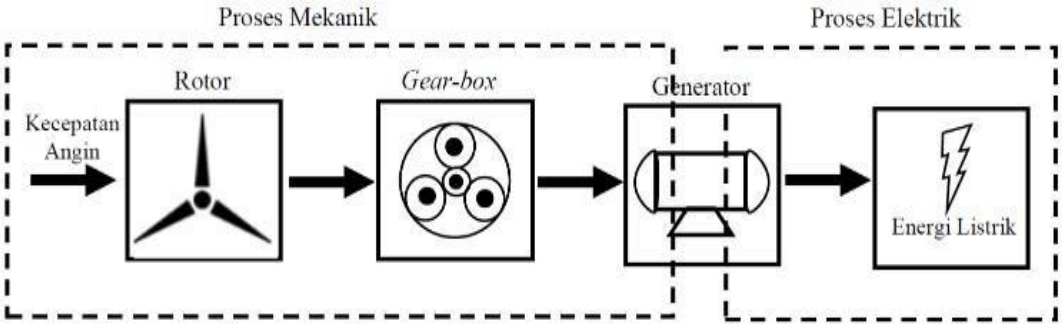

Figure 1. PLTB

PLTB has two main components, namely wind turbines and generators. Wind turbines are used to convert wind power into mechanical power in the form of rotation on the rotor to rotate the generator. At the same time, the generator will act as a machine to convert mechanical energy into electrical energy. The performance of this PLTB system is one of the systems that is influenced by factors such as generator efficiency.(Putra, Kananda, STMT,, & Muhtar, S.Pd.,, 2019)

Wind Turbine

Wind turbines are part of a PLTB system that converts wind energy into mechanical energy. This energy change occurs because the shape of the turbine is like a propeller. The wind turbine can rotate, the three winds move to the turbine area as a turbine booster. The rotation of the propeller is used to rotate the rotor on the generator.(Basri & Djaman, 2019)

Based on the rotation of the rotor, wind turbines have two types, namely horizontal wind turbines and vertical wind turbines. Horizontal wind turbines have a rotor direction of rotation parallel to the direction of the coming wind, while vertical wind turbines have a rotor opposite the direction of the wind. The principle of force on the horizontal axis is lift and drag, while on the vertical axis it is only drag.(Putra, Kananda, STMT,, & Muhtar, S.Pd.,, 2019)

The following are some types of axis wind turbines:

a) *Horizontal Axis Wind Turbine*(HAWT)

The horizontal axis wind turbine is the most commonly used wind turbine today, this type of turbine has a horizontal axis connected to the rotor and generator at the top of the tower. The horizontal axis turbine will rotate when the wind hits the axis turbine from the front, and this axis turbine is equipped with an axis turbine tail which functions to help the generator move to adjust the direction of the wind blowing at the highest speed. This type of horizontal axis turbine requires a tall tower to get the maximum wind speed.(Haikal, 2021)

b) *Vertical Axis Wind Turbine*(VAWT)

Vertical axis wind turbines are wind axis turbines with the rotor axis mounted perpendicularly, the vertical axis on the main rotor will allow the axis turbine to receive and capture wind from all directions. The advantages of a vertical axis turbine will be useful in areas that have wind conditions that often change or vary so that it is more efficient in utilizing wind energy and is very suitable for the construction of power plants in coastal areas. In a vertical axis turbine, tower construction is not needed because the generator can be placed closer to the ground and makes it easier in terms of maintenance.(Haikal, 2021)

METHODS

In writing this thesis, the author collects data in the following way:

