Vertical Axis Wind Turbine at WVU Tech

Alex Perry, Tavon Johnson
Undergraduate Mechanical Engineering Students

Farshid Zabihian
Assistant Professor
West Virginia University Institute of Technology
Montgomery, WV, USA
Email: acperry@mix.wvu.edu, tajohnson@mix.wvu.edu, farshid.zabihian@mail.wvu.edu

Abstract

This project was initiated to study the effects of West Virginia's topography on wind energy and how Vertical Axis Wind Turbine (VAWT) could be utilized to harness energy that may otherwise be lost by conventional horizontal axis turbine designs. It was determined the best route would be to experimentally analyze a VAWT. To do this analysis, the team evaluated potential purchasing options for a pre-designed VAWT kit. The kit has been purchased and is currently undergoing construction. Upon completion of construction, mounting will occur and analysis will be done of energy generated.

INTRODUCTION

In the 1940s, prototypes for large wind turbines were being developed in efforts to produce large amounts of energy [1]. The most common wind turbines currently available are Horizontal Axis Wind Turbines (HAWTs). These turbines are good for "wind farms", which generally consist of a large flat area with multiple HAWTs [2]. However, horizontal axis turbines have shown a significant decrease in energy production when utilized in urban and residential environments [3].

As of now, there are limited resources on VAWTs; experimental studies are needed to determine what factors contribute to their failure. It also needs to be better determined what needs to be done to prevent them from stalling at low wind speeds. In general, more information needs to become available before companies decide if they want to invest in VAWTs.

The team investigated the costs and energy benefits for horizontal axis wind turbines in comparison to vertical axis wind turbines. The team decided to take the next step to design and fabricate a Vertical Axis Wind Turbine.[4] The installation of this turbine will help to better determine the reliability of VAWTs.

A design was created, but after reviewing the design and available resources, the team decided to take a different route and purchase a pre-designed VAWT kit. This kit will need to be assembled and mounted. Once constructed, the team will conduct experimental analysis on the VAWT. The specific type of experimental analysis will be determined after the construction of the wind turbine.

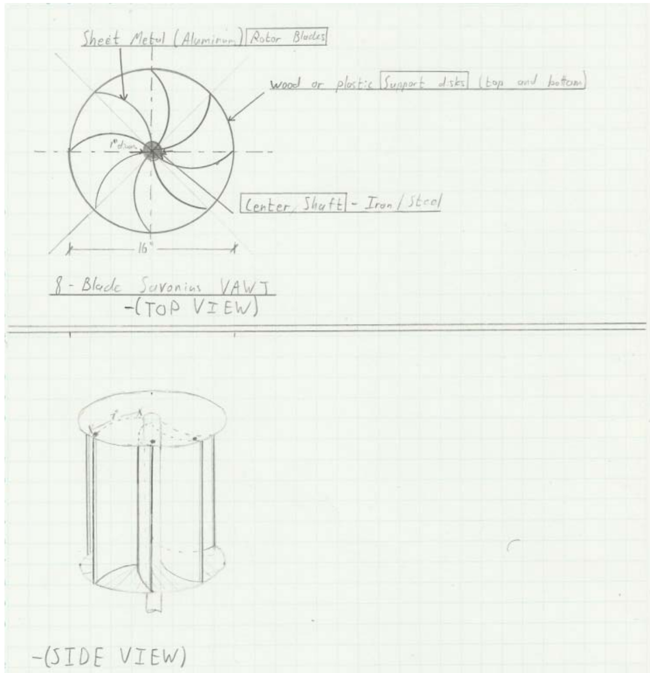

Figure (1): Original proposed design before being modified to have four blades

The original proposed design was to build an 8-blade Savonious turbine (Figure 1). After consideration of the feasibility of having eight blades, the team decided that it would be more practical for their applications to use a 4-blade design. However, the team came to this decision after it was determined that they would purchase a kit.

