FLOATING OFFSHORE VERTICAL AXIS WIND TURBINE PROJECT

D. Todd Griffith, Joshua Paquette, Matthew Barone, Brian Owens, Diana Bull

Wind Energy Technologies Department

INTRODUCTION & MOTIVATION

Strong offshore wind resources available in US coastal regions with large population (and load) centers make offshore wind energy attractive. Estimates suggest that over 2000 GW is available in US offshore water depths of 60 meters and more. However, high costs must be addressed to realize the potential benefits of the offshore resource. Sandia is developing and evaluating technology to access this deep-water offshore wind resource where floating systems are required.

SAVING VAWT DESIGN & ANALYSIS TOOLS

Code for Axial and Cross-flow TURbine Simulation (CACTUS)
- Arbitrary VAWT geometries
- Pre- and post-processing tool

Offshore Wind Energy Simulation Toolkit (OWENS)
- Finite element structural dynamics formulation
- 3D Timoshenko beam element
- Rotational effects and geometric non-linearities
- Structural couplings (beam-mast, seal-mast, etc.)
- Static, transient, and modal analysis

FLOATING VAWT DESIGN STUDIES

Sandia’s rotor design studies include aerodynamic and structural design of a series of 5 MW VAWT rotors through an investigation of the following rotor design parameters: rotor configuration, number of blades, material choice, chord size, and blade tapering scheme.

VAWT ROTOR CONFIGURATION DESCRIPTION
- Carbon
- 3 blades
- Large chord
- Generator
- VAWT Components
- Rotor
- Drive-train
- Support structure
- Electrical infrastructure
- Other
- Other

FLOATING PLATFORM DESIGN STUDIES

Current work focuses on platform and mooring design specific to VAWTs. Sandia is considering a range of platform options that use different stability mechanisms.

VAWT DESIGN GUIDELINES & CONCLUSIONS

Tower resonance has historically been an issue for VAWTs. Sandia developed and verified an analytical expression for critical tower modes of an n-bladed VAWT resulting in guidelines for VAWT designers to understand critical per-rev frequencies that drive tower resonance.

AEROELASTIC STABILITY INVESTIGATION

Using aerelastic theory as implemented in Sandia’s BLade Aerelastic Stability Tool (BLAST), VAWT flutter speeds were estimated for aerelastic stability investigations of large, multi-MW VAWT designs.

CONCLUSIONS

In deep water where floating platforms are required, VAWTs could potentially lower the cost of energy. Sandia continues to investigate the technical and economic feasibility of floating offshore VAWT systems.

Key activities and accomplishments of this project include:
- Rotor design studies for large-scale VAWTs, including aerodynamic and structural design
- Platform design studies to address VAWT specific conditions [in progress]
- System-level design studies and VAWT LCOE model development [in progress]
- VAWT design tool development
- Design guidelines for VAWTs [in progress]

Despite technical challenges associated with floating VAWTs, the systems have significant inherent advantages over floating HAWTs for reducing capital costs and reducing lifecycle O&M costs.