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Analysis of the Effect of Temperature on Testing of Unidirectional Generator Rotation Speed and Wind Speed in Wind Power Plants

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Abstract: Renewable power plants and alternative power are the best options to meet the world's electricity needs considering the expensive and scarce of petroleum power which has remained the main option in the power generation system. Electric power is something of the main need used by humans. Nationally, the demand for electricity continues to increase to coincide with the rate of population growth, but the rate of demand for very fast power is not matched by the real creation of power zones. Currently, national energy is still focused on fossil energy, namely coal, petroleum, and natural gas. With the increasing use of energy, especially petroleum, until in the future the amount also continues to be limited, fossil energy reserves will decrease and will not be relied on to meet energy needs, because its non-renewable nature requires to quickly explore renewable energy sources. The results of the research tried at an average voltage of 5.12 Volts. As well as the average wind speed of = 4.88 m/s on the contrary, the average rotation speed of the generator is = 8.4 rpm.

Keywords: Rotation; Temperature; Unidirectional Generator; Wind

Introduction

Indonesia is a vast archipelago, therefore meeting the needs and provision of electricity in remote areas, outer islands, and border areas is a significant issue that requires special studies in its resolution. Residents in areas that have not been electrified tend to be isolated from economic growth, knowledge, and technological advances. In 2008, the article of the Indonesian State Electricity Association stated in number 3 that the purpose and field of business is to carry out the business of providing electricity for universal interests in sufficient quantity and quality as a form of application of Government duties in order to fulfill supporting national development (Quentara & Suryani, 2017). The growth of technology in the current globalization period has an effect on the huge increase in electricity demand, both in developed countries and growing countries such as Indonesia. Renewable power plants or alternative power are the best option to meet the world's electricity needs considering the expensive and scarce of petroleum power which has always been the main option in the power generation system (Sumarno, 2019). Electric power is one of the most meaningful things in human life. Electric power is needed in several zones, namely household, industrial, business, social, government office buildings, and universal line lighting (Garci, 2019). Electric power is a major need used by humans. Nationally, the need for electricity continues to grow along with the pace of population development, but the rapid pace of power demand is not matched by the real creation of power zones. Currently, national energy is still focused on fossil energy, namely coal, petroleum, and natural gas. With the increasing use of energy, especially petroleum, until in the future the amount also continues to be limited, fossil energy reserves will decrease and will not be relied on to meet energy needs, because its non-renewable nature requires to quickly explore renewable energy sources.

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Not only that, another reason is to reduce pollution caused by fuel oil consumption, because the largest source of pollution in the world comes from exhaust gas or fuel oil emissions, so a solution is needed to overcome the problem, composed of alternative energy that is quite available on earth and can be expected to continue. Low wind speed does not mean that the power capabilities listed in it cannot be utilized or converted into electric power, it can always be used but a generator that matches the characteristics of the wind speed is needed. Wind power plants with low speeds generally have the same uses and working methods as other wind power plants. Wind is energy that takes place due to the temperature ratio between cold and heat flowing. Wind is air that moves so that it has speed, power, and direction. The trigger of this movement is the warming of the earth by solar radiation. This wind movement has kinetic energy, therefore wind power can be converted into other energy such as electric power by using windmills or wind turbines (Sumardiyanto & Hidayat, 2018).

The thing that arises is what kind of effect the change in wind speed has on the energy produced. What kind of effect temperature has on generator current testing and wind speed in wind power plants. Furthermore, so that this research can lead to the goal and avoid very many cases that arise, until the author shares the limits of problems that match the title of the research, there are also limits to problems as follows. Reviews only recognize the impact of air on the energy obtained by turbines. Reviews only recognize the speed of rotation of the turbine during the impact of wind. Reviews only recognize the strong output voltage that the generator gets at the speed of air and the rotation of the wind turbine. So that the title "Analysis of the Effect of Temperature on Testing the Rotational Speed of the Generator and the Air Speed of the Air Energy Power Plant".

