DESIGN AND CONSTRUCTION OF WIND POWER FOR STREET LIGHTING

This report is composed as one of requirements to complete the bachelor degree (S1) at Department of Electrical Engineering, Faculty of Engineering
Universitas Muhammadiyah Surakarta

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Abstrak

Listrik adalah kebutuhan yang sangat penting dimasa sekarang dan masa depan. Akan tetapi, untuk sekarang masih bergantung pada pembangkit listrik konvensional. Pembangkit listrik tenaga konvensional ini, sangat banyak menimbulkan ancaman seperti polusi, dan juga bahan bakar fosil akan semakin berkurang. Permasalahan seperti ini, akan berdampak pada masa depan. Oleh sebab itu, peneliti dituntut untuk mengembangkansistem pembangkit yang ramah lingkungan dan juga tidak menghabiskan bahan bakar fosil. Pembangkit listrik yang saat ini sudah banyak berkembang dan memanfaatkan energi dari alam. Banyak juga pembangkit yang ramah lingkungan dan tidak menghabiskan bahan bakar fosil. Seperti pembangkit listrik tenaga air, pembangkit listrik tenaga panas matahari, pembangkit listrik tenaga uap, dan juga pembangkit listrik tenaga angin. Untuk di Indonesia, energi dari alam yang belu dimanfaatkan sangatlah banyak. Seperti sinar matahari dan angin yang melimpah. Akan tetapi kurang sadarnya tentang sumber daya yang tidak dapat diperbarui yang menjadi permasalahan di Indonesia. Angin di Indonesia seperti di daerah pesisir sangatlah bagus untuk membangun pembangkit listrik tenaga angin. Pembangkit listrik tenaga angin dengan *low speed* memang perlu dikamebangkan di Indonesia. Pembangkit listrik tenaga angin dengan *low speed* perlu dikembangkan untuk mensuplai tegangan pada jalan. Dengan penggantian jenis lampu untuk menghemat daya dan listrik dapat diperoleh dengan mudah.

Kata kunci : *pembangkit listrik, energi terbarukan, pembangkit listrik tenaga angin.*

Abstract

Electricity is a very important need in the present and the future. However, for now, still rely on conventional power plant. This conventional power plants, unbelievably many pose a threat. Such as pollution and also fossil fuels will decrease. Problems like this will have an impact on the future. Therefore, we are required to develop a system of power plants that are environmentally friendly and do not spend on fossil fuels. The power plant is now widely grown and harness the energy of nature. Many power plants are also environmentally friendly and do not spend on fossil fuels. As we know, hydroelectric power plants, steam power plants, and wind power. In Indonesia for many developing power plants that utilize energy from nature. In Indonesia alone, the energy of nature that has not been used very much. Such as sunlight and wind are abundant. But less conscious about the resources that can not be updated which is the case in Indonesia. Winds in Indonesia such as in coastal areas is very good for building wind power plants. Wind power generation with low speed needs to be developed for the supply voltage on street lighting. With the replacement of the type of bulbs to save power, electricity can be obtained easily.

Keyword: power plant, renewable energy, wind power.

1. PRELIMINARY

Electricity is one of the energy that is a became main staple for almost all humans. Electricity became one of the vital energy and becomes an important requirement in all economic activities and human activities. To meet the human need has many built electric power generation system in Indonesia. Currently, the government has committed to realize the supply of electricity as much as 35 thousand Megawatts (MW) within a period of 5 years (2014-2019). Government and the private sector in cooperation with PLN will build 109 power plants, of which 35 projects were done by PLN and 74 other projects undertaken by the private / Independent Power Producer (IPP). Related with generating the necessary electrical machine that is able to convert mechanical energy into electrical energy, in this case the generator.

Generator is one of the electric machines that work based on the energy of motion / mechanical and convert them into electrical energy that can be utilized in daily life - today. The generator uses the principle of trial faraday ie turning the magnet in a coil or opposite, when the magnet moves in a coil, changes the flux of magnetic force (changing dissemination of direction of the magnetic field) in the coil and penetrate perpendicular to the coil so that the resulting potential difference between the ends of the coil (raise electricity), it is caused of changing in magnetic flux. Magnetic flux can be changed by moving the magnet in a coil or opposite by using other energy sources, such as wind and water to rotate the blades - turbine blades so that the magnet moves.

