Maximizing Energy Capture in Low Wind Speed Environments

Dr. Hazel Marie – Mentor

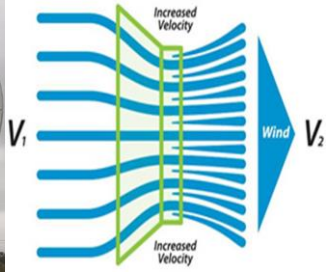
Amber Deming, Alexandra Eisenhart, Efrain Velez, Joshua Westhead, Kevin Yacucci

Abstract

Using a 3D-printed model of a wind turbine shroud, we tested whether a shroud can increase the wind speed by acting as a standing airfoil to maximize the energy capture of low wind speed environments. An experiment was performed in a low speed wind-tunnel to measure the experimental increase in wind velocity. This data showed an increase in airspeed of up to 1.65 times that of the downstream airspeed. Energy data from a full-size, shrouded wind turbine was collected to determine the percentage of energy that can be captured compared to the actual wind speed. The data collected from the full-size, shrouded wind turbine was then compared to that of a similarly-sized standard wind turbine.

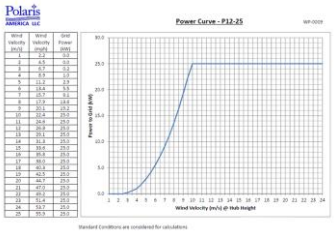
How a Shroud Works

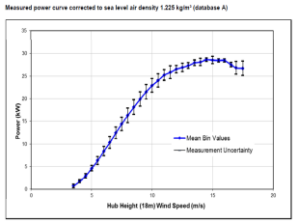
The shrouded wind turbine is the more advanced version of the conventional wind turbines with the addition of a surrounding component that holds the blades inside. The shroud works on the same principle as that of a jet engine. A shroud increases the speed of the blades thus producing significant power augmentation. Shrouded wind turbines use lenses to create low-pressure vortices that produce more air, increasing wind speed, and thus creating more wind power. In a shrouded turbine air moves through a hole, and more wind power is gained rather than lost by going around the blades in a traditional turbine. These engineering marvels have proved themselves to be energy efficient, friendlier to wildlife, safer, more durable, space efficient, and less noisy than their predecessors.

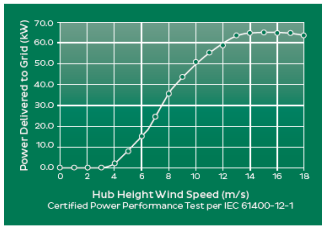


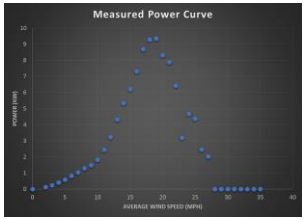
Field Study

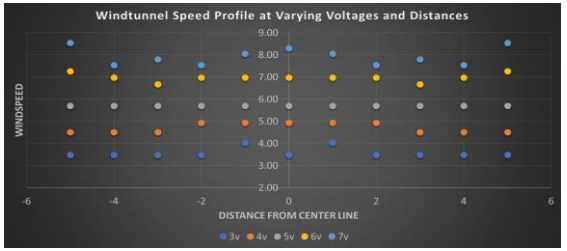
When comparing the 25-kW shrouded turbine from Green Energy Technologies with other projects, the characteristics considered were rotor diameter and power rating. The power output is directly proportional to the size of the rotor, and power rating was also considered because that is the most power a turbine can generate while still being stable. Power curves will be featured for a 25 kW standard wind turbine from Polaris America, and two other standard turbines – a 25 kW turbine called the Solid Wind Power SWP25 Power, called the Endurance E Series E3120-4. The last two benefit from being tested under IEC 61400-12-1 power performance test standards, which is a standard used across the industry,

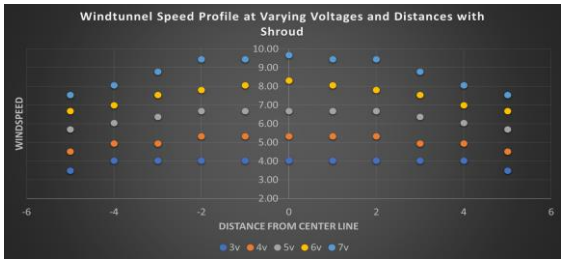




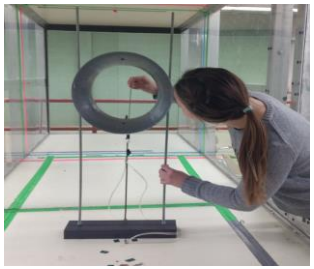


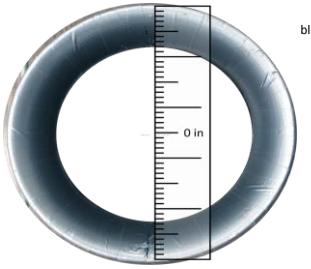






Our Experiment





Advantages of a Shroud

The use of a shroud on a wind turbine can be very useful. A shroud increases the wind speed going past the blades of the turbine. This lowers cut in speed for a turbine, therefore making a wind turbine usable in a low wind speed area. The increase in wind speed also increases power output and efficiency of a wind turbine.

Wind Projects Completed and Operating in Ohio

Formulas Used

Inches of water to Pascals $248.84 * P_{in}H_2O = P_{Pa}$

Wind speed (meters per second):

Wind speed (m/s) =

Density of air (Constant): 1.225 kg/m3

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