Method

The equipment and materials used in this research are as follows: Research Equipment 1. Soldering that you want to use to assemble or connect circuits. 2. Electrical Measuring Equipment used to measure energy in and energy out. 3. Hands Tools (such as hand tools: Screwdrivers, Pliers, Equipment locks, and so on). Research materials and equipment 1. The vertical fan propeller plays a role in capturing the arrival of wind speed and replacing wind gusts into motion power that wants to rotate the generator. 2. DC generators act as power plants used to supply electricity needs. 3. The Charge Controller plays a role in controlling the current for charging the battery so that overcharging is not established (excess charging energy because the battery is full) and excess voltage from the Generator. 4. The battery acts as a storage of electric power in the form of chemical power or power conversion that works based on electrochemical principles. 5. The inverter plays a role in replacing DC voltage into direct electric voltage.

Result and Discussion

Electrical Energy

Electricity is a source of energy that can transfer energy into another electronic form. This electric power is needed by various levels of citizens. Electricity is a series of physical phenomena related to the flow of electric charge. Electricity causes various consequences, such as lightning, electromagnetic induction, static electricity, and electric current. Without realizing it, electricity has become a primary need for human life, without electricity electronic equipment that is commonly used cannot function or be used properly (Asep et al., 2022).

Wind Turbines

A wind turbine is a part of a wind power generation system that functions as a wind power catcher to be transformed into motion power to rotate the generator. There are many types of wind turbines for its form. These include propeller, darrieus, sailwing, fan-type, savious, vertical and horizontal types (Adam et al., 2019). Wind turbines are used to create power from kinetic power into electric power, which continues to be increasing wind speed to make the power produced also increase (Murniati, 2022). The ability of wind power in Indonesia with an average wind speed of close to 3-5 m/s and a total energy that can be generated of 9,290 MW, this is one of the power capabilities that is quite large, considering that in Indonesia it only uses close to 1% of its potential. Wind class and wind speed can be seen in Table 1.

Table 1. Wind Class and Wind Speed

Class Level	Wind Velocity (m/s)	Wind Velocity (km/jam)	Wind Velocity (knot/jam)
1	0.3–1.5	1–5.4	0.58–2.92
2	1.6–3.3	5.5–11.9	23.11–6.42
3	3.4–5.4	312.0–19.5	6.61–10.06
4	5.5–7.9	19.6–28.5	10.7–15.4
5	8.0–10.7	28.6–38.5	15.6–20.8
6	10.8–10.7	38.6–49.7	621–26.8
7	13.9–17.1	49.8–61.5	27–33.3
8	17.2	20.7-61.6	74.5-33.5
9	20.8	24.4-74.7	87.9-40.5
10	24.5	28.4-88.0	102.3-47.7
11	28.5	32.6-102.4	117.0 55.4
12	>32.6 > 118	>32.6 > 118	>32.6 > 118
	63.4	63.4	63.4

Source : Putri et al., (2022).

The speed of wind power will cause kinetic power (E) which will be used to rotate wind turbines. Indonesia has a long coastline can be a great ability in the use of wind power and air changes caused by global warming can actually increase wind capabilities in Indonesia. In the process session, the use of wind power can go through two stages, namely: (1) The wind flow that moves the rotor is about to turn clockwise. (2) The rotation of the rotor connects the generator until it creates electricity. Kinetic power (Oak) is generated from wind sweeps (Haryanti et al., 2023).

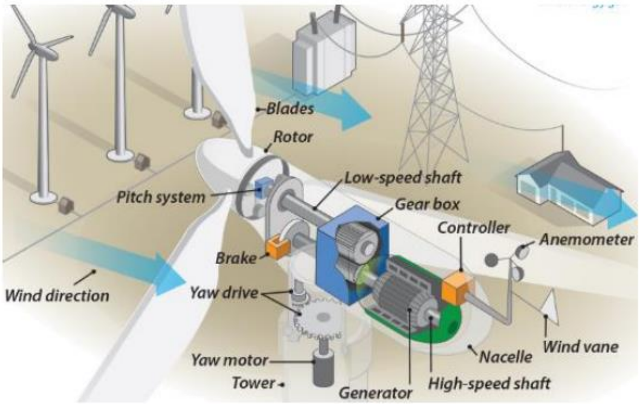

Figure 1. Wind Turbine Parts.
Source: Priyambodo & Agung, (2019)

