Energi dan Kelistrikan: Jurnal Ilmiah
Vol. 13, No. 2, Juli - Desember 2021, P-ISSN 1979-0783, E-ISSN 2655-5042
https://doi.org/10.33322/energi.v13i2.1535

The Effect of the Shape of a Laboratory Scale Wind Power Generator in Generating Energy

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ABSTRACT

In this study, the influence of the shape of the propellers of a laboratory-scale wind power plant on the energy produced will be measured. It is known that the number of propellers and wind speed greatly affect the energy produced. With this, researchers will conduct research on the influence of the shape of the propeller on the energy produced. with the aim of knowing the effect of the shape of the propeller on the energy produced. The methods used are literature studies and experiments where literature studies are carried out to find references to the problems raised, experimental research is to design tools and try out to find causal data. The results of this study indicate that flat-shaped propellers get or produce higher energy compared to thin and curved propellers. By experimenting on the fan in "LOW" mode with the RPM value of 461.7, the voltage value is 5.32 Volts, Ampere 0.552 and power (Watt) 2.937. in "MEDIUM" mode the RPM value is 461.7, the voltage value is 5.44 Volts, the Ampere value is 0.556 and the power value (Watt) is 3.025, in the "HIGH" mode the RPM value is 366.4 With the highest voltage is 5.49 Volts, Ampere 0.558 and power (watts) 3,063. The conclusion obtained shows that the shape of the propeller affects the energy produced.

Keywords: *Wind Power, Propeller shape, RPM, Voltage, Watt*

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1. PRELIMINARY

The result of poor fossil energy in the environment in the form of pollution and its contribution to the phenomenon of climate change which is the cause is the "greenhouse effect". Utilizing renewable natural resources is something that must be done and must continue to be developed so that there are no crises and scarce energy[1]. Indonesia is an archipelagic country with 2/3 of its territory is ocean and has the fourth longest coastline in the world (after the US, Canada, and Russia) which is ± 95,181 Km and is located on the equator, and has 17,480 islands. Most of these islands have not been electrified by the State Electricity Center, therefore windmills are one of the potential alternatives to meet energy needs in Indonesia, especially in archipelagic areas with wind potential that is continuously available. This windmill uses wind power which is converted into electrical energy[2].

Indonesia has identified wind energy potential which is around 978 MW. At a number of locations in several regions of Indonesia, several studies and measurements of wind energy potential have been carried out by the relevant government institutions, namely LAPAN and BMKG. Wind energy on land has limited potential, the average wind speed is between 3 m/s and 7 m/s/[3].

Wind energy is a type of renewable energy with a pollutant level of zero (zero) and its presence is very abundant for the equatorial region[4]. At speeds between 5 to 20 m/s is a speed that can work well in large-sala wind turbine technology. For areas less than 5 m/s it is more appropriate and suitable to be converted into mechanical energy or small-scale electricity generation, and to use a vertical axis wind turbine to produce good electrical energy[5].wind turbine horizontal axis is wind turbine modelthe most commonly used. The shape like an airplane propeller generally[6]. Theoretically, in the previous chapter it has been calculated that the more number of blades will allow lower drag force on the turbine surface which has the potential to rotate faster[7].The greater the wind speed then the smaller the value of efficiency obtained[8]

Wind Power Plant is a system that requires wind as a source to be converted into electrical energy. The simple concept is that the wind as a source is used to rotate the pinwheel which is connected to a generator where the generator has a copper coil so that it occurs (electromotive force)[9].Of the three differences in the number of propellers, the maximum turbine generator output power value at a wind speed of 5 m/s is produced by 5 propellers with a turbine shaft output power value of 23,755 watts[10]. Based on previous research, researchers get a problem, namely whether the shape of the propeller can affect the energy produced. Thus the researchers took the title "The influence of the shape of the propeller of a laboratory-scale wind power plant in producing energy". With a case study using 3 propellers with a flat shape, 3 propellers with a curved shape and 3 propellers with a thin shape. With the aim of the study, namely to get the value of the energy obtained and to get the influence of the shape of the propeller.