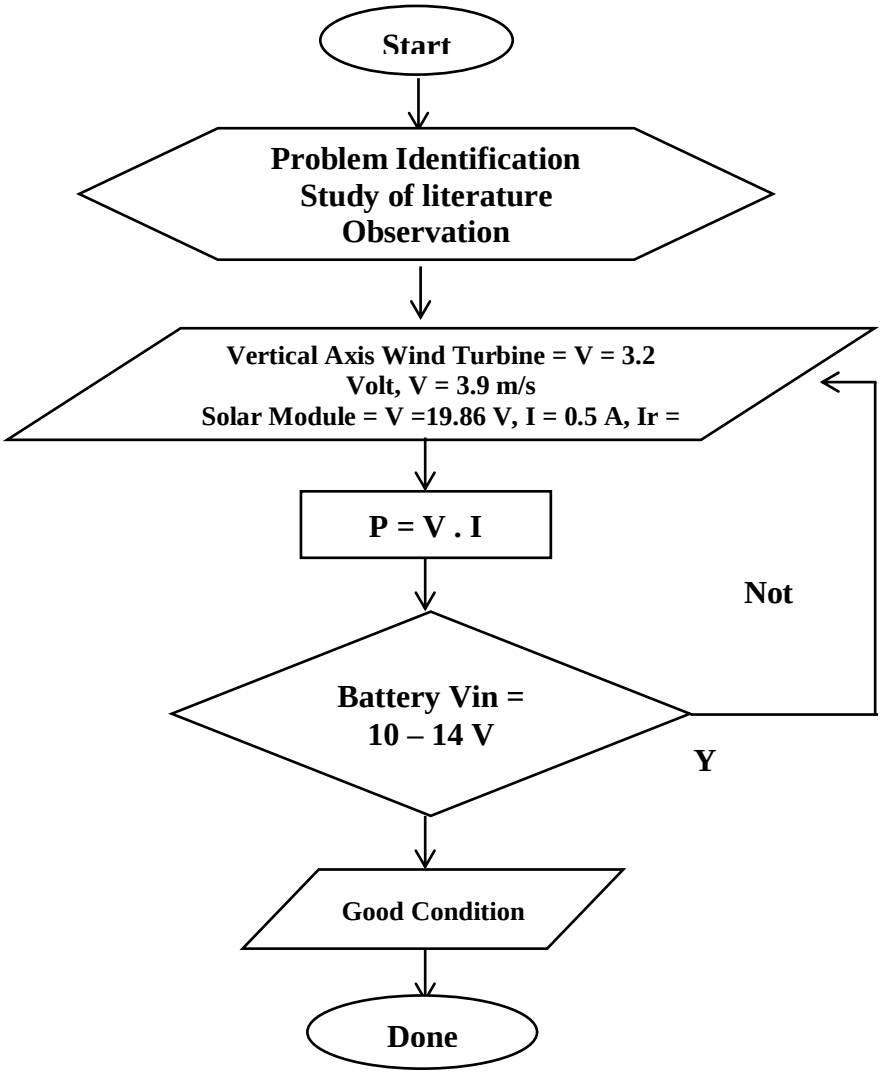

Figure 2. Methods

a. Identification of the problem is by formulating the background to the objectives in this study.
b. Literature study, namely collecting data from journals and websites that are in accordance with the research topic being carried out, namely about combination or hybrid power plants
c. Observation, namely the collection of data as input for the simulation is carried out by direct surveys in the laboratory by recording, reviewing and identifying the specifications of the hybrid generator.
d. Hold consultations and guidance with supervisors.
e. Exchanging ideas and opinions with competent friends and alumni.

Figure 3. Solar and wind power plants

RESULTS AND DISCUSSION

Vertical Axis Wind Turbine Testing

This test uses an anemometer as a wind speed meter and a multimeter to determine the performance of the Vertical Axis Wind Turbine in generating the output voltage. The test time was carried out at 15.00 WIB to 16.30 WIB using the wind.

Table 1. Wind of Speed Testing Using Anemometer

Temperature (ºC)	Wind speed (m/s)	Voltage (V)
33.4 ºC	1.1m/s	1.02V
33.4 ºC	1.2m/s	1.07V
33.3 ºC	1.3m/s	1.18V
33.3 ºC	1.4m/s	1.28V
33.3 ºC	1.6m/s	1.47V
33.2 ºC	1.7m/s	1.62V
33.2 ºC	1.8m/s	1.69V
33.2 ºC	1.9m/s	1.71V
33.2 ºC	2.0m/s	1.78V
33.1 ºC	2.2m/s	1.84V
33.1 ºC	2.3m/s	1.89V
33.1 ºC	2.6m/s	2.03V
33 ºC	2.8m/s	2.05V
33 ºC	3.9m/s	3.20V

Based on table. The temperature measured on the anemometer is in the range of 33 degrees with a time range from 15.00 WIB to 16.30 WIB. The relationship between wind speed and the resulting output voltage is presented in the figure:

