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D4.5 State-of-the-art models for the two LIFES50+ 10MW floater concepts

This report describes the implementation in FAST of the DTU 10MW Reference Wind Turbine mounted on two floating substructures, namely the LIFES50+ OO-Star Wind Floater Semi 10MW and the NAUTILUS-10 floating substructure. The two floating substructures and turbine configurations are defined in D4.2 and the present numerical implementations are consistent with those definitions. FAST v8.16 is selected as the version for implementation of the state-of-the-art models. The purpose of this implementation is to serve as a reference for different activities carried out by partners within the project consortium, and also to provide realistic reference models for public use out-side of LIFES50+. The land-based wind turbine structural and aerodynamic models were already implemented in FAST within the LIFES50+ project. In this report, attention is given to the changes necessary to adapt the FAST model to the two floating substructures. These changes entail controller, tower structural properties, floating substructure hydrodynamics and mooring system. The basic DTU Wind Energy controller was tuned by the developers of each floating concept, in order to avoid the "negative damping" problem. The tower in one of the models is defined down to the still water level to capture some of the floating substructure flexibility. The mooring lines are implemented in the FAST module MoorDyn, which is a dynamic lumped-mass mooring line model that allows the user to define multi-segmented mooring lines. Hydrodynamics properties (hydrostatic stiffness matrix, frequency-dependent added mass and radiation damping matrices, and frequency-dependent vector of wave excitation forces) are precomputed in the radiation-diffraction solver WAMIT for both floating substructures, and transformed to time domain by convolution. Viscous effects, not captured by radiation-diffraction theory, are captured internally in HydroDyn by inclusion of the Morison drag term for the OO-Star Semi floating substructure, while they are modelled through linear and quadratic global damping matrices for the NAUTILUS-10 floating substructure. A first set of simulations for system identification purposes is carried out to assess system properties such as static offset, natural frequencies and response to regular waves. The controller is tested in a simulation with uniform wind ranging from cut-in to cut-out wind speed. A set of simulations in stochastic wind and waves is carried out to characterize the global response of both floating sub-structures, showing that the models behave as expected. The results are presented and the main physical phenomena are discussed. Finally, accessibility and referencing information for the two public models is given.