2. LITERATURE RIVIEW

In the process of this research using the method of literature study (library) and experimental research. Literature studies are used to find reference materials related to the issues raised, references taken are from previous research journals. The experimental method is to try to design tools and try out to find causal data in the process through experiments so that they can find out the effect of the shape of the propeller on the energy produced.

Vol. 13, No. 2, Juli - Desember 2021, P-ISSN 1979-0783, E-ISSN 2655-5042
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2.1. Research Time and Place

The research was conducted on June 1, 2021 until June 25, 2021 from the initial stage to completion. All research processes are carried out at the Electrical Engineering Laboratory, Faculty of Engineering, University of Muhammadiyah Prof. DR. HAMKA. Jl. Tanah Merdeka, No. 06, Kampung Rambutan, Pasar Rebo, East Jakarta.

At this stage is a stage that includes research in detail as follows:

1. The first stage is to prepare all the equipment needed to carry out and assemble it.
2. Connect the output or output of the wind power plant module to the input of the renewable energy monitor.
3. Connect the monitor output or renewble energy output to the LED indicator.
4. Connect the power from the renewable energy monitor to a personal computer or laptop with the Horizon Fuel Cell Technologies software or application installed.
5. Turn on the fan and direct it to the wind power plant module that has been assembled, with a fan distance of 40 cm.
6. Measure what happens to the output or output produced.
7. Change the propeller when the research on the flat propeller has been measured
8. Replace the flat propeller with a curved vane, and measure the resulting energy.
9. After replacing it with a thin blade, and measure the energy produced.

3. RESULTS AND DISCUSION

This section will discuss related to the data that has been measured, the results of the influence of the shape of the propeller on the energy produced and in this chapter will also discuss the results of data analysis that has been carried out or obtained.

3.1. Measurement data results, the number of propellers is three. flat propeller shape.

Table 1. RPM Measurement Data on Wind Speed, Number of Propellers 3, Flat Shape.

Wind velocity	RPM
LOW	366.4
MEDIUM	461.7
HIGH	483.5

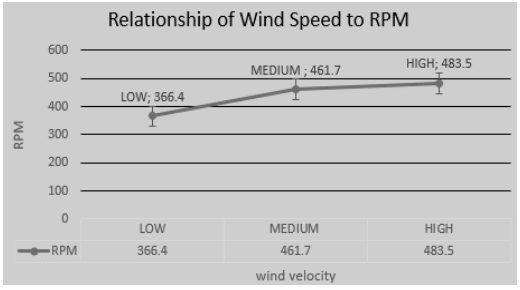

Figure 1. Graph of The Relationship Between Wind Speed and RPM

Based on the graph above, it is explained that there is a very close relationship between wind speed and RPM, namely the lower the wind speed "LOW" also shows the lower the value of the RPM is 366.4, and so on with the increase in the wind speed "MEDIUM" the more the value of the

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RPM is 461.7 When the wind speed is in a maximum state of "HIGH", the RPM value is even greater, which is 483.5.

Table 2. Voltage Measurement Data Against RPM, Number of Propellers 3, Flat Shape.

RPM	VOLTAGE(VOLT)
366.4	5.32
461.7	5.44
483.5	5.49

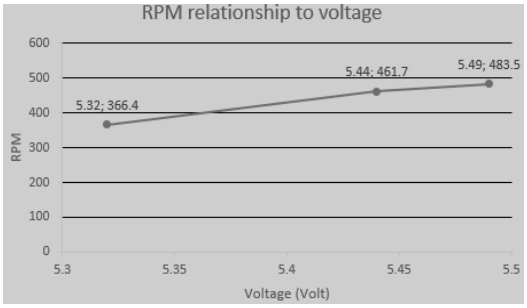

Figure 2. Graph of RPM Against Voltage

Based on the graph above, it is explained that the relationship between RPM and voltage (volts) is that the lower the RPM value, the lower the voltage value (volts), and so on, the higher the RPM value, the higher the voltage. The RPM value is 366.4 with a voltage value of 5.22, the RPM value is 461.7 with a voltage value of 5.44 and the highest RPM value is 483.5 with a voltage value of 5.49.