Indonesia is one of country have a many energy resources, one of them is wind energy. Indonesia is an archipelago and one of country located at the equator is a factor that Indonesia has abundant wind energy potential. Basically winds occurs due to the difference in temperature between the hot air and cold air.

The potential of wind energy in Indonesia is quite sufficient, because the average wind speed ranges from 3.5 to 7 m / s. Results of mapping National Institute of Aeronautics and Space (LAPAN) at 120 locations show, some regions have wind speeds above 5 m / sec, respectively East Nusa Tenggara, West Nusa Tenggara, South Sulawesi, and the southern coast of Java.

Tabel 1. Grouping the wind energy potential (source: LAPAN, 2005)

Class	Wind speed (m/s)	Specific power (W/m)	Capacity (kW)	Location
Small scale	2,5 – 4,0	<75	< 10	Java, NTB, NTT, Maluku, Sulawesi
Medium scale	4,0 – 5,0	75 – 150	10 – 100	NTB, NTT, North Sulawesi
Big scale	> 5,0	> 150	> 100	South Sulawesi, NTB, NTT, Java's southern coast

According from the data, Region Indonesia is very support for the implementation of Wind Power, both small scale and large scale. Usually the generator is applied to wind power is the type of high speed induction generator, the generator of this type requires high speed and also need the initial electrical energy to create the magnetic field, so it is not suitable to be applied in areas of low wind speed. For that reason, in this research will be developed generator that can be used in wind turbine or other sources of low-powered propulsion. In addition, the generator will be made this must be cheap, easy to build, easy to maintain, low speed and can be developed (scaled up).

Power plant with renewable energy, particularly in wind power generation is strongly influenced by the mechanical design prime mover and generators, while the generator with permanent magnet is one kind of generator electricity very efficiently used in the generation of this type, this is because the permanent magnet generator is able to work well on high speed and low RPM.

Based on this construction is very easy to design a permanent magnet generator with a specific output value. To change the value of the output of the generator can be done by changing parameters such as the strength of the magnetic flux, number of coils and windings of each coil, number and dimensions of the magnet and also the size of the diameter of the wire

Andi Pradana (2008) in his research entitled "Design stator within the rotor with the most optimal permanent magnet generator" produces a conclusion

that the greater the distance stator against the rotor RPM then the resulting voltage and current decreases.

Research on permanent magnet generators also conducted by Dhanar Yuwono Aji (2009) with the title "Design generator axial low speed by using a permanent magnet" lead to the conclusion that the more the number of loops in each coil, so the output voltage generated greater. From some of the above results, it is very helpful in designing this generator, both in terms of design, construction, material type and the number of poles that will apply.

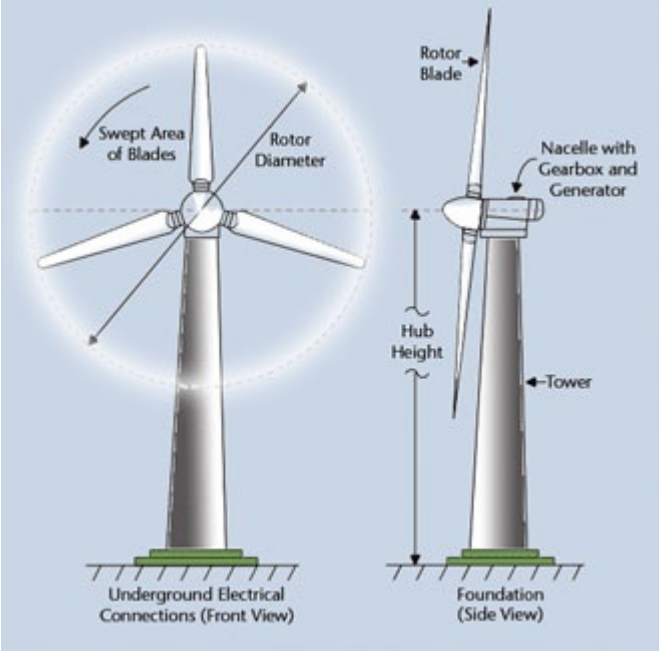
2. RESEARCH PROCEDURE

The first step in this research is to search for literature studies. This is done to collect data related research that will be done and finalize the concept in the research to be done. The data collected in the form of scientific journals, scientific articles, books, online media (internet), the data is used as a reference in doing research that will be done.

