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MODELING A HYBRID SYSTEM OF SOLAR POWER PLANTS WITH VERTICAL WINDMILLS

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Abstract. The current energy crisis teaches us, the people of Indonesia, that serious and systematic efforts to develop and source renewable energy to reduce dependence on fuel must be carried out immediately. The use of renewable and environmentally friendly energy sources, especially those that can reduce the various adverse effects caused by the use of fossil fuels. The urge to leave petroleum as a source of national energy supply is currently being rolled out by various parties, including themselves. These steps are needed to get Indonesia out of the sustainable energy crisis. To optimize it, it is necessary to combine two generators, namely PLTS with PLTB. The purpose of this study is to determine the combination of a power generation system produced by a vertical wind power plant with solar power with a hybrid system which is expected to optimize the power generation system between the two plants. The method used in this study is modeling a solar power generation system with wind power from a vertical windmill, with this method it is expected to produce the same voltage generator or simultaneously. From the results of research conducted, the maximum combination of PLTS and PLTB generation during the day, for the night it is still not maximally influenced by other factors, inconsistent winds reaching 6m/second so that the voltage can remain 12 Volt dc, so that battery charging becomes unstable.

Keywords : hybrid, generator, wind power, solar power

1. INTRODUCTION

The limitations of electrical energy and the dwindling dependence on fossil fuels force the government to look for other alternatives as energy sources. The potential of abundant natural resources, whether air, wind, or sun, is an alternative opportunity that must be utilized as well as possible by the government. One way is to combine the two energy sources, which is commonly referred to as a hybrid system. If one energy source cannot produce energy, then another energy source will supply energy to the load [1]. Wind is one of the natural resources that can be used to produce electricity and cannot be exhausted to be developed, therefore wind energy is an alternative energy that has good prospects to meet the shortage of electrical energy in addition to always available wind energy is also environmentally friendly energy. Two or more forms of energy sources can be combined to form a complementary hybrid energy system lack in every resource [2]. Hybrid systems have advantages over systems that rely on it single energy source [3].

Modeling the supply of primary energy for renewable energy in the primary energy mix in 2025 is 23.0% and in 2050 it is 31.2%. The portion of the primary energy mix for renewable New Energy is by the primary energy target for new and renewable energy, which is at least 23% in 2025 and at least 31% in 2050. The results of modeling of primary energy supply. New and renewable energy [3].

The wind occurs because of the difference in temperature between hot air and cold air. At the hot equator, the air gets hotter, expands and becomes lighter, rises upwards, and moves 30^o to 60^o to cooler areas like the Poles. On the other hand, in the cold polar regions, the air becomes cold and descends downwards so that air circulation occurs in the form of air movement from the North Pole to the Equator along the earth's

surface around 30º to 60º, and vice versa. movement of air from the equator back to the North Pole through the higher layers of air.

To convert the kinetic energy of the wind into electricity, it is necessary wind turbine. The function of wind speed and turbine blade area is the total power that can be captured by the wind turbine [4]. A power plant is a power plant that uses wind as an energy source to produce electrical energy. This plant can convert wind energy into electrical energy by using wind turbines or windmills. The power generation system that uses wind as an energy source is an alternative system that is growing rapidly, considering that wind is one of the unlimited natural energies of all time.

Wind turbines are divided into two groups, namely horizontal axis turbines, horizontal axis wind turbines usually have two or three modules. Another type is the vertical axis turbine. This three-blade turbine is operated downwind, with the module facing the wind.

Constraints to the use of windmills are wind speed and wind direction that change from time to time. Therefore, a good wind turbine is a turbine that can receive wind from all directions while being able to work at low wind speeds, one of which is the Vertical Axis Wind Turbine (TASV). These turbines have lower efficiency compared to horizontal axis wind turbines.

Various types of TASV are often used, including the Savonius Type, Darrieus Type, and the H-Rotor Type. The factory TASV is the simplest type and is a large version of the anemometer. The Savonius turbine can rotate due to the thrust of the wind so that the rotation of the rotor does not exceed the wind speed. Although the power coefficient for this type of wind turbine varies from 30% to 45%, according to many researchers for the Savonius type it is usually no more than 25%. This type of turbine is suitable for low power applications and is typically used at different wind speeds [5]. Small wind turbines are usually selected for local use. With the ability to generate electricity less than 100 kW, usually installed in remote areas [6].

The main component that builds PV mini-grid is the solar module. which converts solar energy into electrical energy. This component converts energy from sunlight into electrical energy [7]. Solar cells are vital components made of semiconductor materials. Multicrystalline silicon is the most widely used material in the solar cell industry. Multicrystalline and monocrystalline silicon yields relatively higher efficiencies than amorphous silicon." The electrical energy produced by a single solar cell is so small that it takes several solar cells that are combined into a panel called a solar panel or solar photovoltaic panel" [1]. "In principle, the use of solar energy as a generator of electrical energy and the photoelectric element that functions as a converter of light energy into electrical energy is commonly called a solar cell [8][9].

