State-of-the-art model for the LIFES50+ OO-Star Wind Floater Semi 10MW floating wind turbine

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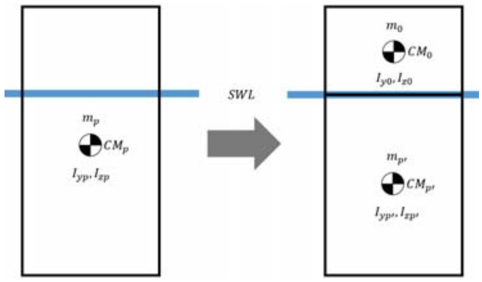
Introduction

A FAST [1] model of the DTU 10MW Reference Wind Turbine [2] mounted on the LIFES50+ OO-Star Wind Floater Semi 10MW platform [3] has been developed from a FAST model of the onshore turbine [4]. The changes entail controller, tower structural properties, platform hydrodynamics and mooring system. The basic DTU Wind Energy controller was tuned to avoid the negative damping problem. The flexible tower was extended down to the still water level to capture some of the platform flexibility. Hydrodynamics were precomputed in WAMIT, while viscous drag effects are captured in HydroDyn by the Morison drag term. The platform was defined in HydroDyn to approximate the main drag loads on the structure, keeping in mind that only circular members can be modelled. The mooring system was implemented in MoorDyn. A set of simulations was carried out to assess the system natural frequencies, the response to regular waves, the controller behavior and the global system response to stochastic wind and waves. Further details on the modelling approaches, the simulation results and the model availability can be found in [5].

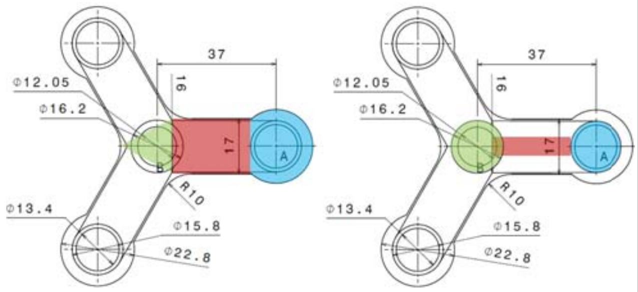
Modelling of the tower

To capture some of the floater flexibility, the portion of floating platform between SWL and tower interface was modelled as part of the tower, and the inertia properties of the platform were modified accordingly. This approach reduced the tower coupled natural frequency from 0.786 Hz to 0.75 Hz. However, the tower natural frequency obtained with a fully flexible numerical model was 0.59 Hz. This difference highlights the effect of the flexible substructure on the dynamics of the system.



Modelling of the viscous drag

Given the complexity of the floating platform, the viscous drag loads on the physical structure (left) were modelled in HydroDyn with a series of cylindrical members and heave plates (right). This ensures that the global drag loads in surge, heave and pitch are well captured.

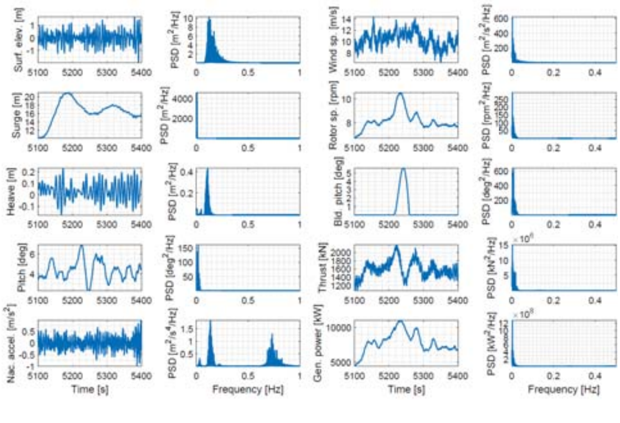


The object of study

DTU 10MW Reference Wind Turbine + OO-Star Wind Floater Semi 10MW

Response to stochastic wind and waves

The system's response to small irregular waves and near-rated turbulent wind is shown here. The platform responses are excited by wind (surge, pitch) and waves (heave, nacelle). The tower natural frequency is also excited. The controller can be seen in action around 5200 s, when the rotor exceeds the rated speed and the blades are pitched to return the wind turbine to below-rated conditions.



Literature cited

[1] Jonkman J, Jonkman B. NWTC Information Portal (FAST v8). https://nwtc.nrel.gov/FAST8

[2] Bak et al., 2013. "Description of the DTU 10MW reference wind turbine," DTU Wind Energy.

[3] Yu et al., 2017. "LIFES50+ D4.2: Public definition of the two LIFES50+ 10MW floater concepts," University of Stuttgart.

[4] Borg et al., 2015. "LIFES50+ D1.2: Wind turbine models for the design," Technical University of Denmark.

[5] Pegalajar-Jurado et al., 2017. "State-of-the-art model for the LIFES50+ OO-Star Wind Floater Semi 10MW floating wind turbine", *Journal of Physics: Conference Series.* Unpublished.

Acknowledgments

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