Team 25: Taller Wind Turbine for Low Wind Speed Regions

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Project Overview

Current 80 meter wind turbines are not cost-effective for use in the Southeastern U.S. due to lower average wind speeds.

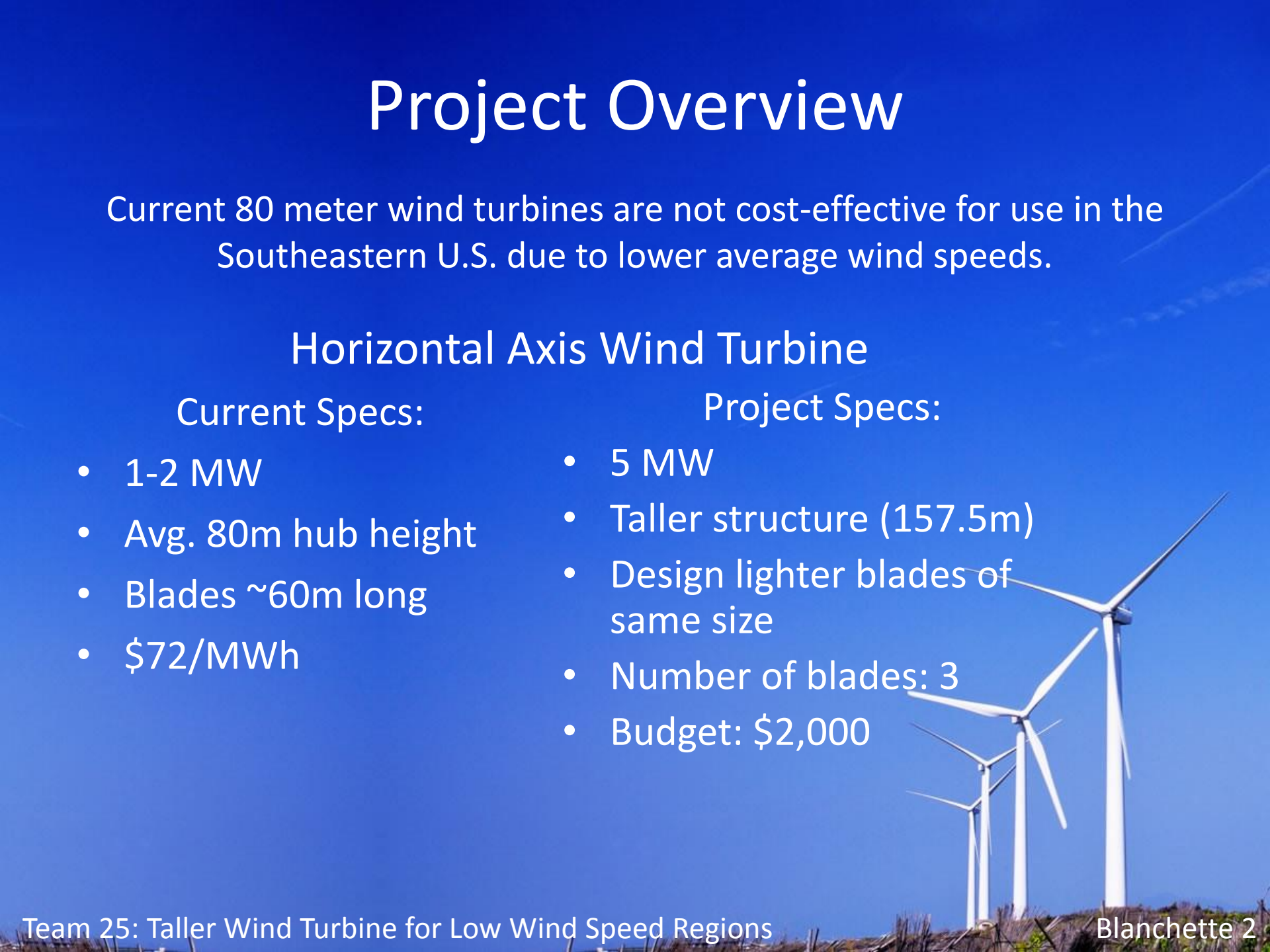
Horizontal Axis Wind Turbine

Current Specs:

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

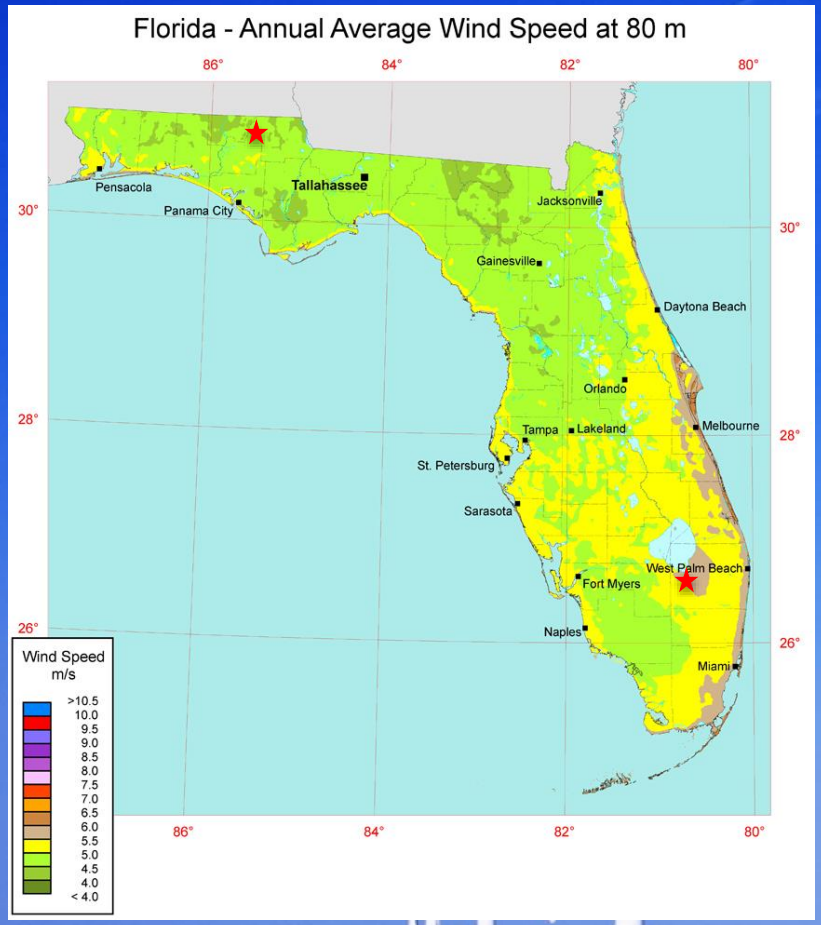
Project Specs:

- 5 MW
- Taller structure (157.5m)
- Design lighter blades of same size
- Number of blades: 3
- Budget: $2,000



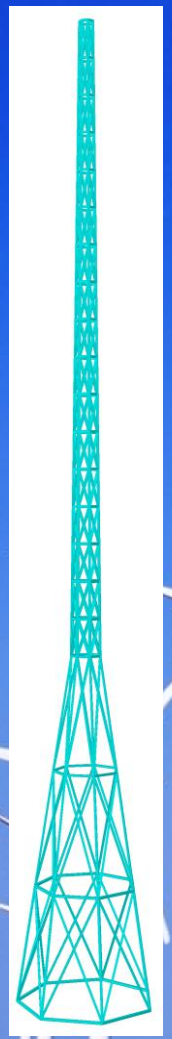
Location Selected

- Compared Locations:
  - North of Marianna
    - Highest elevation in Florida
    - Lower wind speeds
  - Southeast of Lake Okeechobee
    - Lower elevation
    - Highest wind speeds at 80m
    - Selected location