Table 3. Voltage Measurement Data Against Amperes. Number of Propellers 3. Flat Shape.

VOLTAGE(VOLT)	AMPERE
5.32	0.552
5.44	0.556
5.49	0.558

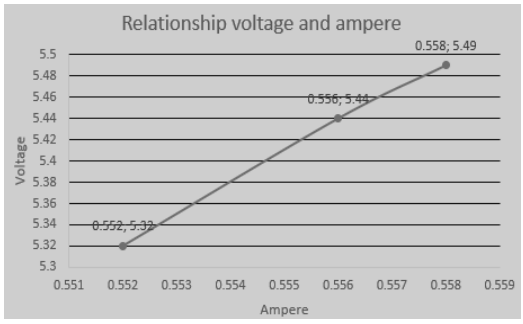

Figure 3. Graph of The Relationship of Voltage to Amperes

Based on the graph above, it explains the relationship between voltage and amperage, that is, increasing the value of the voltage will have an impact on the ampere value. When the voltage is higher, the amperage value will also increase. The graph shows the voltage value of 5.32 the

Vol. 13, No. 2, Juli - Desember 2021, P-ISSN 1979-0783, E-ISSN 2655-5042
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amperage value is 0.552, the voltage value is 5.44 the ampere value is 0.556, and at the highest voltage the ampere value is 5.49 with the ampere value 0.558.

Table 4. Data for Measuring Amperes to Watts. Number of Propellers 3. Flat Shape.

AMPERE	Watt
0.552	2.937
0.556	3.025
0.558	3.063

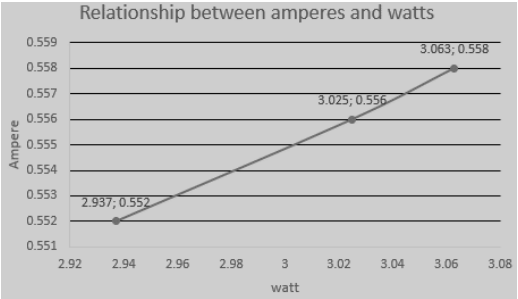

Figure 4. Graph of Ampere-to-Watt Relationship

The graph above describes the relationship between amperes and watts, where it can be analyzed that with increasing amperage, the wattage value will increase as well. the lowest amperage value is 0.552 and the lowest wattage value is 2,937. The highest amperage value is 0.558 with the highest wattage value of 3.063. Output power calculation, output power$P_{out} = V.I$

$$P_{out}low = V.I \quad (1)$$

= 5.32 x 0.552
= 2.937 watt

$$P_{out}medium = V.I \quad (2)$$

= 5.44 x 0.556
= 3.025 watt

$$P_{out}high = V.I \quad (3)$$

= 5.49 x 0.558
= 3.063 watt

3.2. Measurement data, the number of propellers is three. curved blade shape.

Table 5. Wind speed RPM measurement data. number of propellers 3. Curved shape.

Wind velocity	RPM
LOW	273.5
MEDIUM	274,3
HIGH	275,4

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https://doi.org/10.33322/energi.v13i2.1535

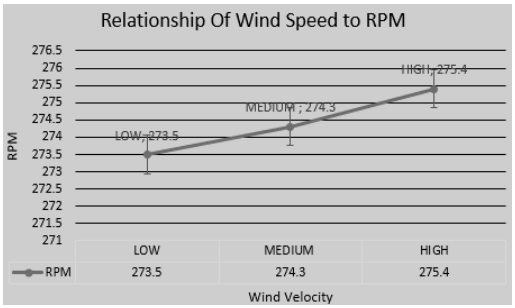

Figure 5. Graph of The Relationship Between Wind Speed and RPM

The graph above explains the relationship between RPM and wind speed. Based on the graph above, it explains that there is a very close relationship between wind speed and RPM, namely the lower the wind speed, the "LOW" mode also shows the lower the value of the RPM, which is 273.5, and so on with the increase in wind speed mode. "MEDIUM" the more the value of the RPM is 274.3 and when the wind speed is in the maximum state of the "HIGH" mode, the RPM value is getting bigger, which is 275.4.