Wind Power Plant

Wind Power Plant or often also referred to as Bayu Power Plant (PLTB) is one of the renewable power plants that is area-friendly and has good work efficiency when compared to other renewable power plants. The working principle of PLTB is to use wind kinetic power that enters the turbine efficient zone to rotate the propeller/windmill, after that this rotary power is forwarded to the generator to generate electric power. Based on information from GWEC, the number of PLTB in the world today is 157. 900 Mwa (as of the end of 2009), and this type of plant annually faces an increase in construction by 20-30%. Current PLTB technology can replace wind motion power into electric power with an average efficiency of 40%. This 40% efficiency is because there will always be kinetic power left in the wind because the wind coming out of the turbine cannot have a speed equal to zero. Bayu Power Plant (PLTB) is a renewable alternative power using wind power as the driving force. The operation of a power plant requires monitoring parameters related to a generation system such as monitoring Current, Voltage, Energy, Energy Aspects, Frequency, and wind speed this aims to make it easier to analyze cases located in a system that has been made (Pratama et al., 2023). In its use, wind power is captured by windmills to rotate generators contained in wind turbines and create electricity. When the rotor turns, until automatically the generator wants to flow electric power as in Figure 2.

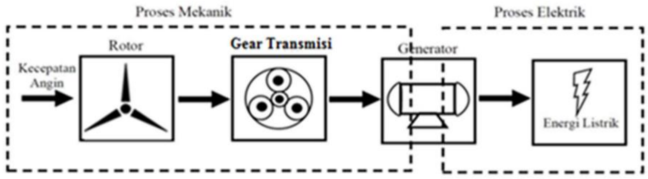

Figure 2. Wind Power Plant Process.
Source: Haryanti et al., (2023)

Generator

Generators are equipment to replace mechanical power into electrical power. The use of the generator is to convert motion power or mechanical power into electrical power by using electromagnetic induction (Manishe et al., 2021). Generator is one of the electrical machines, which replaces motion or mechanical power into electric power. The generator consists of 2 main parts, namely the anchor coil and the field coil placed on the stator and rotor. The stator is a part that is stationary / always, and the rotor is the part that turns on the engine. The generator is one of the most significant components in steam power plants, without a generator until the kinetic power produced by the turbine cannot be replaced into electric power, there are various types of generators, one of which is a permanent magnet generator, which the author uses in an article entitled generator analysis of steam power plant prototypes (Pratama, 2023).

Generator energy (Pgen) is the amount of electrical energy that can be generated by the generator due to the rotation of the generator rotor which is coupled with the turbine shaft. The amount of energy of this generator depends on the efficiency of the generator and the efficiency contained in mechanical transmission (when using mechanical transmission). So that the energy formula (Formula 1) that can be generated by the generator can be written as follows :

$$P_{Gen} = Cp\left(\frac{1}{2}\right)(\rho a)Av^3\left(\eta_{gearbox}\right)\left(\eta_{generator}\right) \quad (1)$$

Information : $\eta_{gearbox}$ = transmisi mekanik
$\eta_{generator}$ = efisiensi generator

The effect of wind on the energy produced by direct current generators

When testing wind turbines that use DC generators as initial testing. DC generators used in wind turbines can move with the main mover of the wind turbine as well as create electric power. The procedure consists of measuring wind speed with a DC generator and turbine rotation with a digital tachometer. The information generated by the DC generator can be seen in Table 2.

Table 2. Preliminary Test Results of Wind Power Plants with Unidirectional Generators.