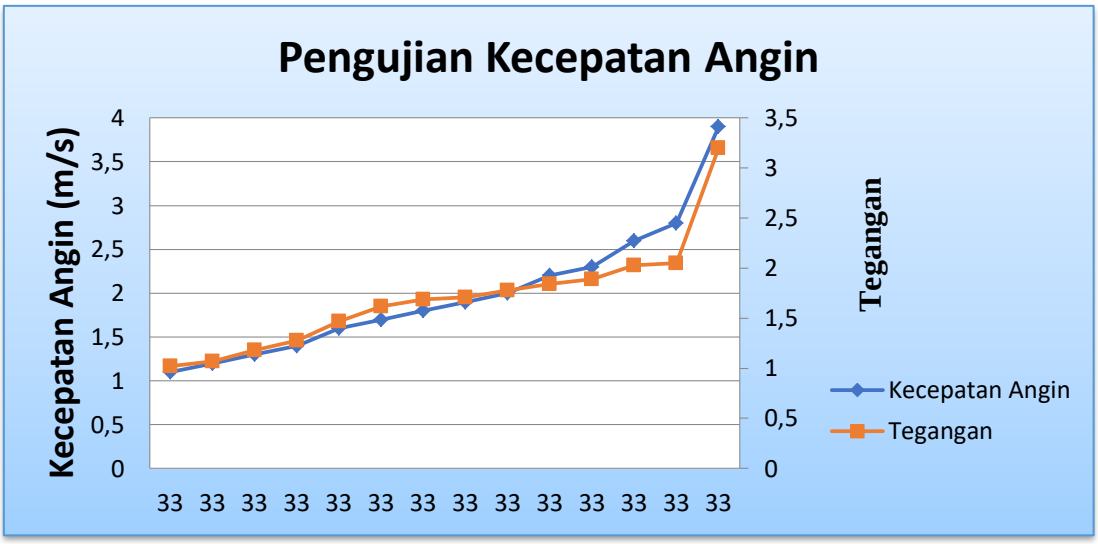

Figure 4. Graphical image of wind speed testing on a VAWT

The lowest measured output voltage is 1.02 Volts at a wind speed of 1.1 m/s as the wind speed increases, the output voltage generated by the Vertical Axis Wind Turbine continues to increase where the highest voltage at the time of the test is measured at 3.20 Volts at wind speed 3.9m/s.

Solar Module Testing

The test used a 100 WP monocrystalline type solar module to understand the working principle of the solar module.

Unloaded Solar Module Testing

This test uses a measurement method with a solar module directly connected to a multitester measuring instrument. This test aims to determine the characteristics of the solar module by measuring the open voltage (Voc) and short circuit current (Isc). The schematic of the test circuit is shown in the following figure:

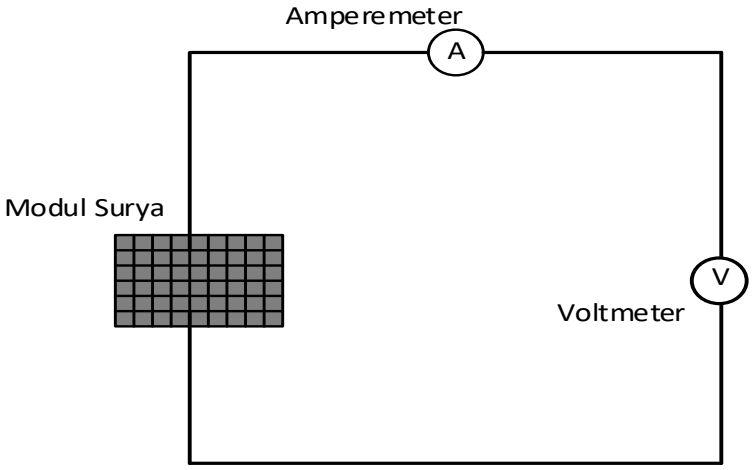

Figure 5. Schematic Figure of the Unloaded Solar Module Testing Circuit

Data from unloaded solar module testing results is shown in the following table:

Table 2. Data of Unloaded Solar Module Test Results

Hours (t)	Sunlight intensity (W/m^2)	Open voltage (V)	Short circuit current (A)
10.40	97,128	18.90	0.59
10.50	110,033	19,72	0.59

11.00	110,055	19.78	0.58
11.10	109,916	19,26	0.56
11.20	109,938	11.27	0.56
11.30	109,888	19,13	0.55
11.40	109,994	19.52	0.57
11.50	109,944	19.40	0.51
12.00	110,094	19.80	0.58
12.10	100,096	19.86	0.58

Source: author, 2022

The output voltage of the module is very much affected by the temperature and intensity of sunlight received by the solar module. The higher the intensity of sunlight, the open voltage will also increase. The highest measured sunlight intensity is 100.096 W/m² where the open voltage (Voc) is measured at 19.86 Volts and the short circuit current (Isc) is 0.58 Amperes.

CONCLUSION

Based on the test results in the study entitled "Optimization Analysis of Hybrid Power Generation Systems the following conclusions can be drawn:

1. The voltage in the Vertical Axis Wind Turbine test is not optimal to produce an output of 12 Volts, the highest measured voltage is 3.20 Volts at a wind speed of 3.9 m/s.
2. The intensity of sunlight is very influential in testing the solar module with a 5 V/DC load which produces an input power (Pin) of 74.907 Watts, an output power (Pout) of 11.484 Watts with an efficiency of 15%.

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