Table 6. Voltage Measurement Data Against RPM, Number of Propellers 3, Curved Shape.

RPM	VOLTAGE(VOLT)
273.5	4.85
274.3	4.89
275.4	4.93

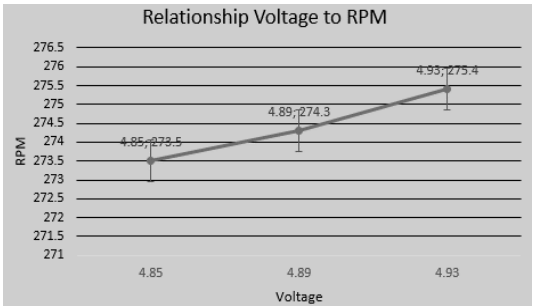

Figure 6. Graph of RPM Against Voltage

The graph above explains the relationship between voltage and RPM, based on the graphic data above, the value of RPM will be directly proportional to the amount of voltage. The greater the RPM, the greater the voltage generated. The data above shows the lowest RPM value, which is 273.5 with a voltage value of 4.85. then the RPM value is 274.3 with a voltage value of 4.89. and the highest RPM value is 275.4 with the highest voltage value is 4.93.

Table 7. Voltage Measurement Data Against Amperes. Number of Propellers 3. Curved Shape.

VOLTAGE (VOLT)	AMPERE
4.85	0.599
4.89	0.564
4.93	0.567

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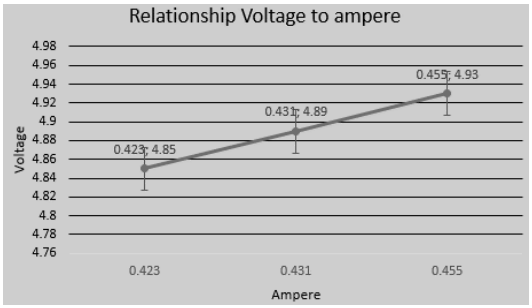

Figure 7. Graph of The Relationship of Voltage to Amperes

Based on the graph above, it explains the relationship between voltage and amperage. Increasing the value of the voltage will have an impact on the amperage value. When the voltage is higher, the amperage value will also increase. The graph shows the voltage value of 4.85 with the amperage value of 0.423. The voltage value is 4.89 with anamperage value of 0.431, and at the highest voltage the value is 4.93 with an amperage value of 0.455.

Table 8. Data for Measuring Amperes to Watts. Number of Propellers 3. Curved Shape.

AMPERE	watt
0.423	2.051
0.431	2.107
0.455	2.243

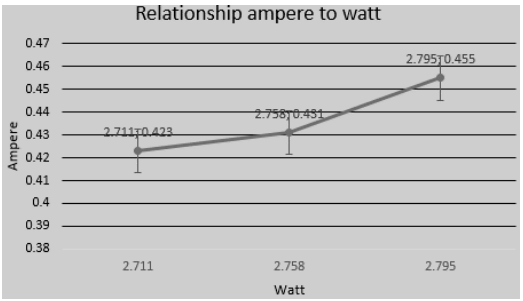

Figure 8. Graph of Ampere-to-Watt Relationship

The graph above describes the relationship between amperes and watts. Where it can be analyzed that with increasing amperage, the value of watts will increase as well. With the lowest amperage value is 0.423 and the lowest wattage value is 2.711, the highest ampere value is 0.4.55 with the highest wattage value is 2.795. Outputpower calculation, output power $P_{out} = V.I$

$$P_{out}low = V.I \quad (4)$$

= 4.85 x 0.423
= 2.051 watt

$$P_{out}medium = V.I \quad (5)$$

= 4.89 x 0.431
= 2.107 watt

$$P_{out}high = V.I \quad (6)$$

= 4.93 x 0.455
= 2.243 watt

Vol. 13, No. 2, Juli - Desember 2021, P-ISSN 1979-0783, E-ISSN 2655-5042
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3.3. Measurement data, the number of propellers is three. Thin blade shape.

