

CWC23: Small-Scale Offshore Wind Turbine

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Mechanical Engineering Senior Design 2023
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Introduction

The **2023 Collegiate Wind Competition (CWC)**—hosted by the U.S. Department of Energy—tasks teams to design a small-scale wind turbine with a fixed-bottom, offshore foundation that can withstand wind speeds up to 22 m/s. Scoring is based on:

- Power production and control
- On-command safety stop
- Foundation durability

Our Winning Strategy

Power Production and Control

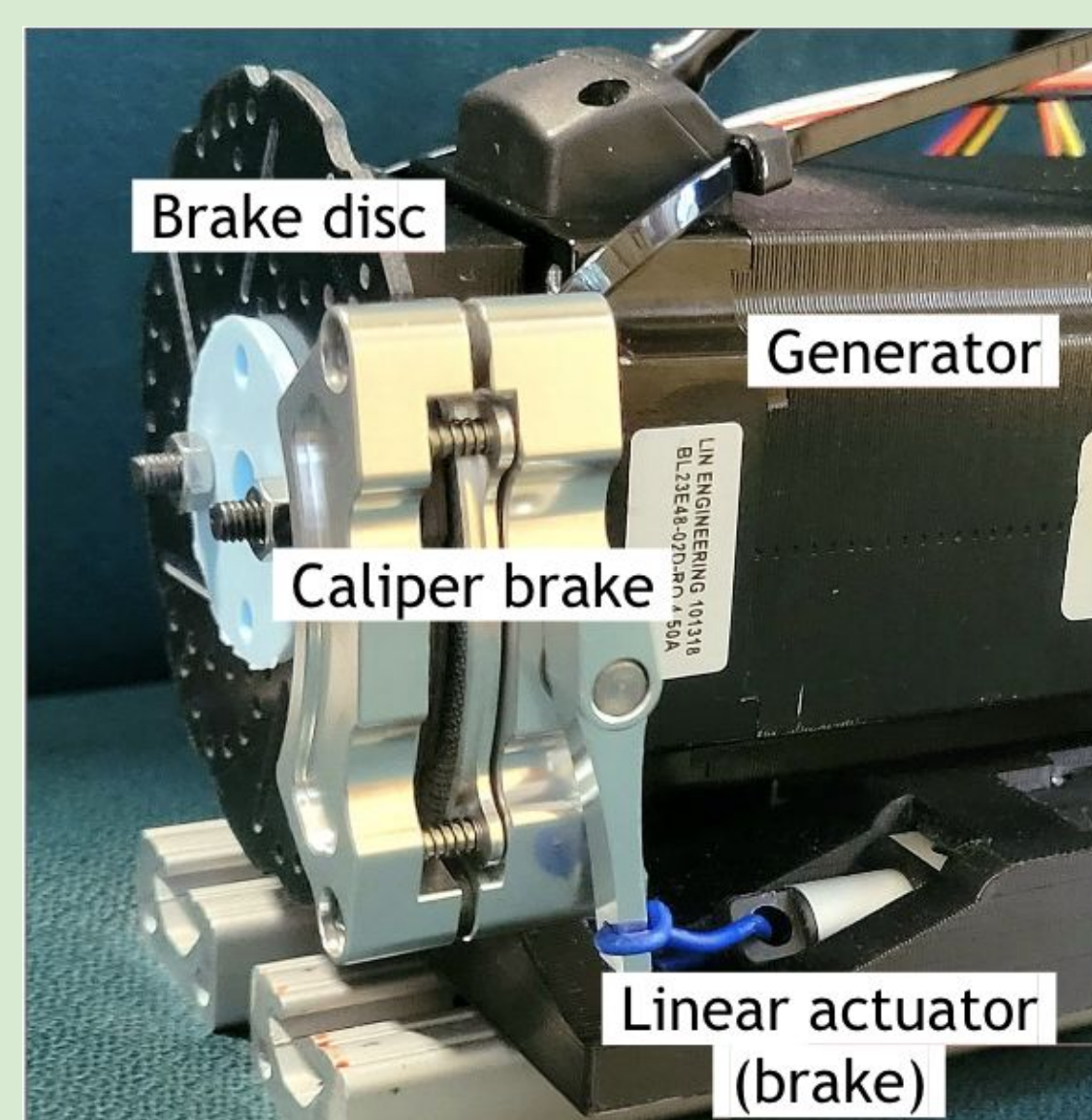
- **Custom blades** feature a high-performance airfoil at the tip and a thicker airfoil at the base for structural integrity
- **Active control** of blade pitch angle and generator load resistance maximizes power output from 5 - 11 m/s and maintains constant power from 11 - 14 m/s
- **Pitot tube** measures wind speed data

