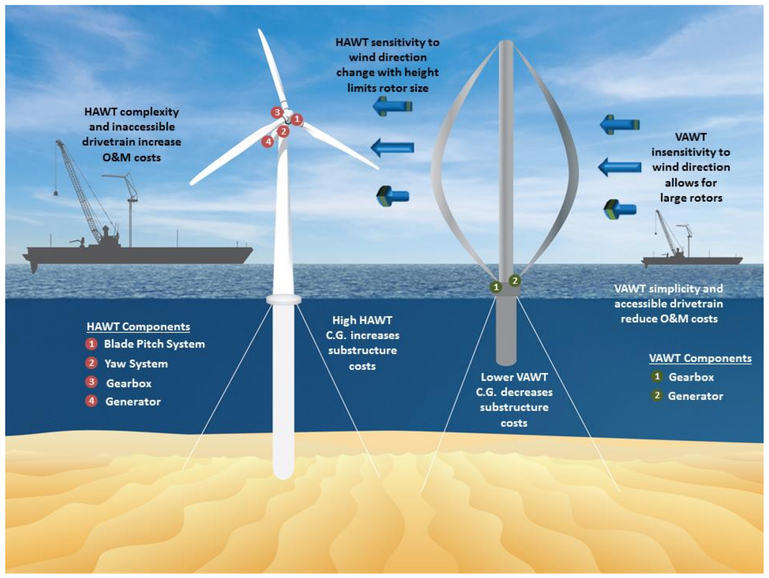
Sandia National Laboratories

Floating Offshore Vertical-Axis Wind Turbine Project Summary

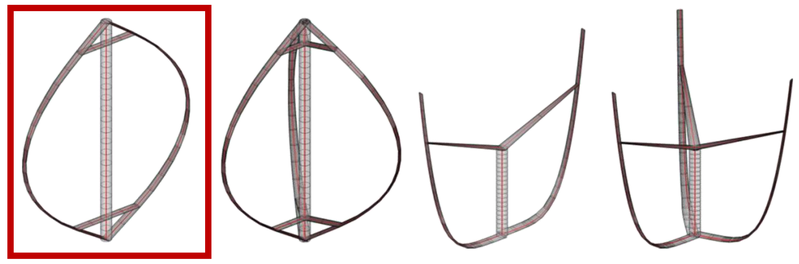
Project Motivation and VAWT Benefits

- Lower center of gravity reduces topside moment of inertia and resulting platform costs
- Platform-level placement of drivetrain components and elimination of yaw and pitch systems likely reduces O&M costs
- Improved aerodynamic performance at scale



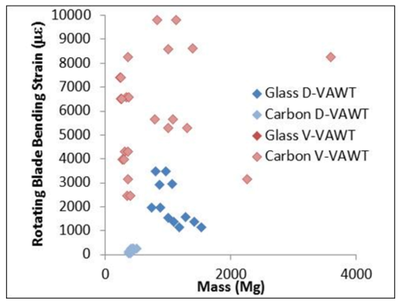
Rotor Design Studies

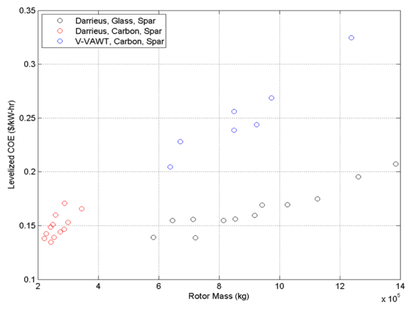
The optimal architecture for VAWTs was studied to determine which has the greatest potential to reduce LCOE.



Darrieus and V-VAWT architectures with exponents ranging from "V" to "U" shapes were studied

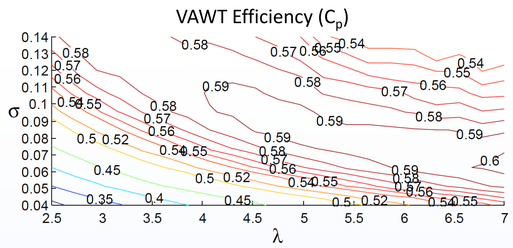
The Darrieus design was selected due to its ability to reduce strain by carrying the loads mostly axially, reducing the resulting material cost and weight.

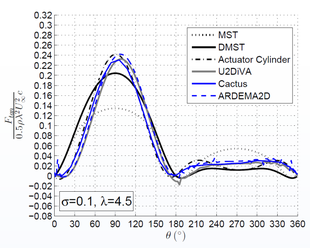




Performance Considerations

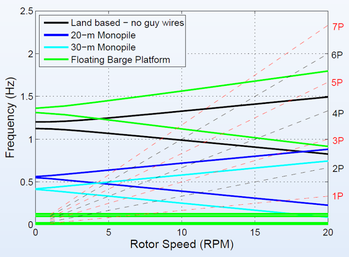
VAWTs operate through 360° relative to incoming wind and in their own wake. For large VAWTs this effect on angle of attack is minimized while the effective double passage through the wind can actually produce higher efficiencies than HAWTs.

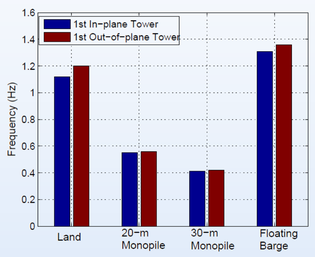




Sandia's free wake vortex code CACTUS shows high VAWT efficiencies, comparing well to full CFD results at a fraction of the computational cost

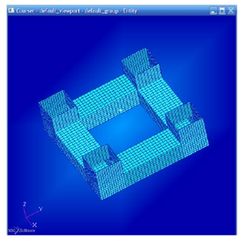
VAWTs have more complicated structural dynamics considerations than HAWTs, which are eased in part for floating platforms.

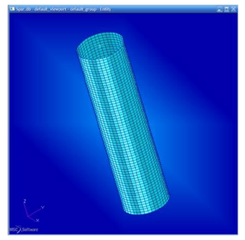


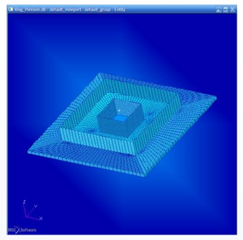


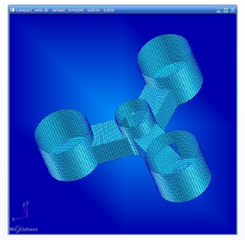
Sandia's structural dynamics code OWENS shows how the floating platform boundary condition increases the tower resonant frequencies moving them further from wave excitation

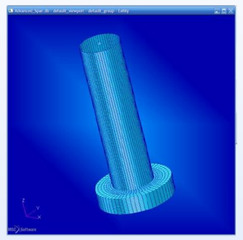
Platform Design and Optimization

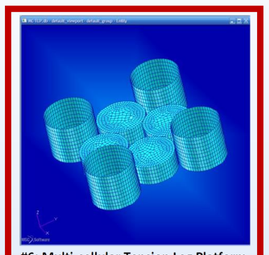

#1: Four-column Semi-submersible


#2: Classic Spar


#3: Ring Pontoon


#4: Compact Semi-submersible


#5: Advanced Spar


#6: Multi-cellular Tension Leg Platform

- Floating platform design and analysis was performed to determine the optimal floating platform architecture for LCOE and performance
- 6 platforms covering the range of floating system stability mechanisms were studied and compared
- A tension leg platform with multiple columns was the lowest cost option per Stress Engineering Services
- Performance benefits from the small roll/pitch motions include increased energy capture and reduced inertial loading on the turbine, meriting further consideration of TLPs

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