Team 25: Taller Wind Turbine for Low Wind Speed Regions

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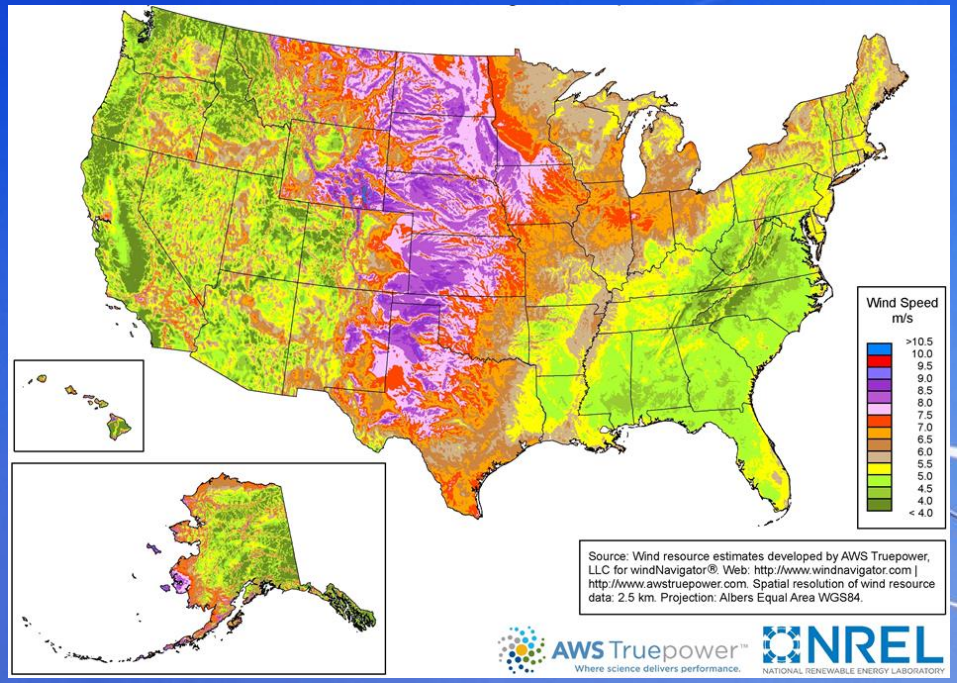
Problem Statement

- Traditional wind turbines are not effective in the Southeastern U.S.



Project Goals

Horizontal Axis Wind Turbines

Current Specs:

- 1-2 MW
- Avg. 80 m hub height
- Blades ~60 m long
- $72/MWh

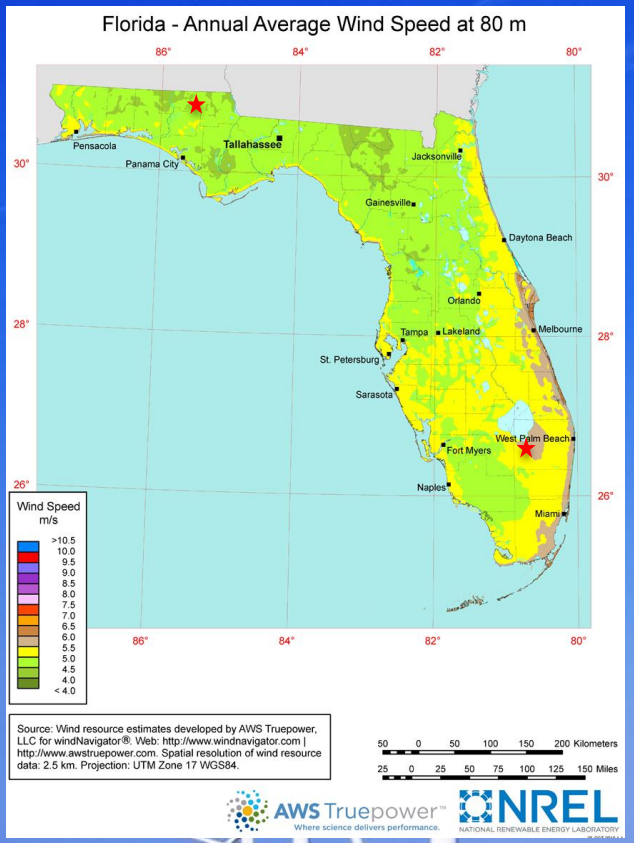
Project Specs:

- 5 MW
- Taller structure (120-160m)
- Design lighter blades of same size
- Budget: $2,000

Early Challenge

- Lack data for wind speed above 80 m
- Consulted with Dr. Powell (COAPS)

$$U_1 = \frac{U_*}{k} ln\left(\frac{z_1}{z_0}\right)$$



Tower Materials

Concrete

- Less maintenance
- Heavy
- Limited transportation

Steel

- High strength/weight ratio
- Easily transported
- Ductile
- Recyclable

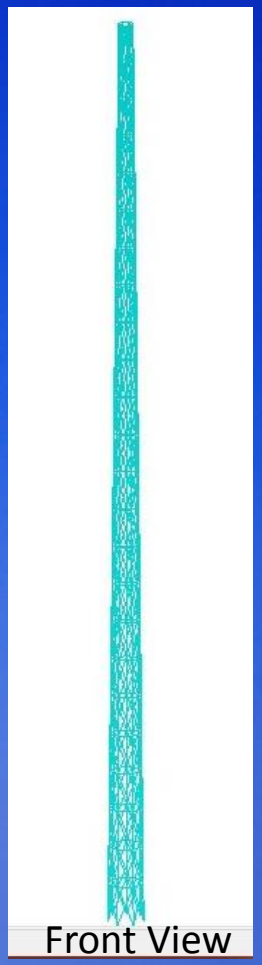
Tower Design

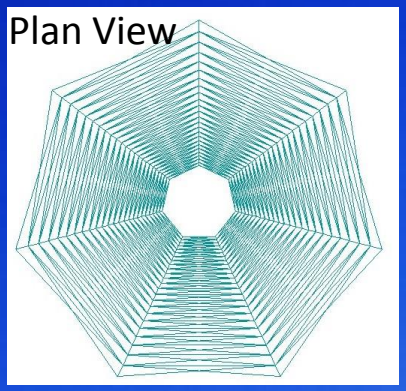
- Steel Tube
  - Most common
  - Very stable
  - Not economical for taller towers