On-Command Safety Stop

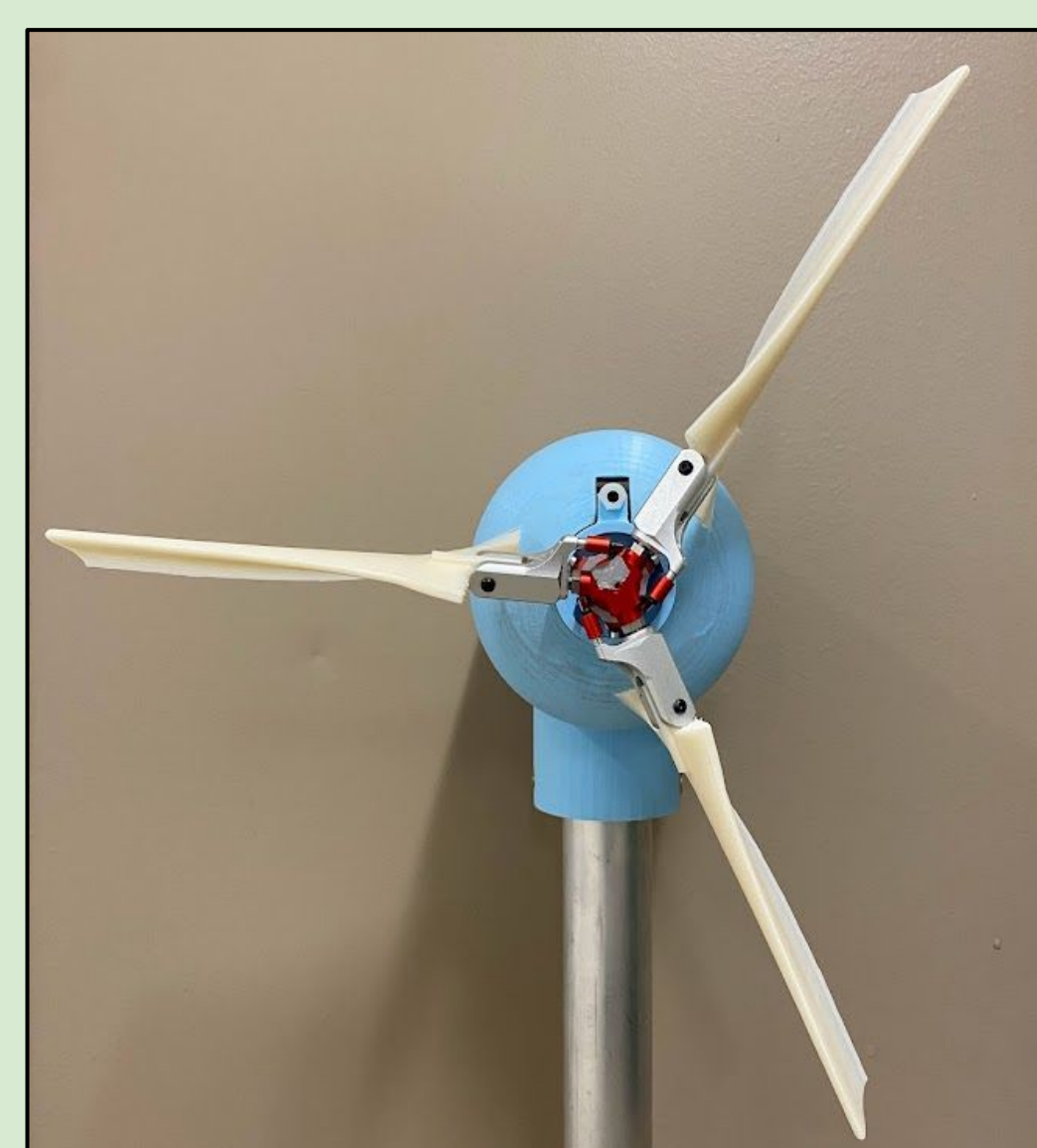
- **Dual braking system** uses blade feathering and fail-safe disc brake