Tower Design

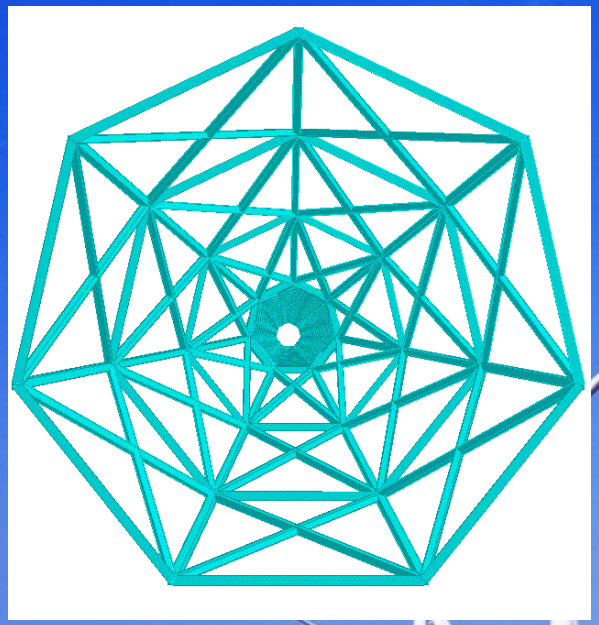
- 157.5m hub height
- Design
  - Bracing: HSST 12x12
  - Column: HSST 14x14
- Total Thrust: 640N
  - Designed: 890N
- Base of tower was widened
  - Adding internal bracing to increase strength & reduce weight



Tower Design

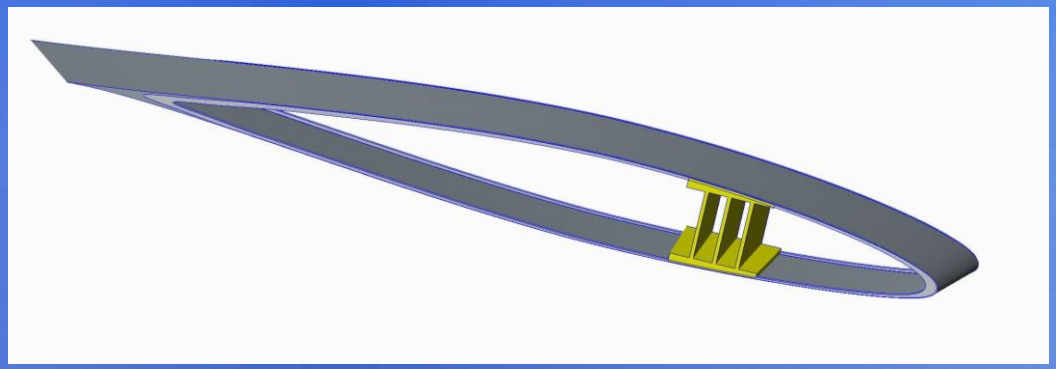
- 7 sides
  - Allows for wider base (restricted by semi trailer size)
- Connection design
  - Modular construction
  - Male-Female plugs
  - Reduce construction time

Bottom View



Blade Design

- Blade Length: 61.5m
- Cross-sectional shape: NACA-64
- Shell Material: E-Glass, 12K Carbon Fiber, Epoxy, Styrene Acrylonitrile (SAN) Foam
- Spar: Triple I-Beam
  - Good distribution of load
  - Lightweight
  - AL-6061