Table 9. Wind Speed RPM Measurement Data. Number of Propellers 3. Thin Shape.

Kecepatanangin	RPM
LOW	284.2
MEDIUM	285.3
HIGH	287.0

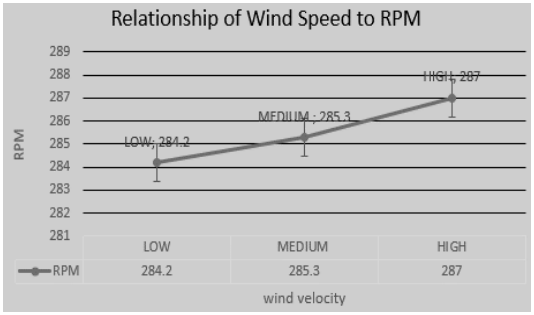

Figure 9. Graph of The Relationship Between Wind Speed and RPM

The graph above explains the relationship between RPM and wind speed. Based on the graph above, it can be concluded that there is a very close relationship between wind speed and RPM, namely the lower the wind speed in the "LOW" mode, the lower the value of the RPM is 284.2, and so on with the increase in wind speed. the "MEDIUM" mode, the value of the RPM is 285.3 and when the wind speed is in the maximum state of the "HIGH" mode, the value of the RPM is 287.0

Table 10. Voltage Measurement Data Against RPM, Number of Propellers 3, Thin Shape.

RPM	VOLTAGE(VOLT)
284.2	4.32
285.3	4.35
287.0	4.49

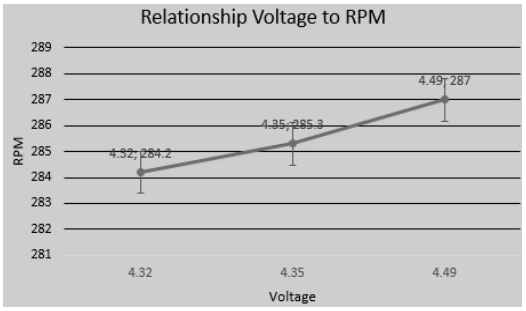

Figure 10. Graph of RPM Against Voltage

The graph above explains the relationship between voltage and RPM, based on the graphic data above, the magnitude of the RPM value will be directly proportional to the voltage. The greater the RPM, the greater the voltage generated. The data above shows the lowest RPM value,

Vol. 13, No. 2, Juli - Desember 2021, P-ISSN 1979-0783, E-ISSN 2655-5042
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which is 284.2 with a voltage value of 4.32. RPM value is 285.3 with a voltage value of 4.35. and the highest RPM value is 287.0 with the highest voltage value also 4.49

Table 11. Voltage Measurement Data Against Amperes. Number of Propellers 3. Thin Shape.

VOLTAGE(VOLT)	AMPERE
4.32	0.342
4.35	0.371
4.49	0.383

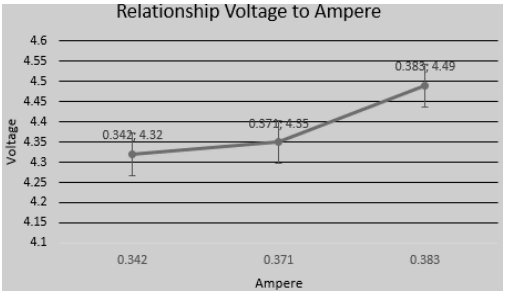

Figure 11. Graph of The Relationship of Voltage to Amperes

Based on the graph above, it explains the relationship between voltage and amperage. That is, increasing the voltage value will have an impact on the ampere value. When the voltage value is higher, the amperage value will also increase. The graph shows the voltage value 4.32, the amperage value is 0.342, the voltage value is 4.35, the ampere value is 0.371, and at the highest voltage with a value of 4.49, the ampere value is 0.383.