Foundation Durability

- **Suction caisson foundation** anchors the turbine in a water tank with sand bed
- **Feathered blades** minimize mechanical loads on the turbine foundation from 15 - 22 m/s wind speeds
- **Streamlined nacelle** improves aerodynamic efficiency by reducing drag



Fail-safe disc brake

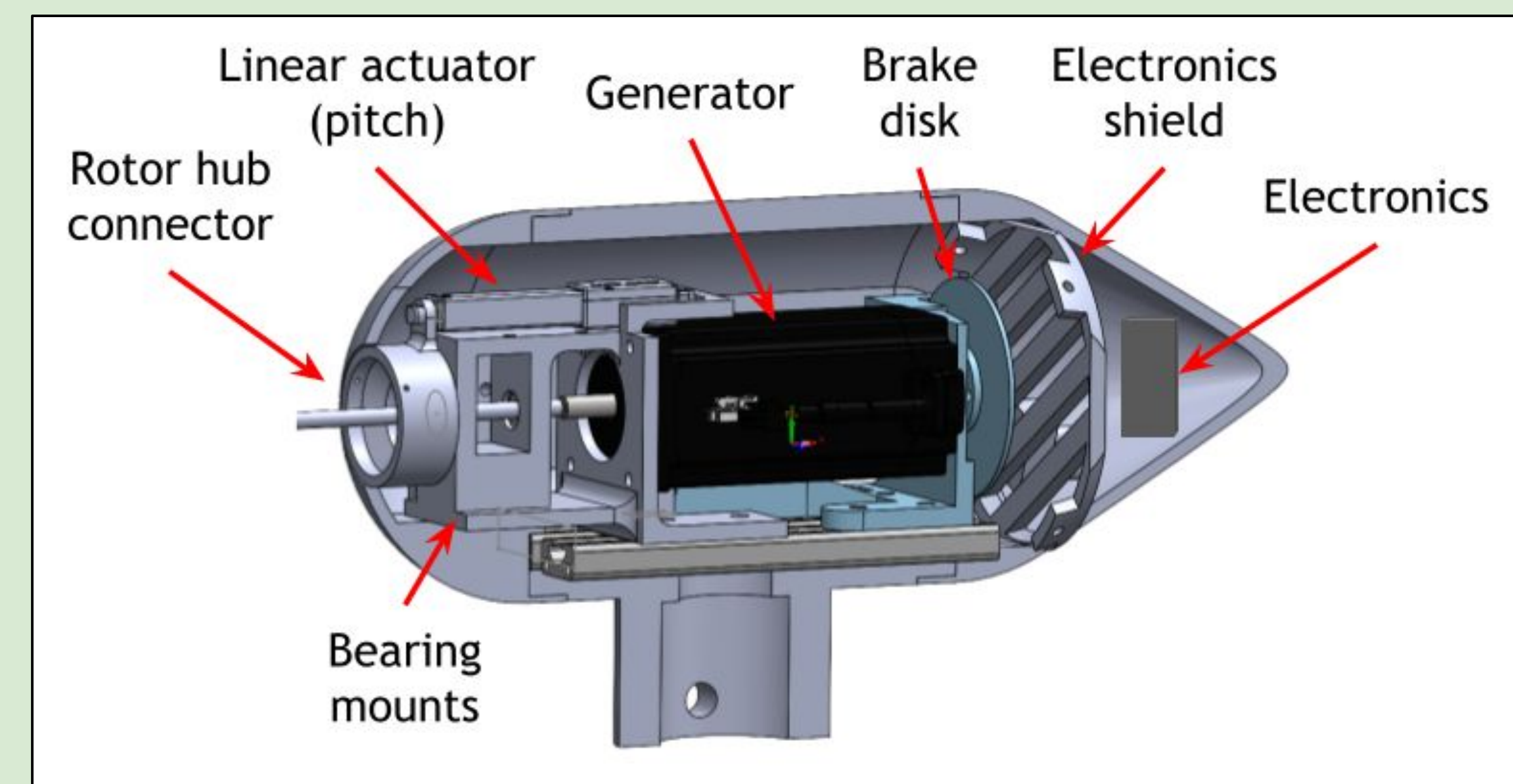


Feathered blades

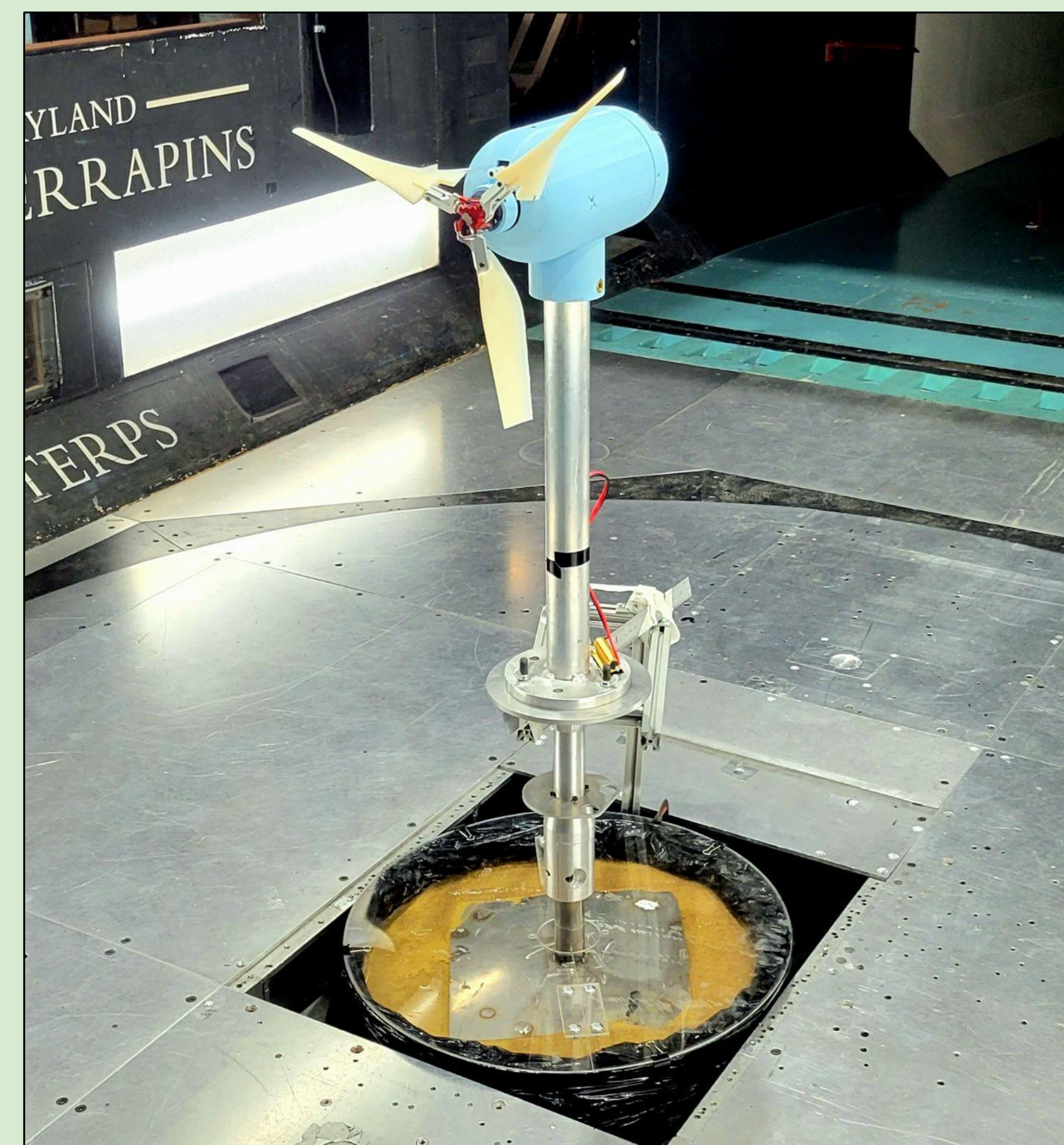


Pitched blades

Design Overview



Cross section of nacelle

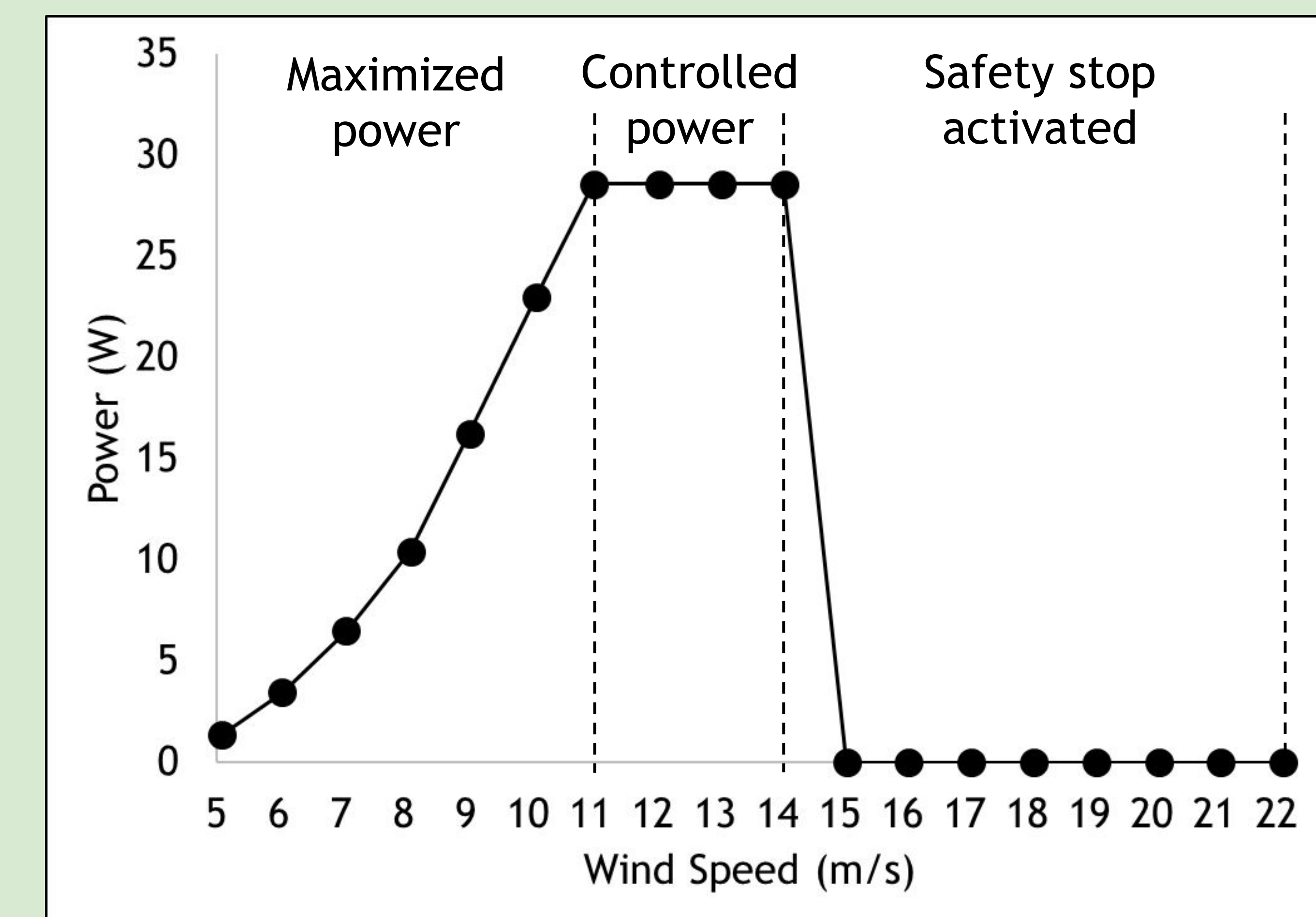


Integrated turbine during wind tunnel testing

Testing and Results

We conducted wind tunnel testing to ensure optimal power production and foundation durability of our wind turbine.

Our turbine achieves a maximum efficiency of 25% at 10 m/s and generates a maximum power of 29 W at 11 m/s.



Power production curve

Our foundation withstands all required wind speeds (5 - 22 m/s) with only 4 mm of deflection (max 25 mm allowed).

Conclusion

On May 15, 2023, we will bring our turbine to compete against 12 other collegiate teams in the 2023 CWC at the University of Colorado Boulder.

Acknowledgements

JHU: Dr. Stephen Belkoff, Dr. Dennice Gayme, Dr. Rui Ni, Dr. Charles Meneveau, Dr. Steven Marra, Emmett Turner, Sharon Reitsma, Daren Ayres, Stipe Iveljic, Rich Middlestadt, Chris Gunther, the Hopkins Student Wind Energy Team
Industry Mentors: Pete Albanese (GE Renewables), Kristin Dugas (Scout Energy), Jessica Fischer (RWE Renewables), Willa Grinsfelder (Natel Energy), Annika Torp (Siemens Gamesa)

References