After making the decision to purchase a VAWT kit, the team determined that the turbine could be mounted onto the roof of the Leonard C. Nelson Engineering building next to the existing HAWT.

The purchase of this turbine will give the team the ability to experimentally compare the efficiency between the vertical and horizontal axis turbines in identical wind conditions. Having identical wind conditions will allow the team and future students to accurately determine which turbine is more effective in this region.

METHODS

The team has chosen to purchase the Lynx Wind Gull 160 as their preferred option for experimental analysis. The turbine has a depth of 40” and a height of 40”, and will be mounted on a ten foot pole with a 1.5” diameter. The start-up speed of this VAWT ranges from 0.447 m/s - 0.894 m/s. Output is 10-15 watts at 4.47 m/s and 185 watts at 12.52 m/s.

Figure (2): Lynx Wind Gull 160 VAWT

While no experimental analysis has been done at this point in the project, there are plans to attach the turbines DC connectors to a 12 Volt battery to regenerate its power. This will be performed by feeding the wiring through a rectifier circuit. Additionally, there will be an experimental phase dedicated to using a grid tie inverter to convert the DC current into an AC current. This will allow the turbine to generate current that can be used to help power a building.

An experiment will be conducted to determine the turbine blade RPM, as well as the tip speed ratio (the ratio between the tangential speed of the tip of a blade and the actual velocity of the wind).

If this experimentation is successful, it is probable that more turbines will be placed on the WVU Tech Campus and surrounding area to provide more opportunities for future research.

BUILD PROCEDURE

The protective coating was removed from the CNC cut parts and with the usage of sandpaper, excess flash was removed from the parts. The spars were then fitted into the blades, which were in turn fitted into the rotor. After fitting the blades, a layer of caulk was added to create a seal and protect from moisture entering the blade assembly. The blade tips were then bolted to both sides of the assembly and caulked into place.

Figure (3): Caulking process of turbine rotor blade

After the caulking process, the blades must be primed and coated on a day with dry, non-windy weather conditions. Final assembly must occur on the roof due to the blades wide wingspan. After completing construction of the turbine, it will be mounted to a support pole. After mounting, the turbine will be ready for the planned analysis.

CONCLUSION

While the team has not reached its primary objective to analyze the efficiency of a VAWT in comparison to a HAWT, steps have been taken to ensure that this analysis is still attainable for future research. These efforts include proper documentation of all research and progress, as well as access to the instruction manual of the partially assembled turbine.

Wind can play a critical role in the state's future as a sustainable energy source. In an ever-changing economy, the state has a great opportunity to better utilize its natural resources. Wind turbines create the perfect opportunity for the state to meet its energy goals at a low long-term cost [6]. Companies that currently invest in wind technology have taken advantage of West Virginia's high elevations in the eastern part of the state to produce energy thus far, but a new frontier is on the horizon [7].

REFERENCES

[1] Union. *Union of Concerned Scientists: How wind energy works*. n.d. Web Article. 6 Febuary 2014..

[2] Daily, Science. *Science Daily: Bold new approach to wind 'farm' design may provide efficiency gains*. 20 July 2011. Web Article. 6 Febuary 2014

[3] Miles, Charles. *Survey of Urban Wind Energy Technology: http://extension.ucdavis.edu/*. October 2006. PDF. 6 Febuary 2014.

[4] Johnson, Tavon, Alex Perry and Andrew Thaxton.

"Application of Vertical Axis Wind Turbines in West Virginia" N.p., n.d. Web. 2 Nov. 2014.

[5*] Lynx Wind: Gull 160 Turbine*

http://www.lynxwind.com/gull-160.html

Retrieved 27 Nov. 2014

[6]*"Wind Energy: A West Virginia Business Opportunity."*

Wind Energy: A West Virginia Business Opportunity. N.p., n.d. Web. 17 Oct. 2013.

[7] *"Vertical Axis Wind Turbines."* WIND-WORKS:

Details. N.p., n.d. Web. 30 Nov. 2013.