The University of Colorado Collegiate Wind Competition Team

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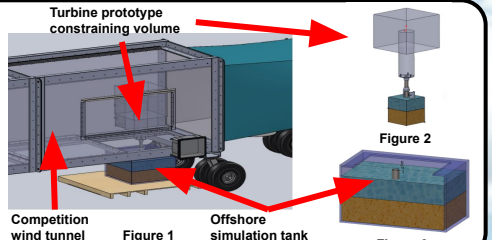
Competition Summary

The Department of Energy Collegiate Wind Competition (CWC) is hosted by the National Renewable Energy Laboratory (NREL) at the 2022 CLEANPOWER conference. Each team creates an offshore wind turbine prototype that is tested in a wind tunnel to determine best design and performance. The purpose of the CWC is to prepare students for the growing wind energy industry with real-world experiences.

Competition Requirements

- The turbine prototype must be designed to withstand continuous winds up to 50 mph at sea level
- The turbine prototype must stay within the constraints outlined in figures 1, 2, and 3



Electrical

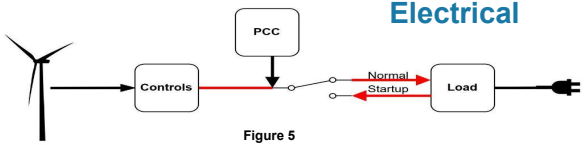


Figure 5

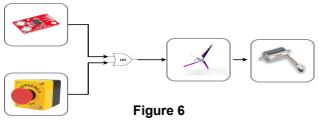


Figure 6

Pitching Servo

- Controls angle of attack of blades
- Activated during E-stop to reduce rotation speed
- Used for curtailment at high wind speeds

Generator

- Converts kinetic energy to electrical energy
- Selection based on minimizing cogging torque and maximizing power output

Rectifier

- Converts 3-phase AC to DC

SEPIC

- Converts varying output voltage from generator into a steady 5 volts
- Used to power microcontroller, E-stop, pitching servo

Microcontroller

- Controls pitching servo, monitors and executes E-stop, reads power output, controls mode switch

Mode Switch

- Controls source power from the load during startup and sink power during normal operation

Emergency Stop

- Shorts terminals of the generator and pitches blades

Variable Resistance

- Byte representation of resistors makes it possible to have 256 different resistance values (parallel combinations)
- Resistor values chosen as power of 2

Software

- Resistance is calculated to sink max power without exceeding generated power (which produces counter torque)

Mechanical

Pitching Mechanism

Changes the angle of attack of the blades with respect to the wind

Blades

NACA 4412 aerofoil, 3 blade designs for different RPMs (1200, 1500, 1800)

Tower

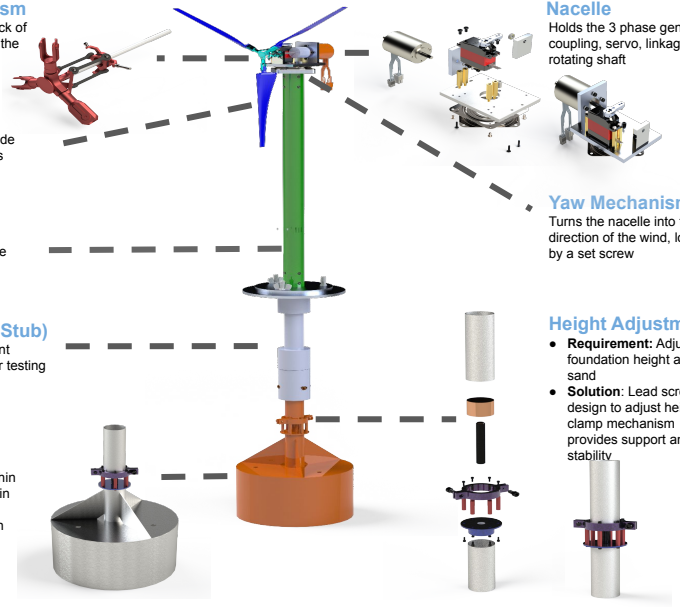
Fiberglass tower to provide structural stability

Transition Piece (Stub)

Reproduction of component provided at competition for testing purposes

Foundation

- **Requirement:** Foundation must fit within an imaginary ~6in x ~6in x ~4in box (WxLxH)
- **Solution:** Upside-down bucket with a ~6in diameter



Nacelle

Holds the 3 phase generator, coupling, servo, linkage, and rotating shaft

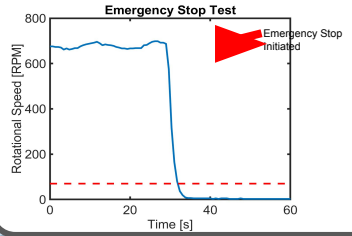
Yaw Mechanism

Turns the nacelle into the direction of the wind, locked by a set screw

Height Adjustment

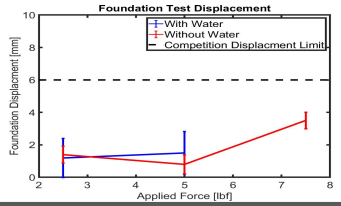
- **Requirement:** Adjust foundation height above sand
- **Solution**: Lead screw design to adjust height, clamp mechanism provides support and stability

Testing



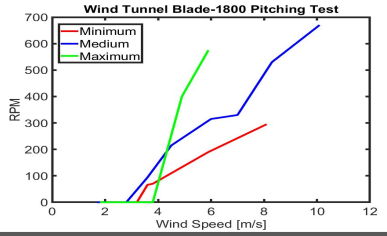
Emergency Stop Test Results

- Turbine rotational speed dropped below the required 10% of nominal operating speed (shown by the dashed red line) in under 10 seconds



Foundation Test Results

- Displacement under ¼ inch (6 mm) requirement for all applied forces in water



Wind Speed Test Results

- Max pitch angle resulted in the highest cut-in speed → ideal for the emergency stop condition
- Min and Medium pitch angles work optimally in 6-25 mph (3-11 m/s) wind speeds → ideal for power output test