Table 12. Data for Measuring Amperes to Watts. Number of Propellers 3. Thin Shape.

AMPERE	watt
0.342	2.032
0.371	2.134
0.383	2.451

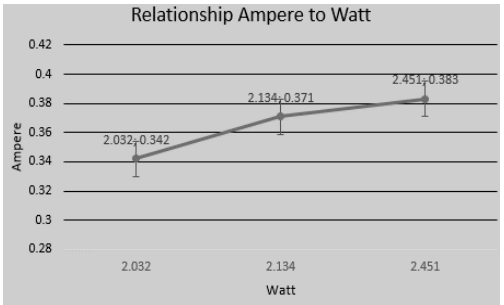

Figure 12. Graph of Ampere-to-Watt Relationship

The graph above describes the relationship between amperes and watts, where it can be analyzed that with increasing amperage, the value of watts will increase as well. With the lowest

Vol. 13, No. 2, Juli - Desember 2021, P-ISSN 1979-0783, E-ISSN 2655-5042
https://doi.org/10.33322/energi.v13i2.1535

amperage value is 0.423 and the lowest watt value is 2.711, the highest ampere value is 0.4.55 with the highest wattage value is 2.795.

3.4. The graphs of all experiments with parameters are RPM and Watts. with three different propeller shapes

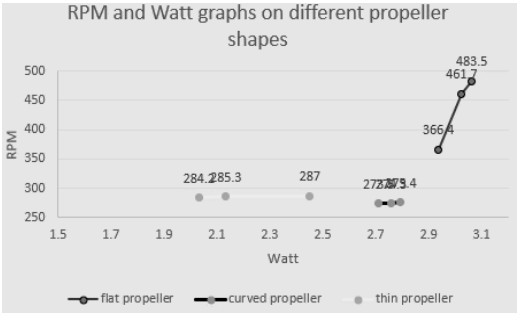

Figure 13. Graph of RPM Against Watts With Different Shapes of The Three Propellers.

Based on the data that has been measured and processed, the graphic above explains that the shape of the propeller is very influential on the energy produced (volts, amperes and watts). The data in the graph showing the red line is an experiment using a flat propeller. The black line shows experiments using curved propellers and the yellow line shows experiments using thin propellers. The value shown on the yellow line graph is for the thin propeller experiment to get the power or wattage which tends to be low, namely the RPM shows the values of 284.2, 285.3, and 287.0 with the wattage values being 2.032, 2.134 and 2.451, respectively.

The value shown on the black line graph uses a curved propeller, the value shown in the curved propeller experiment is the RPM value of 273.5, 274.3, 275.4. with rated power (wattage) respectively 2.711, 2.758 and 2.795

The value shown in the red line graph is an experiment using an average propeller, the values shown are RPM 366.4, 461.7 and 483.5 with power values (watts) respectively 2.937, 3.025, 3.063

4. CONCLUSION

This research produces data that has been measured and plotted using Microsoft Excel in order to get a graph for easy analysis. In this study using 3 different propellers with the number of each propeller 3. In this study it shows that the shape of the propeller is very influential on the energy produced. In this study using 3 forms of propellers. The shape of the first propeller is a flat shape, a curved shape and a thin shape. From when the shape of the propeller is in the form of a flat propeller that gets high energy compared to other propeller shapes. With the highest voltage of 5.49 Volts, 0.558 Ampere and power (watts) 3.063.

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Vol. 13, No. 2, Juli - Desember 2021, P-ISSN 1979-0783, E-ISSN 2655-5042
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