No	Temperature (^{0}C)	Current (A)	Wind Velocity (m/s)	Generator Rotation Speed (rpm)	Voltage (Volt)
1	29	2.4	4.4	7.4	5
2	30	2.2	4.2	6.8	5.2
3	32	2.4	5.2	8	5.4
4	29	2.6	5.0	9.2	5.4
5	30	2.4	5.6	10.6	4.6

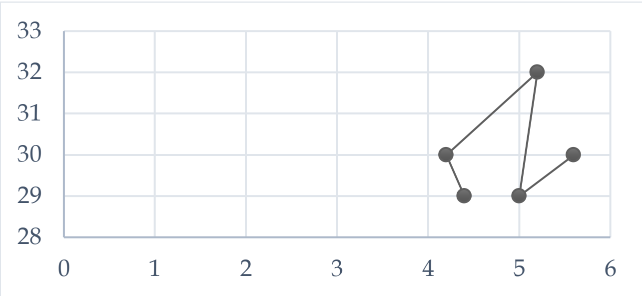

Figure 3. Graph of the Relationship of Temperature to Wind Speed

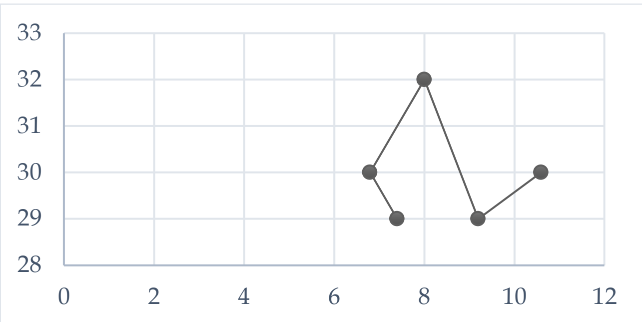

Figure 4. Graph of the Relationship of Temperature to the Rotational Speed of the Generator

Based on figures 3 and 4, it can be seen that the influence of wind on wind speed and generator rotation speed is directly proportional. The influence of wind is very important in carrying out the operation of wind power plants, which are sourced from wind energy. Wind itself is the kinetic energy needed in a process of operating wind turbines. This exposure is in line with the results of study Lopez-Villalobos et al., (2022) which revealed that the effect of the vertical wind speed profile in the surface boundary layer on the mean power production of a horizontal axis wind turbine for La Ventosa, Oaxaca, in Mexico. Two of the most widely used vertical wind speed extrapolation methods for wind resource assessment, the powerlaw and log-law methods, were compared against wind speed data available in the AEM. Research Mohammadi et al., (2016) also revealed that comparing blades of different turbines shows this result is deduced in all of them. Considering results of medium scale optimization of three wind turbine blades with exactly same method, where three different airfoils and attack angles were selected across the blade, indicates that in considered small-scale blades, blades are not long enough to have various condition across the blade. In other words primary condition such as Reynolds number do not cause different airfoil selection, while in medium scale blades selection factors are different enough to choose another airfoil and attack angle.

Nuryogi & Subiyanto, (2019) reveal that modeling and simulating a grid-connected PLTB under dynamic loading on the Power Simulator (PSIM) software with a power rating of 28 kW. The test results showed PLTB connected grid on dynamic loading has good performance. It has been proven that when a grid-connected PLTB is tested under a dynamic load, the maximum power generated by the system is greater than the load supplied, the excess power can be channeled to the grid. However, when the load is greater than the power generated by the PLTB, the grid will overcome this power shortage. El Khchine et al., (2019) reveal that wind energy is one of the fastest-growing renewable energy technologies of electricity generation. Wind energy has proved its potential in combating environmental degradation while ensuring a renewable, efficient and clean energy source. Good wind sites can even be competitive with traditional energy sources. In this paper, we used statistical methods namely Weibull probability density function for evaluating the wind energy potential as a power source in Morocco's regions, in particular Taza and Dakhla cities. Various methods were explored as wind variability, power density, standard deviation, Moroccan and WAsP methods for calculating the Weibull parameters using mean wind speed data measured at one-hour intervals. From the results of research obtained by conducting experiments, analyzing wind turbines, variations of wind speed with different times were obtained.

Conclusion

The effect of changing wind speed in wind power plants on the energy produced by DC generators. The measurement results obtained by observing the results of measuring voltage, current and turbine rotation can be concluded if the results of research tried at an average voltage of 5.12 Volts. As well as the average wind speed of = 4.88 meters / s, while the average generator rotation speed = 8.4 rpm. The influence of wind on wind speed and generator

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Author Contributions

Yusnidah: Conceptualized the research idea, designed methodology, validated, analyzed data, wrote, reviewed, and edited.

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Conflicts of Interest

The author declares no conflict of interest.

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