Other components are the Inverter which functions to change the DC voltage generated by the AC voltage solar cell module to supply AC loads. The battery works as a store of electrical energy which will be charged by electric power from the solar cell system. At the time of discharge, the direct current from the battery will be converted into alternating current by the inverter for later use in the load. To keep the battery from being overcharged and undercharged, the operation of the battery and inverter needs to be controlled by a control system.

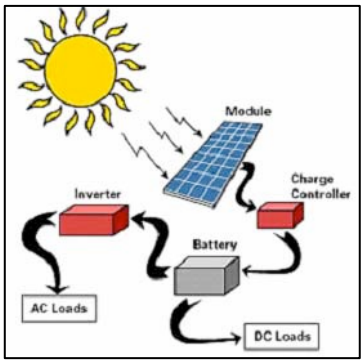

Figure 1. The solar power generation system

2. METHODS

The materials used in this research are multicrystalline solar panels and vertical windmills with the following specifications:

a. 100wp Surya solar panel
b. MPPT hybrid
c. 12v vertical windmill. 200w
d. Anemometer

e. Digital Avometer

Data collection on hybrid generation is done by measuring the voltage generated by the generator with a voltmeter. And the wind speed will be measured with an anemometer.

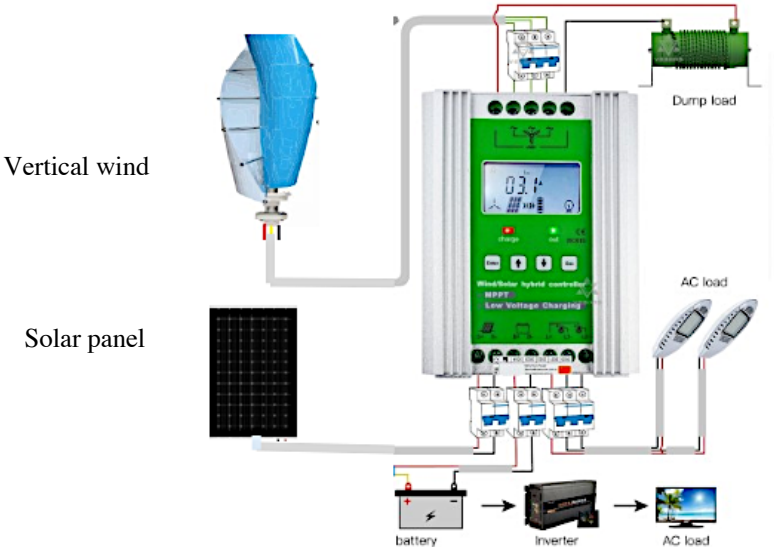

Figure 2. Modeling a solar power generation system with a vertical wind turbine

The connection generated from the two solar and wind power plants will enter the MPPT, where the function of the MPPT here is as a charger controller that will charge the battery, where here you can set how much charging. not empty, which will cause the battery to be damaged. From the battery, an electric current can make the inverter convert the DC voltage to ac back and flow directly to the load.

3. RESULTS AND DISCUSSION

The table below is the result of measuring vertical wind power plants as follows: Measurements are made every hour starting at 14.00 AM and the measured wind speed is 3.9 m/s and the output voltage is 4.7 volts. From 19.00 to 24.00 the average wind speed is 6m/s and the voltage generated is an average of 12 volts, and so on. This measurement step is carried out until 03.00 AM. This measurement is carried out to see the performance of the vertical wind power plant in time, at night, because at night only wind turbine generators can generate voltage.

Table 1. Measurements May 20, 2021

Hour	Wind velocity (m/sc)	V out (Volt)
14.00.	3.09	4.7
15.00.	3.5	4.5
16.00.	3.6	4.7
17.00.	4.2	8
18.00.	6.67	12
19.00.	6.73	12.5
20.00.	5.6	11
21.00.	6.7	12
22.00.	6.8	12.4
23.00.	6.9	12.5
24.00.	6.9	12.5
01.00.	6	12
02.00.	5	8
03.00.	6	11

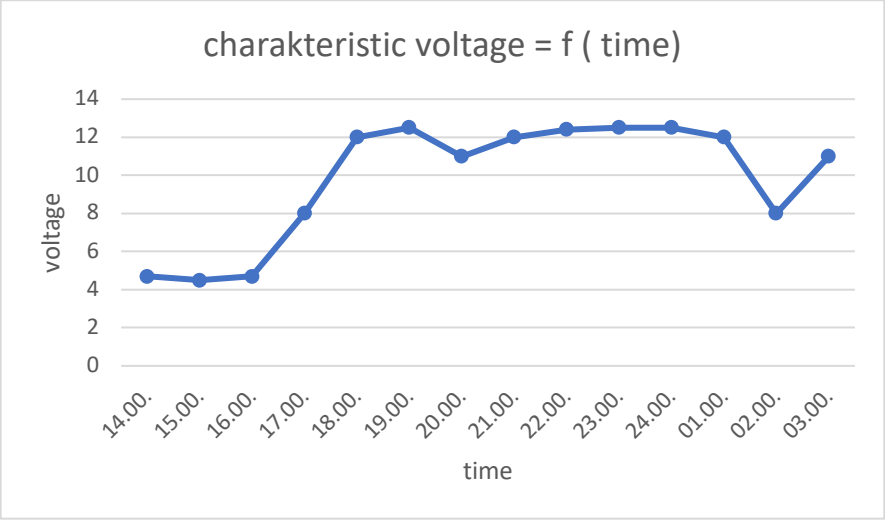

Figure 4 Characteristic of time = f (voltage)