The design of the tool starts with designing the model of the power plant. The design and design of the plant is based on calculations and also from the journal as the basic reference for the design of the plant. The design of the plant starts with the shape to be selected. Wind turbines in principle can be distinguished over two types of turbines based on the direction of rotation.

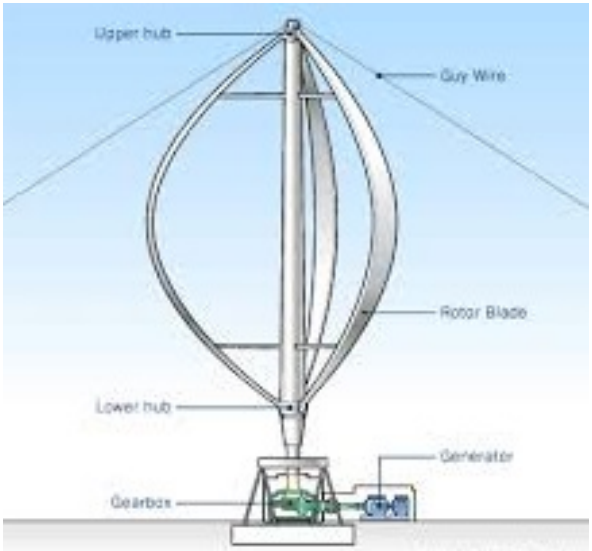
1. Wind turbine that rotates on horizontal axis as known as Horizontal Axis Wind Turbine (HAWT),
2. Wind turbine that rotates on vertical axis as known as Vertical Axis Wind Turbine (VAWT).

Horizontal wind turbines are common models that we often see in wind turbines. The design is similar to a windmill, has a blade and rotates on a vertical axis. The horizontal wind turbine has a rotor shaft and generator at the top of the tower and should be directed toward a blowing wind. Small turbines point to the wind using a directed winde plane, while for larger turbines equipped with sensors connected to the servo motor that direct the blade in the direction of the wind. Most large turbines have a gearbox that changes the rotational speed of the rotor that is transferred to the generator faster.



Picture 1. Horizontal wind power type (source: google image)

The vertical wind turbine has a vertical rotor shaft. The main use of this rotor placement is that wind turbines do not need to be directed toward the wind blowing. This is particularly useful in areas where wind direction is highly variable or has turbulence.



Picture 2. Vertical wind power type (source: google image)

With the vertical axis, generator and other primary components can be placed close to the ground surface, so the tower does not need support and this makes maintenance easier. The main disadvantage of vertical wind turbines is creating a boost while spinning.

The generator is one of the electric machines that work based on the energy of motion / mechanical and convert them into electrical energy that can be utilized in daily life. The generator uses the principle of a faraday experiment that rotates the magnet in a coil or vice versa, when the magnet moves in a coil, a magnetic force flux changes (changes in the direction of the magnetic field) in the coil and pierces perpendicular to the coil so that a potential difference exists between the end of the coil (evokes Electric), this is due to the change of magnetic flux. Magnetic flux can be changed by moving the magnets in a coil or vice versa by utilizing other energy sources, such as wind and water to rotate the turbine blades so as to move the magnet.

Induction generator is one type of an AC generator which applies the principle of induction motors to generate power. The induction generator is operated by moving the rotor mechanically faster than the synchronous speed resulting in negative slippage. An induction generator is a generator that uses the principle of electromagnetic induction in its operation. This generator can work at low speeds and non-fixed speeds, so induction generators are widely used in power plants with low power such as on microhydro power plants or new power plants.

If a conductor that is rotating inside a magnetic field (stator coil) will generate a voltage of

$e = B.l.v$ …….(1)

Where :

e = generated induction voltage (volt)

B = Magnetic flux (weber)

l = length of conductor (m)

