On the preliminary integrated design of a 10MW floating wind turbine

Global interest in floating wind energy investments is rapidly increasing in order to match the 2050 goals. As a relatively new technology, floating wind turbines require specific design procedures to guide future development. At this aim, a systems engineering approach is essential, focusing on optimizing the system holistically rather than optimizing individual components independently.

This research activity presents a preliminary study on the integrated design of floating wind turbines aimed at minimizing the Levelized Cost of Energy (LCOE). The proposed design strategy enhances current substructure design practices by integrating the rotor and tower design. The land-based design methodology has been previously widely developed within an in-house wind turbine design suite, proven in various research and industry projects for designing and scaling land-based turbines. The design approach is structured as a series of nested optimization problems, beginning with the co-design of the blade aerodynamic shape and substructures, including a floating platform and catenary mooring lines. Subsequent steps involve model-based controller design, followed by structural sizing of the blade and tower elements based on load cases defined by certification standards. During this structural optimization, floating substructures are adjusted in line with system mass changes while adhering to system ultimate limit constraints. Depending on the required level of detail, different fidelity levels in the floating turbine models are used, utilizing both a reduced-order model for static aero-hydro-structural evaluations and a fully coupled multi-body model for time-domain load calculations.

To demonstrate this multi-disciplinary, multi-nested design methodology, a classical 10-MW turbine on a spar platform, initially designed for fixed-bottom installations, has been considered for floating conditions. The results reveal substantial design modifications, especially in the rotor's aerodynamic profile and the structural components of the blade and tower, compared to the baseline turbine. For instance, blade mass increased by 77% due to thicker cross-sectional elements needed to withstand additional loads and displacements in a floating environment. These findings underscore the significant interdependence between system components in floating wind turbines, emphasizing that their design should adopt similar holistic techniques to achieve optimal performance.

The final presentation will provide an in-depth description of the design methodology, discuss optimized designs, and compare them with conventional models.