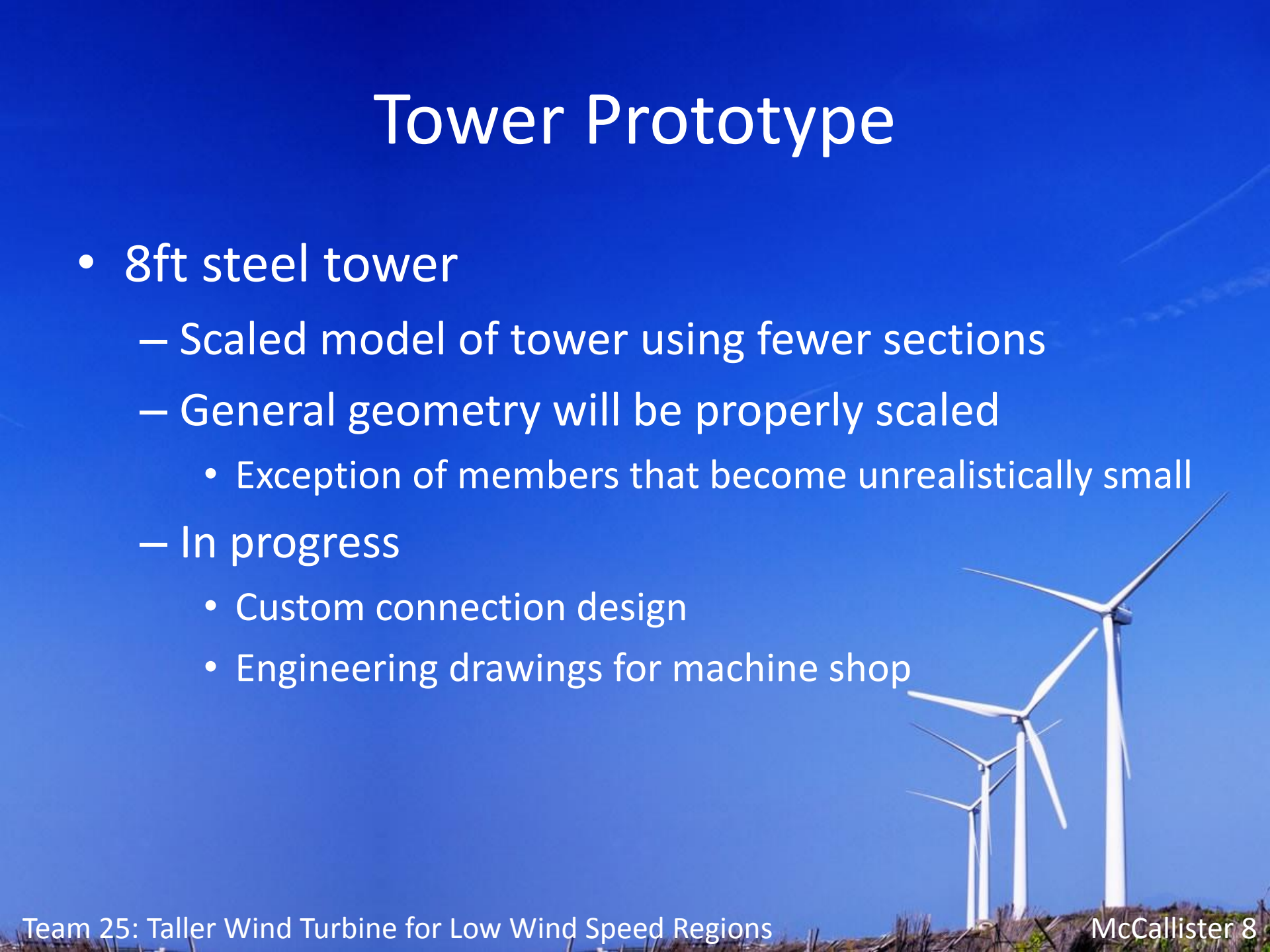


Turbine Assembly

- 225m (740ft) tip height
- 123m (404ft) swept diameter
- 11,875m^2 (128,000ft^2) swept area