- Space Frame
  - Less material
  - Easily transported
  - On site assembly

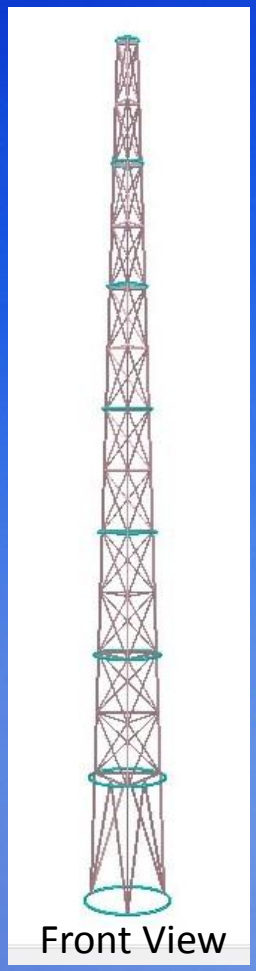
Preliminary Designs

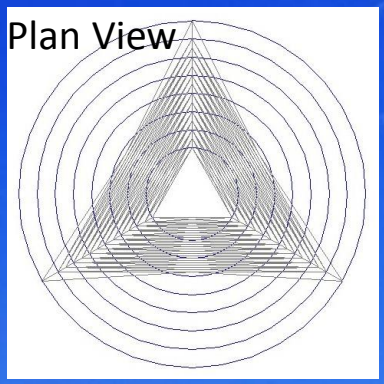
1. Heptagonal Lattice Tower





2. Triangular Lattice Tower

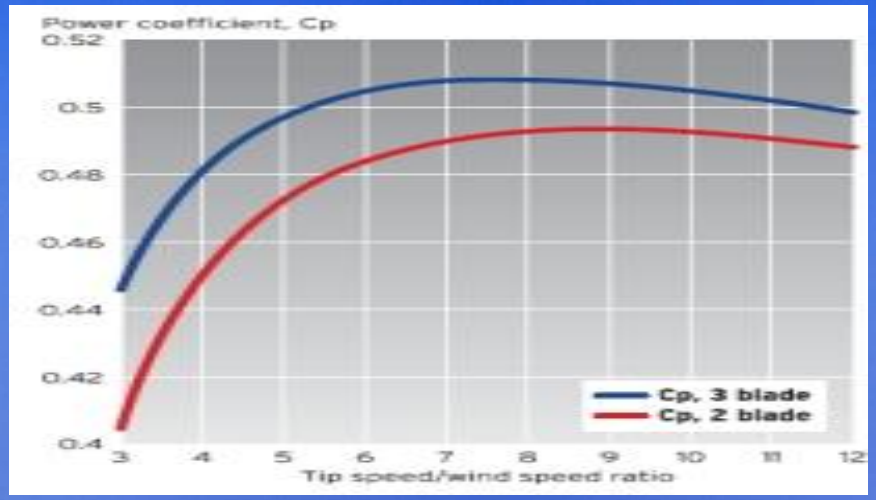




Aerodynamic Performance Analysis

2 Blades

- Lighter turbine weight (~13%)
- Lower gearing ratio needed
- Less balanced
- Louder operation

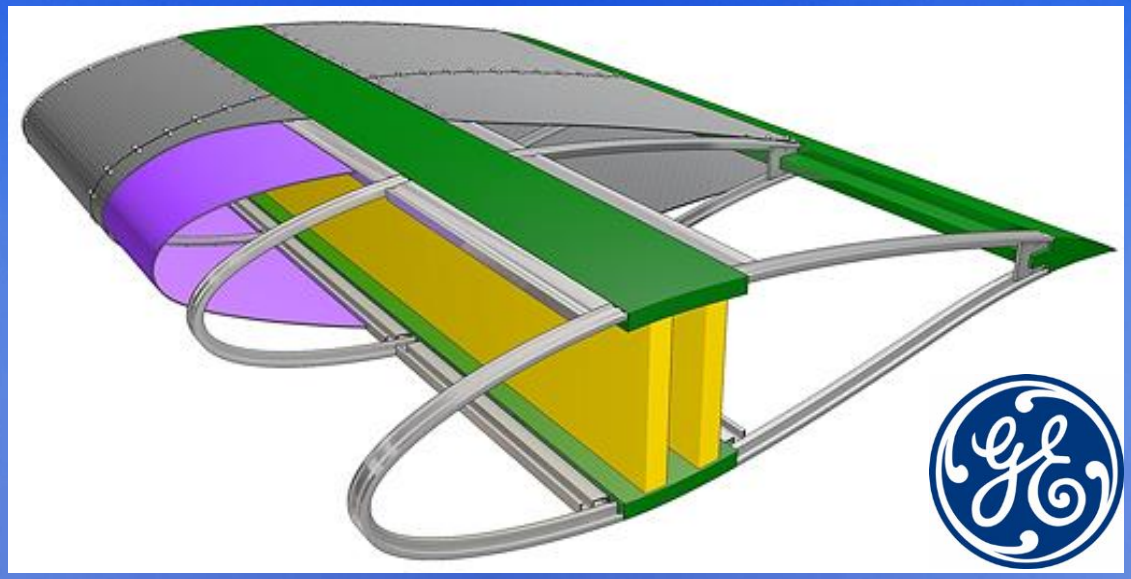


3 Blades

- Increased weight
- More difficult installation
- Restricted airflow
- Faster yaw operations
- More efficient
- Lower noise levels