Tests of wind power plants during the day or night with no-load ac voltage are: to find out the energy produced by the windmill and to find out how much voltage flows both the minimum voltage and the output voltage. This test is carried out on the magnitude of the voltage to the wind speed. In the ac voltage characteristic = wind speed function, when the wind speed is 3.07 to 6.9 m/s, the voltage generated by the power plant increases linearly from 4.7to 12.5 volts.

Table 2. Measurements 6 June 2020

Hour (PM)	Voltage PV (Volt)	Current I (Amper)
11.00.	18.76	2.7
11.30.	18.17	3
12.00.	18.77	2.7
12.30.	18.77	2.7
13.00.	18.70	2.7
13.30.	17.97	3.1
14.00.	17.98	3.1
14.00.	18.11	3

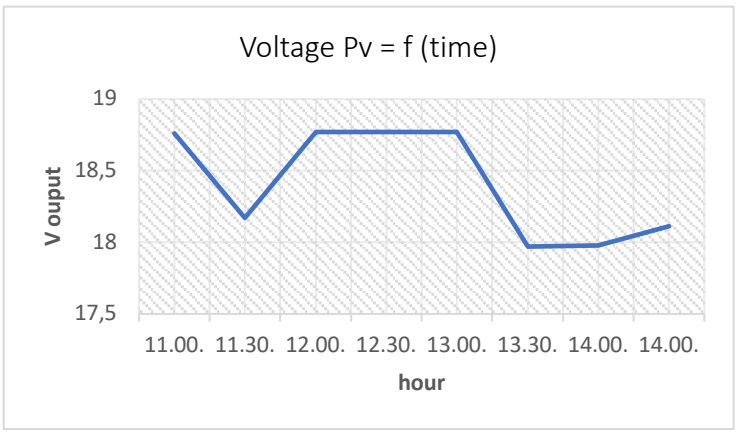

Figure 5. Characteristics V output = f(time)

From the characteristics, the results of testing a solar power plant with a no-load dc voltage are: to find out the energy produced by solar cells and to find out how much dc voltage flows, both the minimum voltage and the output voltage without the maximum voltage. During the day, the average voltage generated is 18 volts from 11.00 to 14.00.

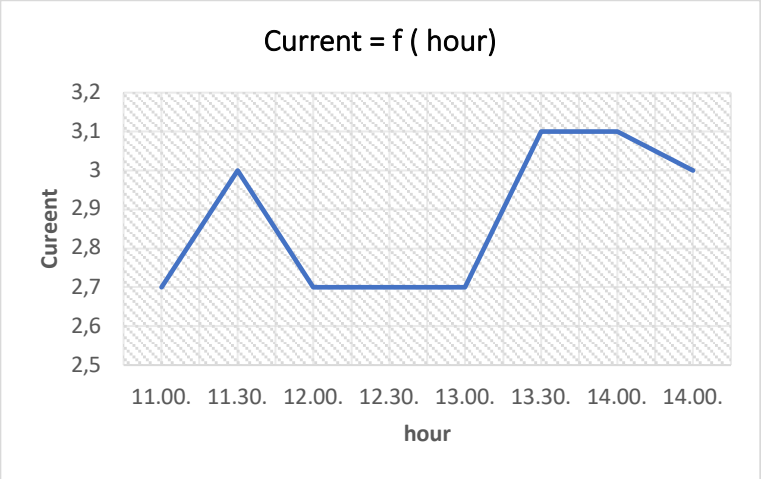

Figure 6. Characteristics Current = F (hour)

From the characteristics, the results of testing a solar power plant with a battery charging DC are to find out the energy produced by solar cells and to find out how much the average DC flows through the battery during the day, the amount of current flowing on average is 2.8 amperage from 11.00 to 14.00 from the above measurements, solar power generation works optimally.

4. CONCLUSION

Modeling a hybrid system of solar power plants with vertical wind power, a new renewable energy supply system that can work in a hybrid way, can work together or alternately both day and night as follows:

a. During the day solar and wind power plants can work together or alternately depend on the sunlight and wind gusts, from the measurement results the system can work well where the voltage is generated on average 12 volts. the amount of current flowing on average is 2.8 amperage from 11.00 to 14.00 from the above measurements, solar power generation works optimally.
b. At night the wind energy generator only works, from the results of the measurement of the voltage, it still fluctuates between 5 volts to 12.5 volts, to produce an average voltage of 12 volts, further research is needed.

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