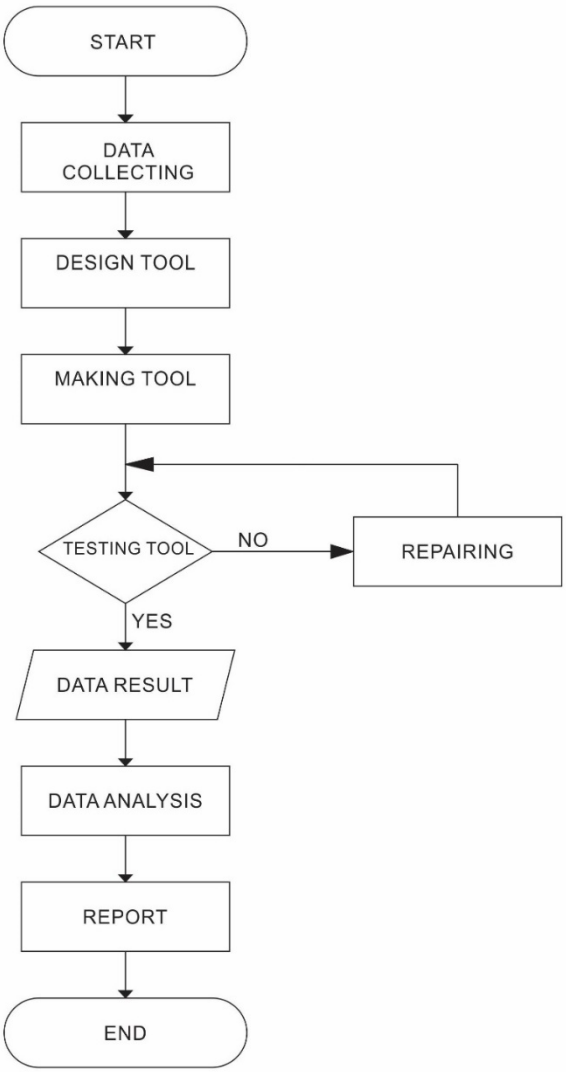
v = speed of magnetic field (m/s)

When connected to the load, current will flow. The current on the rotor will interact with the magnetic field in the stator coil so that a current on the stator coil will appear in reaction to the given mechanical force. In the process of induction motor changes become necessary induction generator reactive power or power magnetization to generate a voltage at the output.

Testing tool is done to obtain data from tools that have been made. In the test done comparison of the results obtained from the research on the

target to be achieved, if the results have not reached the target then the repair tool until the results obtained according to expectations. The test is carried out with tools mounted at a height of 3.5 meters to obtain maximum wind. With the battery load as storage, and also the provision of LDR as a sensor to light the led 10 watts during the evening.

Data analysis was done by collecting data obtained from the test results and then do a comparison of data obtained through the study of literature. The analyzed result must be in accordance with the data obtained from the testing of the tool, to obtain an accurate analysis result. Stages of the research flow can be seen in the following research flowchart:



Picture 3. Flowchart of the study

3. THE RESULT ACHIEVED

From the results achieved of the research, obtained results such as picture 5. wind power plants. This tool has the following specifications :

1. Generator

   Utilize the induction motor from the fan motor, converted the function into an induction generator. The working principle of the induction generator is reversed rather than when the induction machine works as a motor. When the engine acts as a motor, the stator coil is given a voltage so that a rotation field will arise with synchronous speed (ns). However, if the motor serves as a generator, the rotor motor is rotated by a propulsion source with a speed greater than its synchronous speed. An induction generator is a generator that uses the principle of electromagnetic induction in its operation. This generator can work at low speeds and non-fixed speeds, so induction generators are widely used in power plants with low power such as on microhydro power plants or new power plants.

2. Turbine

   The turbine serves to rotate the rotor from the generator, with the help of the wind received. Turbine has 4 blades made of PVC material, with the aim is light and strong.

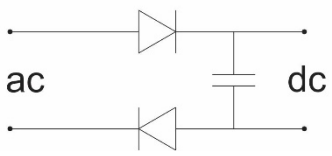
3. Tail

   The tail is a part that has an important role in the horizontal type wind power to move the turbine to always face the wind direction. The tail is made of acrylic, with the purpose is light and strong.

4. Controller (rectifier)

   This section serves as converting AC power into DC electric current. The component of this rectifier is :

   1. Diode 1 watt
   2. Capacitor 22 µF 25 v



Picture 4. Controller (rectifier)

5. Battery

   Battery serves as a storage electricity generated from generator. Specification of battery used:

   a. Voltage = 12 volt

   b. Capacity = 5 Ah

6. Lamp

   Main component for street lightning, specification of the lamp

   a. Voltage = 12 volt

   b. Power = 10 watt

7. Light Sensor

   Used to control light up of the lamp. With this part of the lights on when the intensity of the sun less (at dusk), and turn off the lights when the intensity of sunlight rises (in the morning).

