BEST
Journal of Applied Electrical & Science Technology – University of PGRI Adi Buana Surabaya
p-ISSN 2715-2871
e-ISSN 2714-5247

Design and Construction of Vertical Helix Savonius Wind Turbine for Public Street Lighting

Sagita Rochman
Electrical Engineering
University of PGRI Adi Buana
Surabaya, Indonesia
sagita@unipasby.ac.id

Krishna Wijayakusuma
Electrical Engineering
University of PGRI Adi Buana
Surabaya, Indonesia
KrishnaWijaya22@gmail.com

Rivaldo Josua Jetrin Rolos
Electrical Engineering
University of PGRI Adi Buana
Surabaya, Indonesia
rivaldojetrin@gmail.com

***Abstract*— Wind power generator for lighting public roads in Tambakrejo Village, Sumbermanjing District, Malang Regency in order to minimize the level of traffic accidents. This power plant utilizes wind resources that blow to drive a wind turbine generator that will produce electrical energy. The use of wind to become electrical energy is designed from a vertical helix savonius type wind turbine as a medium for receiving wind gusts that will drive a generator to create electrical energy. The advantage of this helix savonius wind turbine can accommodate all cardinal directions because it has 2 blades that rotate 180. The role of the battery is to store electrical energy before it is distributed for public street lighting. Wind turbines or wind power plants are one of the renewable energy sources that are environmentally friendly and are starting to be widely developed at this time. In the storage and use of this electrical energy, it is very necessary to pay attention so that there is no overcharging / overcharge and excess usage / overdischarge. Therefore, the charge controller battery charging setting is used which will regulate charging or discharging. From the battery it will be connected to the Photocell for automatic control when it is dark and the light will turn on**

Keywords*— *Battery, Charge Controller, Generator, Photocell, Helix Savonius

I. INTRODUCTION

Throughout human history great progress has been made - progress in culture has always been accompanied by an increase energy use. This increase is directly related surrounding population and industrial progress. At the time of this industrial revolution, fuel consumption skyrocketed. So we need an energy source that meets all needs. At this time the energy source that is often used is fossils. However This energy is non -renewable energy and requires new energy sources when fossil energy runs out [1],[2].

To overcome the disturbance to fossils, it is necessary to convert, conserve, and develop renewable energy sources. This development must prioritize the three "E's", namely energy, economy, and ecology. So, the energy source that is developed must be able to obtain large amounts of energy, with minimal expenditure and has very little impact on the environment. Wind energy is currently very dominant and has a great opportunity to be maximized [3],[4].

Wind is a source of energy abundant amount is a source of renewable energy and does not cause air polution, because it does not result in exhaust gases that can creates a greenhouse effect [5]. The natural resource that can be taken or used for free is wind, which is abundant and its availability continues throughout the year [6],[7].

Lighting is needed at night, if at night there is no lighting then the visibility of our eyes is very limited. In the village of Tambakrejo, Sumbermanjing District, Malang Regency, so far there is still very minimal street lighting so that it can cause traffic accidents [8]. There for it is necessary to make lighting in order to reduce the level of traffic accidents by utilizing natural resources, namely the wind in the village [9],[10].

In my research this time I will design a wind power generator using a vertical helix savonius type wind turbine. The way it works is very simple, namely the wind that blows rotates the turbine. proceed to the generator rotor, this generator has a coil in the form of copper which functions as a stator so that an electromotive force (EMF) occurs [11]. With the results of the wind turbine rotation to be used as street lighting in Tambakrejo Village, Sumbermanjing District, Malang Regency [12],[13].

II. METHOD

The thesis chosen by the author is to make a vertical helix savonius type wind turbine as a electrical energy generator. The following are some of the components consisting of:

a. wind turbine
b. Generator
c. MPPT
d. Battery
e. photocell
f. Lamp

p-ISSN 2715-2871
e-ISSN 2714-5247

A. Product Design.

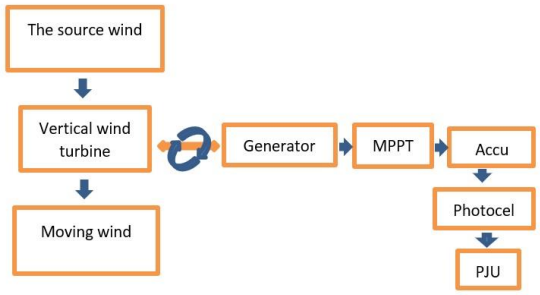

Figure 1. Flowchart product

How the product works:

- The wind that blows drives the wind turbines
- The ass generator installed in the wind turbine rotates too
- The generator generates electricity and is routed to the MPPT wind turbine
- MPPT wind turbine stabilizes the voltage to then be channeled to the battery/battery for storage
- The battery / battery is used to store the voltage obtained from the MPPT, so that the voltage obtained is not immediately lost.
- After the voltage is stored by the battery, it will be connected to the Photocell for an automatic system
- The Photocell output is connected to the lamp, when it is dark the light will turn on automatically

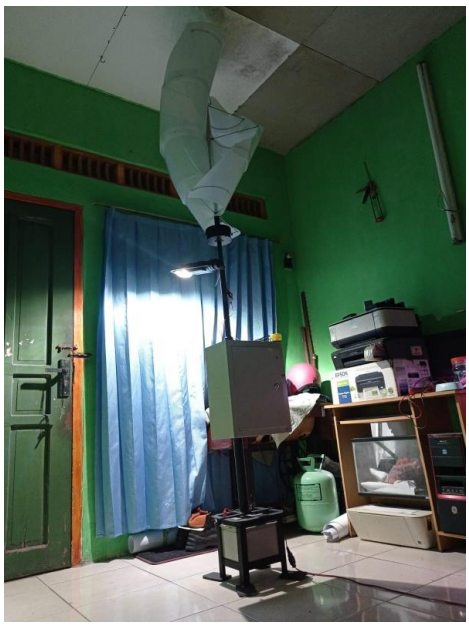

Figure 2. Product Design

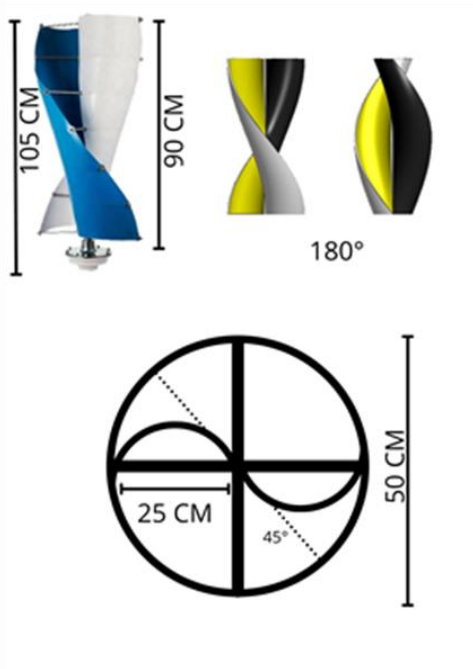

Figure 3. Turbine Diameter

B. Product test

Testing is a process where the tools that we will make can work as we want properly. In accordance with the existing theory, testing will be carried out, among others, as follows:

- Turbine testing, turbine testing is used to drive a generator through gusts of wind
- Generator, generator testing serves to create electrical energy. Which replaces mechanical energy into electrical energy
- Battery / battery, battery testing is used to check whether this battery can still function properly. Because the battery is a component that can store the electric charge obtained from the generator
- Lighting lamps, this test is carried out as the output of the generator, this output is used as street lighting

C. Data Analysis Method

Analyzing the workings of the tool using the quantitative analysis method, analyzing the results of observations during testing on the tool for student lecture presentations which include

- Wind circulation
- Generator
- Turbin

III. RESULT AND DISCUSSION

A. Data Presentation

- Generator Voltage Test

The generator used in this design is a permanent magnet generator. Where the permanent magnet generator has a voltage output that is greater than the output of an

p-ISSN 2715-2871
e-ISSN 2714-5247

ordinary generator, because there is a magnet around the rotor. Unituk can find out the size of the voltage generated by using a multimeter.

- Current Produced by Generator

This test is carried out in order to find out how much current can be generated by the generator. The test is carried out by connecting a multimeter / ammeter in series with the generator cable.

- Wind Testing and Measurement

Wind speed measurements are carried out because this circulation greatly affects the turbine rotation, if the wind is very strong, the turbine rotation will rotate quickly to rotate the generator so that the voltage obtained will be higher.

- Overall Test

The testing of this tool is carried out so that all components can work properly, including wind turbines, generators, MPPT, batteries, and the output as public street lighting

Table 1. Test Result Data

No.	Wind Speed (m/s)	Generator Turns (RPM)	Generator Output Voltage (DC Volts)	Step UP Output Voltage (DC Volts)	Generator Current (A)
1.	2.0	7.9	1.8	1,5	0,1
2.	2,3	11	2,0	1,8	0,1
3.	2,5	12,8	2,4	2,4	0,2
4.	3,1	20,2	2,9	2,9	0,2
5.	3,8	25,1	3,1	9,1	0,3
6.	3,9	31,6	3,6	10,6	0,4
7.	4,1	39.8	3.8	16.4	0.6
8.	5.9	53.1	4.3	21.0	0.7
9.	6.2	60.5	4.9	22.2	0.7
10.	6.3	68.2	5.8	25.4	0.7

B. Data analysis

Based on the research obtained, data analysis was carried out in a gradual and thorough manner. The data obtained from this study include:

- Testing on the generator, how much voltage is generated by a generator whether the generator is working properly so that it can produce an electric voltage.
- Test the current generated by the generator.
- Test the wind speed to potentially turn the turbine.