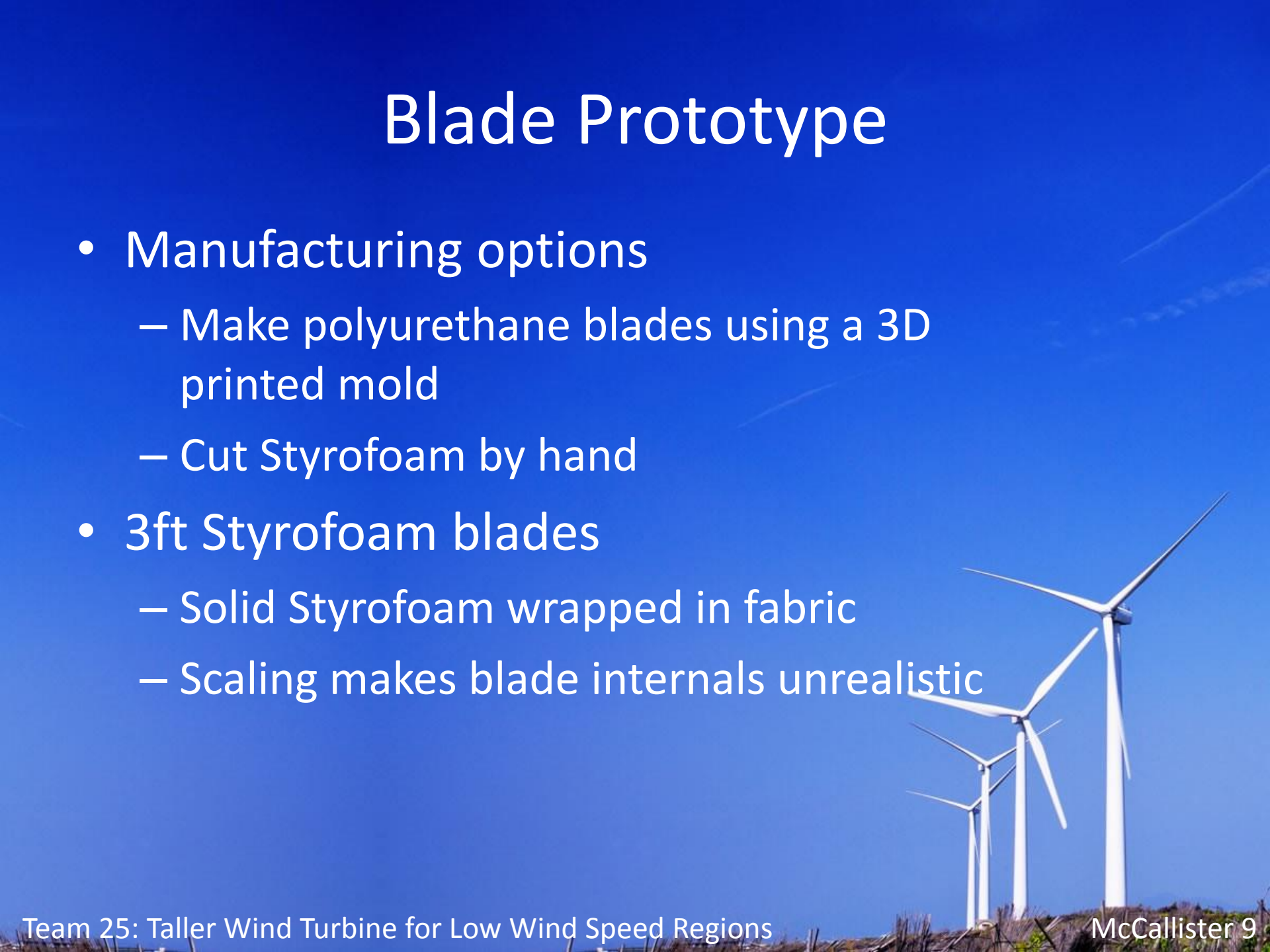
Tower Prototype

- 8ft steel tower
  - Scaled model of tower using fewer sections
  - General geometry will be properly scaled
    - Exception of members that become unrealistically small
  - In progress
    - Custom connection design
    - Engineering drawings for machine shop



Blade Prototype

- Manufacturing options
  - Make polyurethane blades using a 3D printed mold
  - Cut Styrofoam by hand
- 3ft Styrofoam blades
  - Solid Styrofoam wrapped in fabric
  - Scaling makes blade internals unrealistic