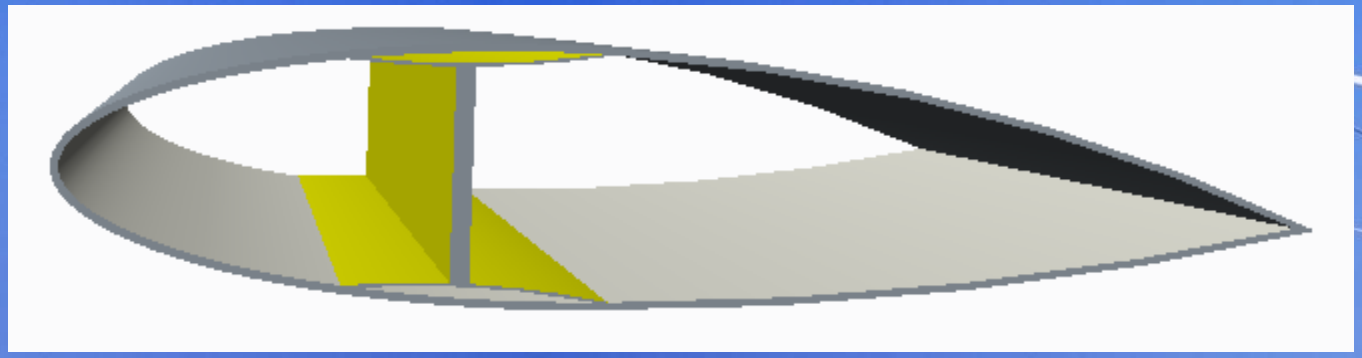
Blade Internal Design

- Contemporary 2 post hollow
  - 2 post structure in middle of blade
  - New materials
- Fabric wrapped



Blade Internal Design

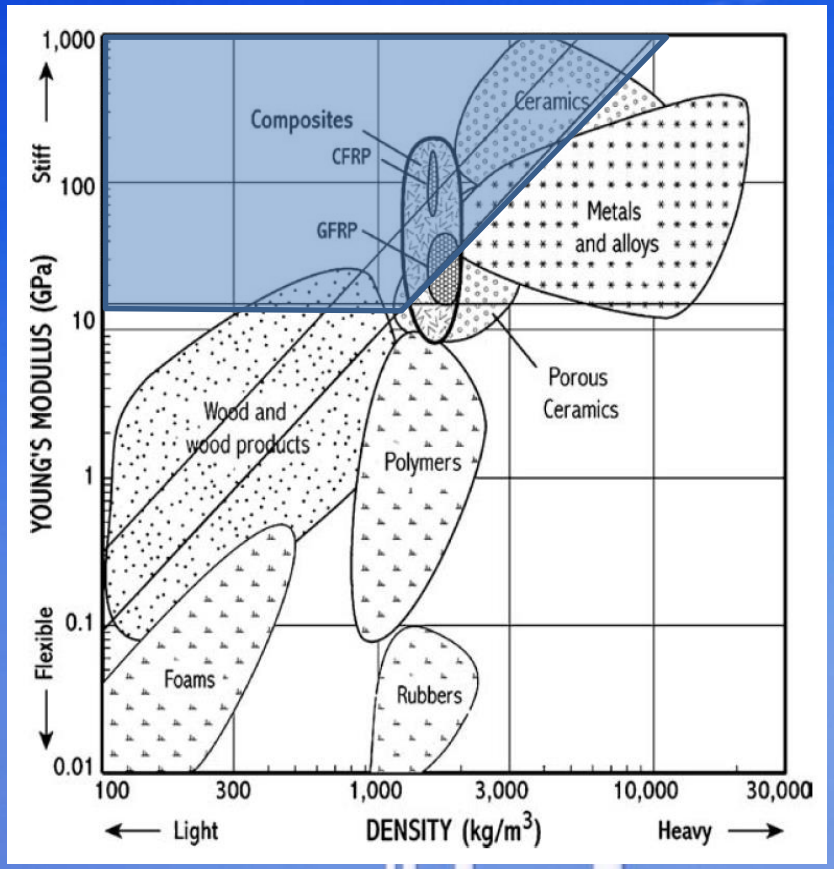
- Single Post Double Shell
  - 1 post structure in middle of blade
  - 2 curved hollow shells
    - Wider support area
  - Less material