Below I will show a graph of the overall tool testing results

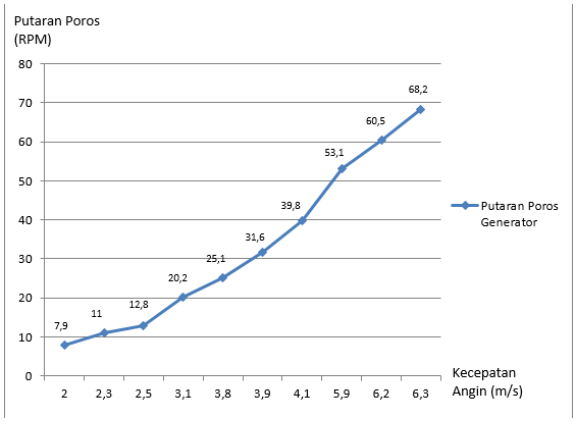

Figure 4. Graph of RPM Relationship and Wind Speed

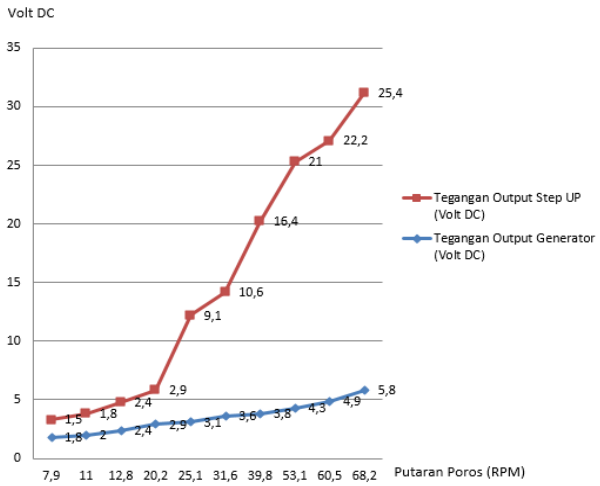

Figure 5. Voltage Increase Result Graph

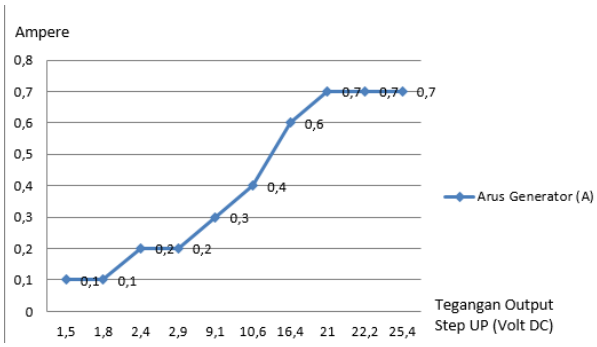

Figure 6. Generator Flow Chart

C. Speaker

In this study the helix savonius wind turbine will rotate when the wind speed reaches 2.0 m/s which can rotate the generator shaft reaching 7.9 RPM to produce a voltage of 1.8 Vdc. The step up starts working optimally when it gets an input voltage of 3V, the wind speed reaches 3.8 and the generator shaft reaches 25.1 RPM.

p-ISSN 2715-2871
e-ISSN 2714-5247

From the test data obtained, the highest voltage obtained is the generator output of 5.8 Vdc the step up to 25.4 Vdc

The voltage released by the MPPT will enter the 38 AH battery and start charging automatically. At the output for connecting the load (PJU) this MPPT can be set according to the desired hour so it is suitable for public street lighting. There is additional equipment, namely a photocell to maximize the savings in the required load that is issued, because the function of the photocell itself is a light sensor.

The results of calculating the rate of the battery charging path by taking the average data from the generator current are as follows:

Is known
V = 14 volts
I = 0.4 ampere
T = 24 hours = 86400 seconds
Asked W?
Answer: W = VIT = 14 x 0.4 x 86400
= 483840 J : 1000 = 483.84 KJ = 134.4 WH

The results of the calculation of the length of the 38AH battery can back up the 30 watt PJU lamp load
P = V x I I = Current (A)
V = P / I P = Power (Watts)
I = P / V V = Voltage (Volts)
Is known.
30 watts load
12 volt, 38 Ah. battery
So.
I = 30 W : 12 V = 2.5 A

Usage time : 38 AH : 2.5 A = 15.2 hours – battery efficiency is 20%
= 15.2 hours – 3.04 hours
= 12.16 hours = 12 hours, 9 minutes, 36 seconds.

