Team 25: Taller Wind Turbine for Low Wind Speed Regions

Steven Blanchette, David Delie, Kimberly Martinson, Jeremiah McCallister, Abigail McCool, Theodore Meros
FAMU-FSU College of Engineering

Abstract

Current wind turbines are not effective to use in Florida because the average wind speed is too low to provide adequate power. This problem has led to the need for a taller wind turbine that can be used in low wind speed regions. In order to produce a taller turbine the team has two main focuses, the tower and the blades. After considering several alternatives the team has selected the final designs of the blades and tower.

Background

The most common wind turbine used in the united states is 80m tall. These turbines generate 1-2MW of electricity at wind speeds of 8-10m/s. Unfortunately, the southeast United States only has wind speeds of 4-5m/s at this height. Due to fact that wind velocity increases with increasing altitude, it desirable to design a taller wind turbine that can harness the larger wind speed that comes with an increase in altitude.

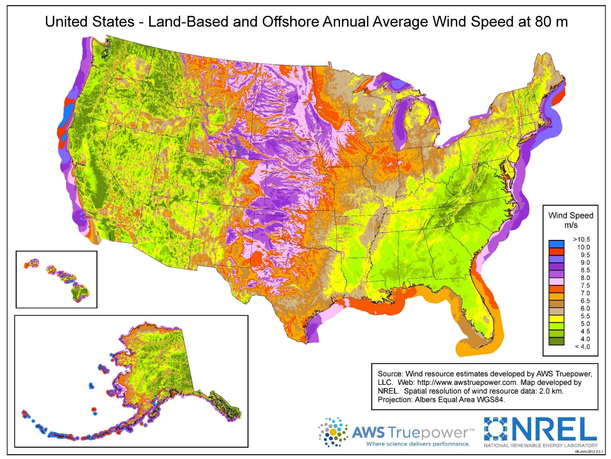

Figure 1. Wind Velocities at 80m

This project is sponsored by the FAMU-FSU College of Engineering and lead by Dr. Sungmoon Jung. Dr. Jung wants the group to focus on using new turbine blade and structural materials that will allow for a new, cost-effective wind turbine to be built in Florida.

Objectives and Constraints

"Current 80 meter wind turbines are not cost-effective for use in the Southeastern U.S."

- Design a wind turbine 150-200% the height of current wind turbines
- Design lighter blades
- Use NREL 5MW generator in design
- Build scaled prototype using $2,000 budget

Tower

- Seven-sided steel lattice tower wrapped in an architectural fabric
- Height: 157.5m
- Typical column: HSST 14X14
- Typical bracing: HSST 10X10
- Optimized tower design for material efficiency
- Majority of tower is preassembled
- Tower base is assembled on site
- Transported by standard semi-trailers

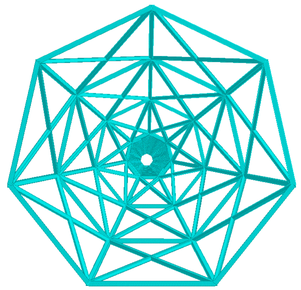

Figure 2. Plan View of Tower

Figure 3. Tower Profile

Blades

- Fabric wrapped wind turbine blade: NACA 64 airfoil
- Length: 61.5m
- Outer fabric made of E-glass reinforced with carbon fiber coated with epoxy
- Styrene Acrylonitrile (SAN) foam used for core
- Triple post bracing beam made of aluminum 6061

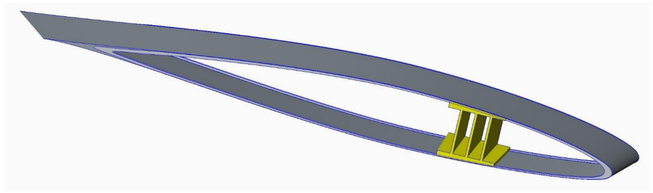

Figure 4. Triple Post Bracing Beam Design

Figure 5. NACA 64 Wind Turbine Blade

Possible Location

- The best locations to put our proposed wind turbine would be north of Mariana and southeast of Lake Okeechobee.
- Mariana is one of the highest altitude areas of Florida so wind speeds will naturally be higher.
- South of Lake Okeechobee has one of the highest on-land wind speeds in the state. These high speeds result from the sea-breeze it experiences so it is a good choice for commercial wind farms.

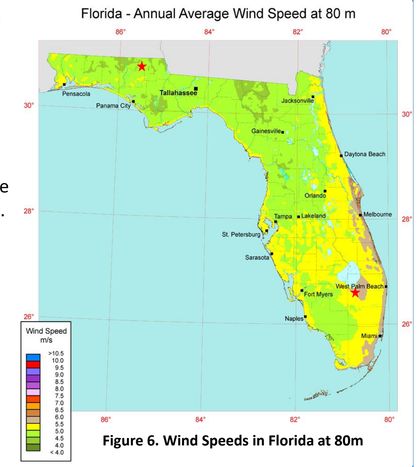

Figure 6. Wind Speeds in Florida at 80m

Prototype

- $2,000 Prototype Budget
- The team will be building a scaled down prototype that fits within the budget.
- Plans are to construct a prototype that consists of an 8ft steel tower with 3ft long turbine blades cut from foam.
- The steel will be obtained from a local metal supplier and the foam and blade fabric will be purchased

Conclusions and Future Work

Over the course of the semester numerous tower and blade designs were developed and analyzed. The team has selected a steel lattice structure as the optimum tower and a triple post bracing beam with a E-glass shell as the best blade design. There are two possible locations for the construction of the design in Florida and the team is currently pricing the materials that will be used for construction of the prototype in spring.

In the spring semester the team plans to compare the chosen design to other wind turbines currently in use and optimize the design to best compete with current turbines.

Acknowledgements

The team would like to thank Dr. Jung and Dr. Taira for always being willing to help the team and answer questions, Dr. Gupta and Dr. Helzer for providing guidance on deliverables, and Dr. Hollis and Dr. Powell for helping on the design of the blades and tower.

Contact

Team 25: Taller Wind Turbine for Low Wind Speed Regions
FAMU-FSU College of Engineering
Email: jjm10j@my.fsu.edu
Website: eng.fsu.edu/me/senior_design/2015/team25