Blade Materials

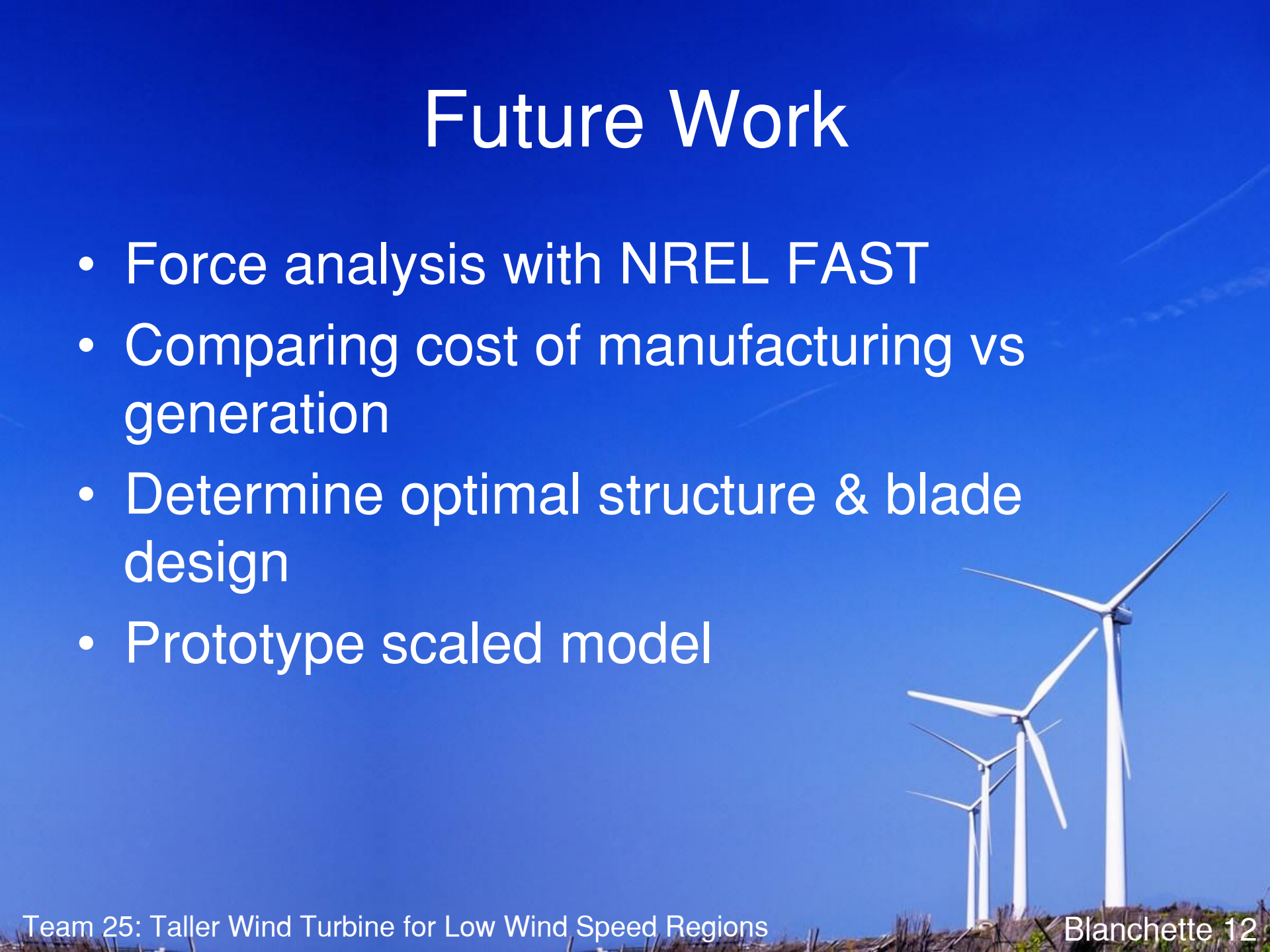
- Fabric Composites
  - Kevlar carbon hybrid
  - Carbon fiber
  - Canvas
- Resins
  - Remove surface roughness
  - Protect from environment

CFRP: Carbon-fiber reinforced polymer
GFRP: Glass-fiber reinforced polymer



Future Work

- Force analysis with NREL FAST
- Comparing cost of manufacturing vs generation
- Determine optimal structure & blade design
- Prototype scaled model



Summary

- Low wind speeds in southeast US inspired desire for taller wind turbine
- Designing a horizontal axis turbine with 3 blades
- Taller lattice tower structure
- Lighter blades
- Currently in design process
- Next Steps:
  - Force analysis
  - Selecting design

References

- Ashby, Michael; 2011; Materials Selection in Mechanical Design, Chp 4, Fig 4.3
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- Team 25 Project Description; FSU Blackboard

Questions?