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D1.2 – Wind turbine models for the design

This report outlines the implementation of the DTU 10MW Reference Wind Turbine within the FAST[1] numerical design tool for use within LIFES50+. The purpose of this implementation is to serve as a reference for floating substructure design and optimization activities carried out by partners within the project consortium. FAST v8.12.00a-bjj was selected as the version for developing the numerical model implementation.

The whole wind turbine system structural model made use of the ElastoDyn module, which considers linearized response shape representations linked through a multi-body formulation. AeroDyn v14 was selected to carry out aerodynamic load calculations as it has unsteady aerodynamic capabilities. The DTU Wind Energy controller was included as a DLL[2], making use of the Bladed-style interface available in FAST.

A systematic assessment of the FAST model implementation was carried out, starting with verifying isolated component natural frequencies as well as whole system natural frequencies. The steady state performance of the FAST model implementation was compared against HAWC2[3], with good overall agreement. Small discrepancies arise close to the rated wind speed due to model sensitivities. The steady state blade pitch angle was larger for the FAST model implementation at above-rated wind speeds due to the simpler blade structural model present relative to HAWC2. The absence of the blade torsional degree of freedom in FAST results in the whole blade required to be pitched to compensate for blade torsional deformations that occur in HAWC2. A wind ramp simulation was subsequently carried out to demonstrate that the FAST controller implementation performs adequately. Finally a reduced set of stochastic simulations were run to characterize control and turbine response performance.

Possible future developments regarding blade structural and aerodynamic modelling are discussed and accessibility to the public version of the DTU 10MW Reference Wind Turbine FAST model implementation is outlined.

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[1] FAST = Fatigue, Aerodynamics, Structures, and Turbulence
[2] DLL = Dynamic Link Library
[3] HAWC2 = Horizontal Axis Wind Turbine simulation Code 2nd generation