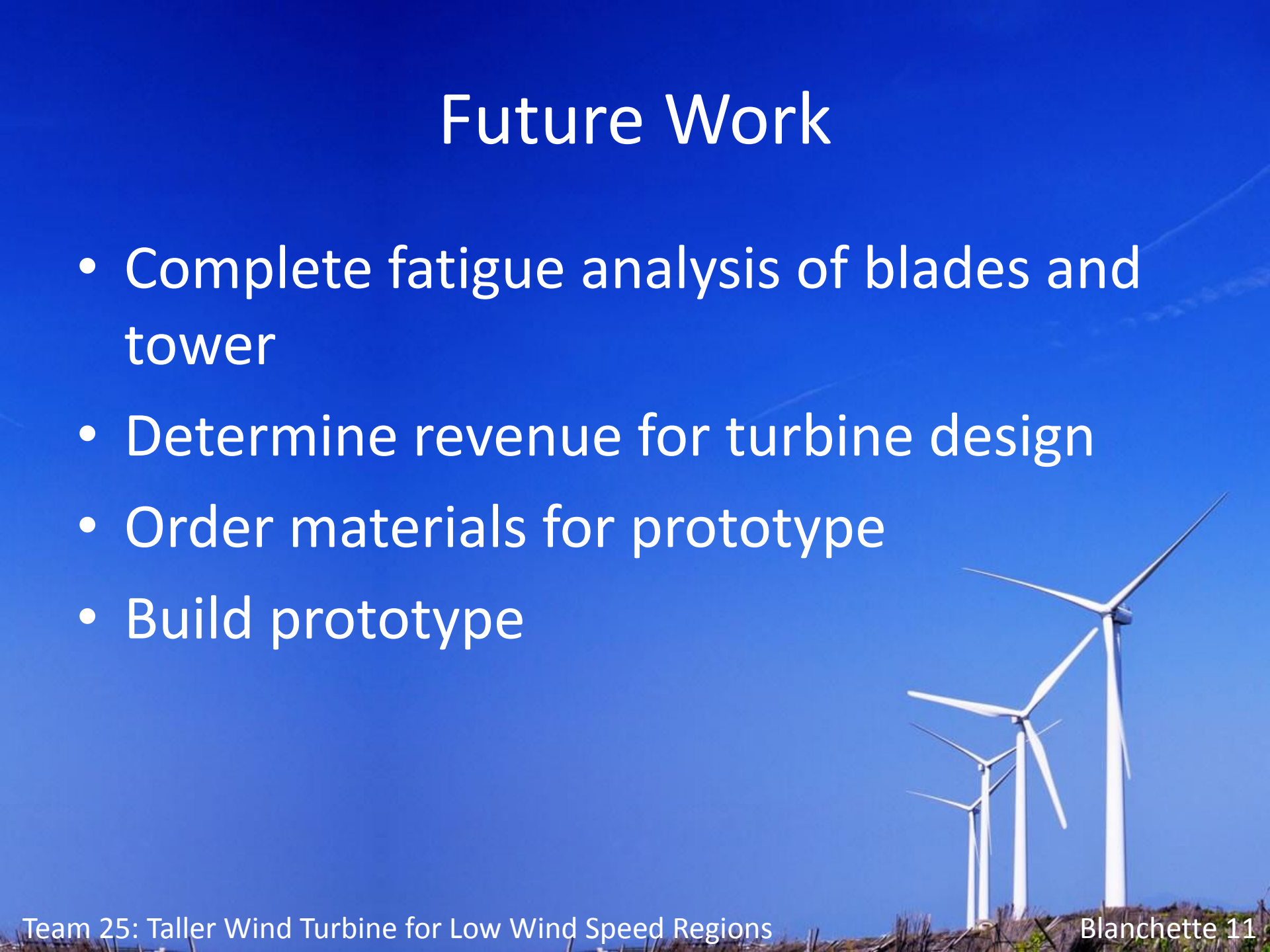


Revenue Calculation

- Obtaining wind data
  - Hourly wind data of 2014
- Calculate power generated from wind speeds
- Cost: 12 cents/kWh
- Comparing to ordinary turbine data
  - Colorado

Future Work

- Complete fatigue analysis of blades and tower
- Determine revenue for turbine design
- Order materials for prototype
- Build prototype



Summary

- Low wind speeds in southeast US inspired desire for taller wind turbine
- Final designs were chosen for tower structure and blade design
- Currently getting quotes for purchasing
- Next Steps
  - Turbine Analysis
  - Obtaining materials
  - Building prototype

References

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- http://www.gettyimages.com/detail/news-photo/aerial-view-of-field-taken-from-goodyear-blimp-above-news-photo/457716040
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Questions?