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Aero-Hydrodynamic Model for a Floating Offshore Wind Turbine

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Abstract : In recent years, Europe has seen a great development of renewable energy, in a perspective of reducing polluting emissions and transitioning to cleaner forms of energy, as established by the European Green New Deal. Wind energy has come to cover almost 15% of European electricity needs andis constantly growing. In particular, far-offshore wind turbines are attractive from the point of view of exploiting high-speed winds and high wind availability. Considering offshore wind turbine siting that combines the resources analysis, the bathymetry, environmental regulations, and maritime traffic and considering the waves influence in the stability of the platform, the hydrodynamic characteristics of the platform become fundamental for the evaluation of the performances of the turbine, especially for the pitch motion. Many platform's geometries have been studied and used in the last few years. Their concept is based upon different considerations as hydrostatic stability, material, cost and mooring system. A new method to reach a high-performances substructure for different kinds of wind turbines is proposed. The system that considers substructure, mooring, and wind turbine is implemented in Orcaflex, and the simulations are performed considering several sea states and wind speeds. An external dynamic library is implemented for the turbine control system. The study shows the comparison among different substructures and the new concepts developed. In order to validate the model, CFD simulations will be performed by mean of STAR CCM+, and a comparison between rigid and elastic body for what concerns blades and tower will be carried out. A global model will be built to predict the productivity of the floating turbine according to siting, resources, substructure, and mooring. The Levelized Cost of Electricity (LCOE) of the system is estimated, giving a complete overview about the advantages of floating offshore wind turbine plants. Different case studies will be presented.

Keywords : aero-hydrodynamic model, computational fluid dynamics, floating offshore wind, siting, verification, and validation
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