Picture 5. Wind power study result

The experiment was conducted in the area, Pusur, Karanglo, Polanharjo, Klaten. The final test was conducted in August 2017 to get more accurate data. Data is taken directly using the following tools:

1. Anemometer
2. Multimeter

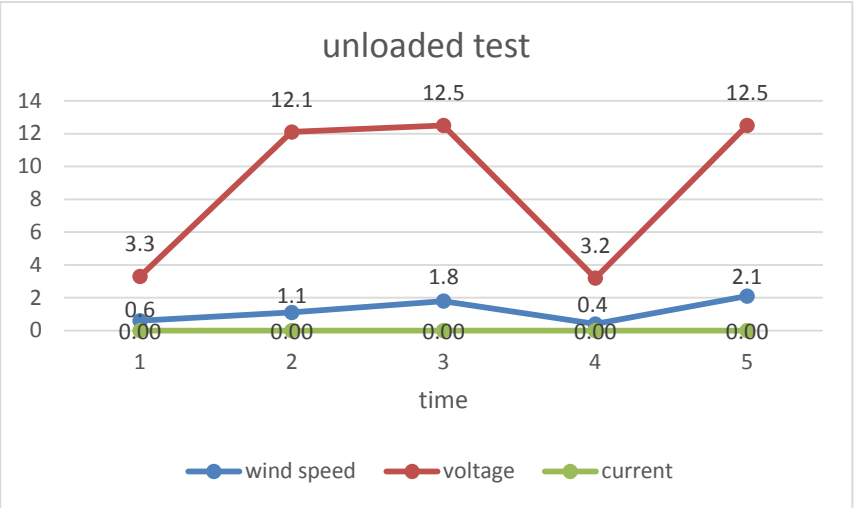
Data taken using 2 steps :

1. Unloaded test

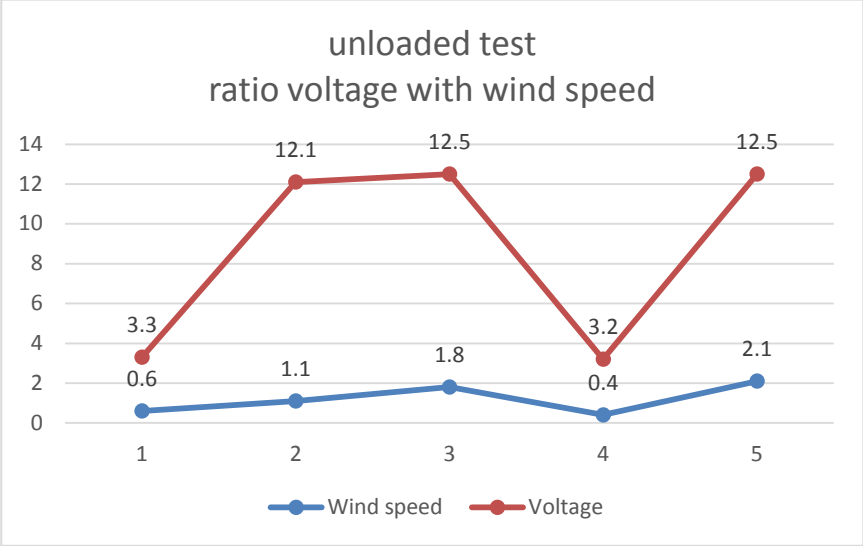
First test is unloaded test,

Table 2. Unloaded test

No	Wind speed	Voltage	Current
1	0.6 m/s	3.3 v	0.00
2	1.1 m/s	12.1 v	0.00
3	1.8 m/s	12.5 v	0.00
4	0.4 m/s	3.2 v	0.00
5	2.1 m/s	12.5 v	0.00



Picture 6. Graph shown of voltage current and power result



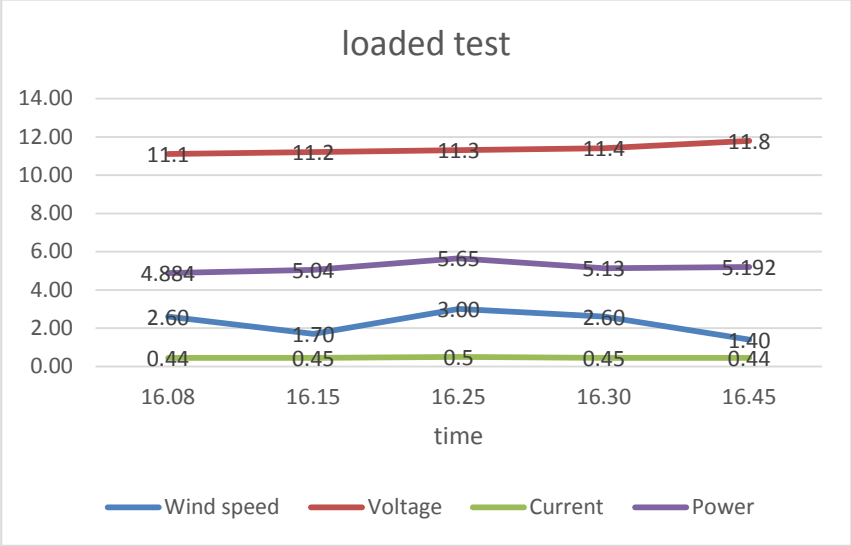
Picture 7. Graph shown of voltage current result