IV. CONCLUSSION

Based on the results of the design and testing that has been completed, the following conclusions can be drawn:

1. The faster the wind gusts, the greater the voltage generated, from the results of testing my tool requires a wind gust of 3.8 m/s, the generator shaft rotation is 25.1 RPM, which produces a voltage of 3.1 V, the new step up can work optimally.
2. The advantage of this helix savoinus wind turbine is that it is easier to catch wind gusts from all directions so it is very appropriate to be applied in the Tambakrejo village, Sumbermanjing sub-district, Malang.

REFERENCES

[1] Adityo Putranto et al. 2011. Design of Vertical Wind Turbine for Household Lighting. Semarang.

[2] Ahmad Farid. 2013. Optimization of the Savonius Wind Turbine Prototype with Variations in Gap and Change in Number of Blades. Pancasakti University, Tegal.

[3] Alfianto, Achmad. "Solar Power Plant Planning with Tile Modification for Solar Panel Installation." *BEST: Journal of Applied Electrical, Science, & Technology* 3.2 (2021): 20-24.

[4] Bilalodine and Sugito. 2010. Optimization of Wind Turbine Prototype Using Conjugate Gradient Method. Periodic Physics, Purwokerto.

[5] Marizka Lustia Dewi. 2010. Analysis of Vertical Shaft Wind Turbine Work. Surakarta.

[6] Ruzita Sumiati and Aidil Zamri. 2013. Design of Miniature Wind Turbine Power Generation for Learning Media. field.

[7] Firmansyah, Fadli Jaya, Arman Suryono. 2014. Battery Charger System by Utilizing Wind Energy Sources For Battery Charging.

[8] F. Eko Wismono Winarno. 2013. Potential HYBRID Power Generation Using Vertical Axis Wind Turbine Savonius type and Solar Panels.

[9] Mochammad MR, et al., 2013. Wind Power Generation System Using Vertical Axis Windmills for Residential Loads. Ten November Institute of Technology, Surabaya

[10] Pramana, Yanatra Budi, et al. "Manufacture of Solar Panel with 300W Inverter for Household Electricity Needs." *Tibuana* 5.01 (2022): 41-45.

[11] Rudianto, Daniel T., 2013. Analysis of Savonius Wind Turbine Characteristics Using Initial Parameter Method. STTA Internal Research Report, Yogyakarta.

[12] Rochman, Sagita, and Mochamad Taufiq Irvan Efendy. "Arduino Based Design of Horizontal Wind Power Generator for Coastal Road Lighting." *BEST: Journal of Applied Electrical, Science, & Technology* 3.1 (2021): 30-33.

[13] Rochman, Sagita. "DESIGN OF VERTICAL AXIS SAVONIUS WINDMILL FOR GENERATING ELECTRICITY USING PERMANENT MAGNET." *Tibuana* 3.01 (2020): 61-66.

[14] Rochman, Sagita, and Andy Hermawan. "Design and Construction of Screw Type Micro Hydro Power Plant." *BEST: Journal of Applied Electrical, Science, & Technology* 4.1 (2022): 21-26.

[15] Sembodo, Budi Prijo. "Rancang Bangun Generator Turbin Angin Putaran Rendah Sebagai Pembangkit Energi Listrik Alternatif Di Daerah Pesisir." *Wahana: Tridarma Perguruan Tinggi* 70.1 (2018): 25-34.

[16] Sujiwa, A., Atmiasri, A., & Purwanto, E. SISTEM KONTROL EFISIENSI DAYA OTOMATIS PADA PERANGKAT PROTOTIPE DESALINASI DUAL OUTPUT BERTENAGA SEL SURYA.

[17] Sujiwa, A., & Santoso, I. (2022). Automatic Coffee Maker Machine Based on Internet of Things (IoT). BEST: Journal of Applied Electrical, Science, & Technology, 4(1), 1-1.

[18] Sumiati, R., 2012. Testing of the Three Blade U Savonius Wind Turbine at the Freshwater Beach Location of Padang. Journal of Mechanical Engineering State Polytechnic Padang

[19] Winarno, Adi, and Mahfud Affandi. "Design and Construction of Smart House Prototype Based Internet of Things (Iot) Using Esp8266." *BEST: Journal of Applied Electrical, Science, & Technology* 4.1 (2022): 11-14.

[20] Zulfikar et al., 2011. Experimental study of the effect of the number of blades on the torque and rotation of the Savonius Type U turbine. Journal of Mechanical Engineering State Polytechnic Padang