From table 2. can be seen comparison between wind speed and voltage, the faster of wind, the greater of voltage generated. From a wind speed of 0.6 m / s it can produce a voltage of 3.3v and when wind speed is 2.1 m / s the resulting voltage is 12.5v produce of current still 0, because the generator has not been connected to the load. From the picture 6. It can be concluded that the voltage is affected by wind speed. As the wind speed up, the resulting voltage also up, and also vice versa.

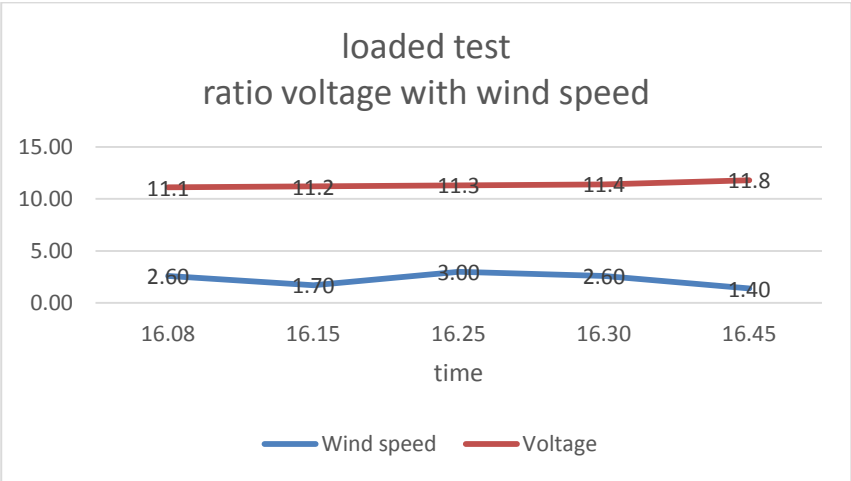
2. Loaded test

Table 3. loaded test

No	Time	Wind speed	Voltage	Current	Power
1	16.08	2.60 m/s	11.1 v	0.44 A	4.884 W
2	16.15	1.70 m/s	11.2 v	0.45 A	5.04 W
3	16.25	3.00 m/s	11.3 v	0.5 A	5.65 W
4	16.30	2.60 m/s	11.4 v	0.45 A	5.13 W
5	16.45	1.40 m/s	11.8 v	0.44 A	5.192 W



Picture 8. Graph shown of voltage current and power result



Picture 9. Graph shown of voltage current result

From table 3. it can be concluded that voltage is influenced by wind speed. When the wind is at 2.6 m / s the resulting voltage is 11.1 v, and the current flowing during the load test is 0.44 A. But during the second test, the wind speed is at 1.7 m / s and the resulting 11.2 v and the current is 0.45 A. Due to differences in wind speeds above and below during the test. Figure 8 shows the comparison between wind speed and voltage. As the wind speed up, the resulting voltage also up.

4. CONCLUSION

Wind power plants can work due to several factors, the factor that is affecting the wind speed, Wind in Indonesia is suitable to build wind power plants. Wind Power small scale that has been made in the research and also have been experiment carried out capable of generating voltages up to 12.50 volts. This is suitable for building small-scale wind power plants. With battery as storage to keep the voltage out of the generator. As the main function in this research, that is as Wind Power Generator As Lighting Street. The tool also includes a light sensor for lighting lamps during the evening.

In testing that has been done the generator is able to issue voltage up to 11.4 volts up to 11.8 volts. It needs to be retested with replacement generator using email wire which is bigger to get bigger current. Makes an aerodynamic propeller for faster wind speed when receiving wind.

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