

Developing the Next Generation 12+ MW Offshore Wind Turbine for Clean and Competitive Electricity

Response of an innovative flexible modular floater for a conceptual 15+ MW wind turbine and sensitivity to design parameters

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Abstract

Conceptual design investigation, focused on the impact of flexibility for the semi-submersible concept. A very important advantage of this concept with respect to upscaling is that the floater stiffness towards rigid body rotation scales with the fourth power of the dimensions. This means that unlike most other wind turbine components, the floater part decreases relatively with upscaling. Floating wind thus benefits from the comprehensive upscaling of wind turbines that has happened in general during many years, and is also a major aim of the ReaLCoE project.

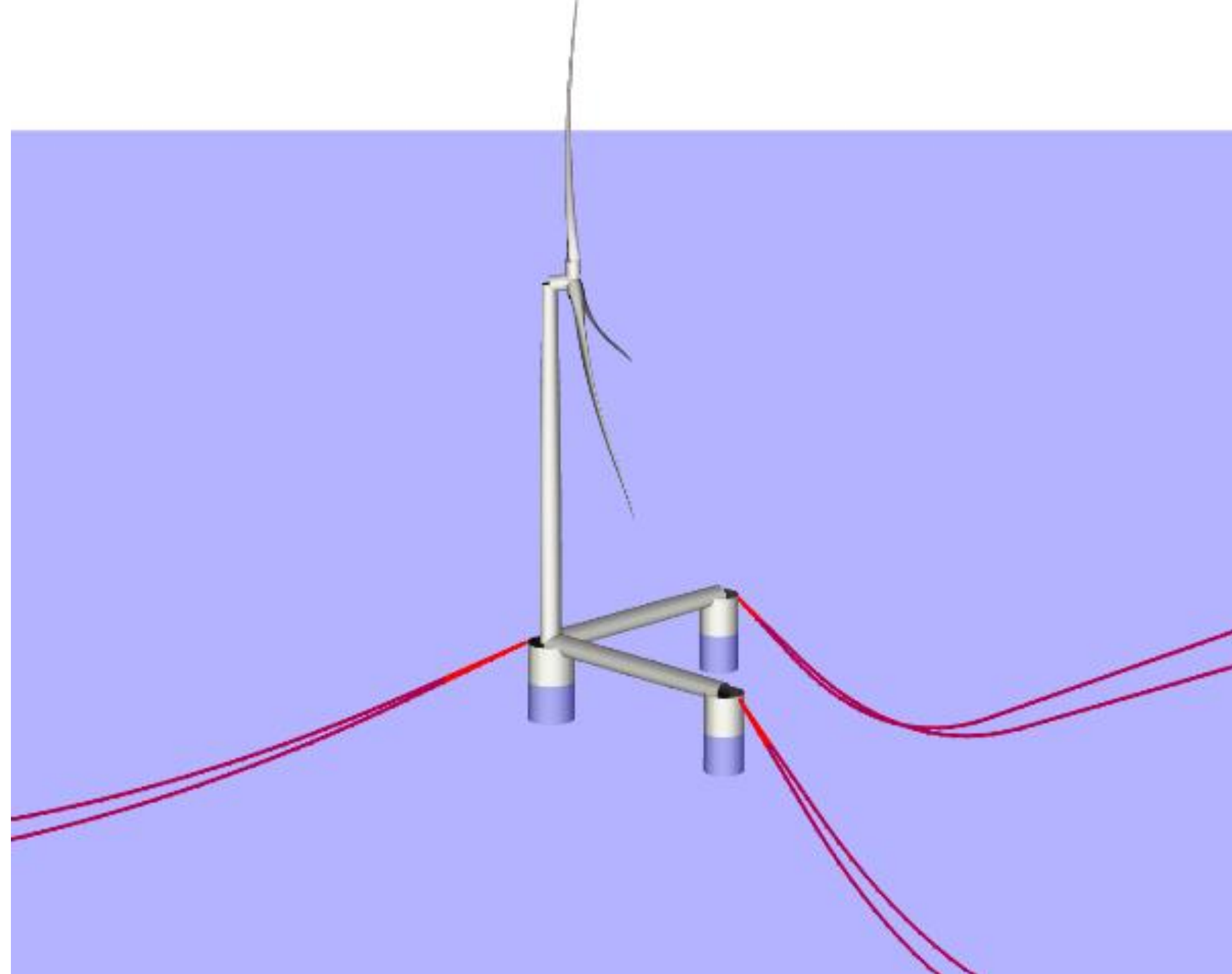


Illustration of the integrated model and the modular design

Parametric simulations

A study of the floater dynamic interaction with 3p is carried out using HAWC2 and DLC1.2 and DLC1.6 at 11 m/s. The 4 different floater cases represented are:

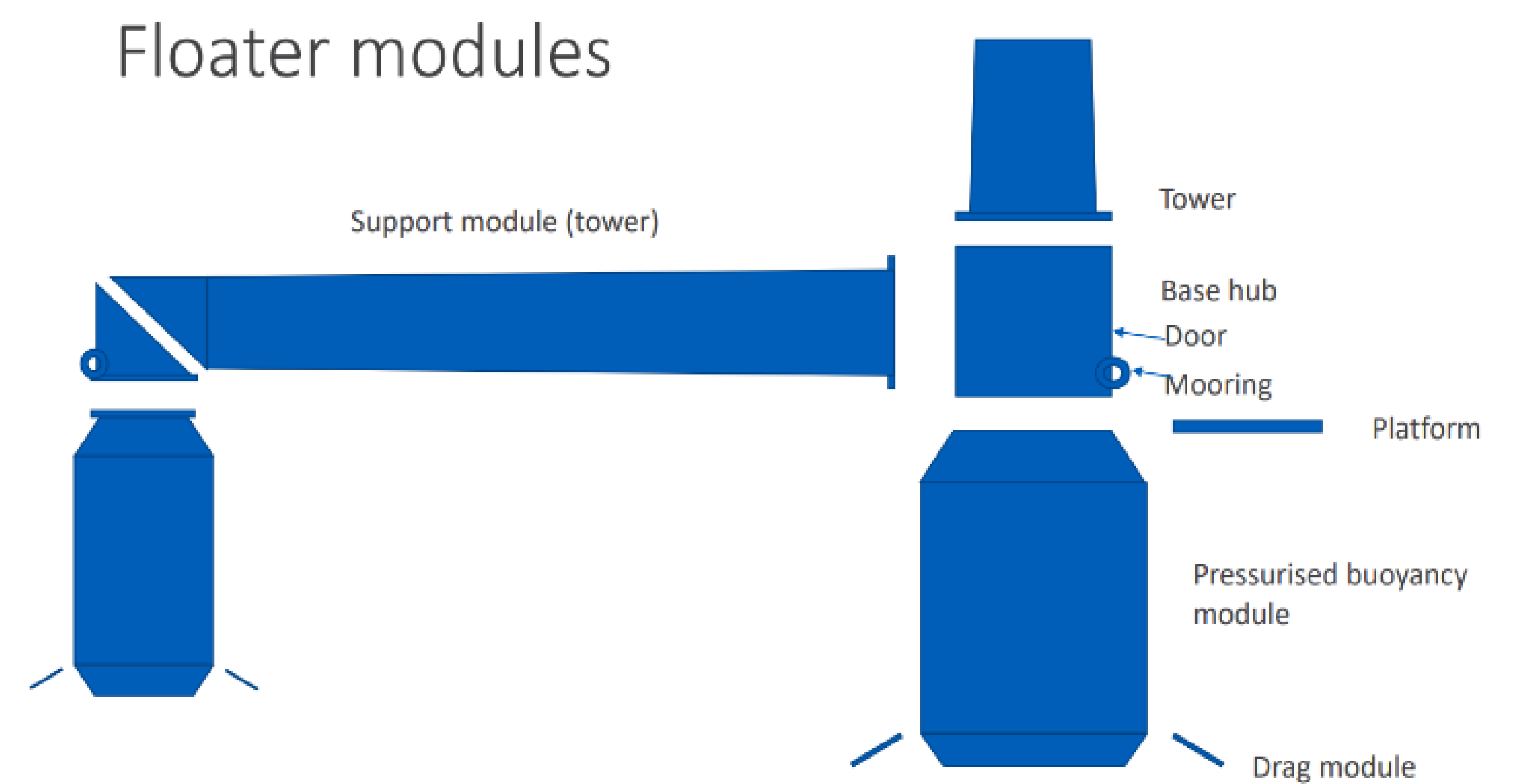
- flex floater - flex tower (blue)
- 2x stiffer floater - flex tower (red)
- rigid floater - flex tower (black)
- rigid floater - 2x stiffer tower (magenta)

Results: Normal Sea State

The response characteristics for operation under normal conditions (DLC1.2) are shown to the right. In this case the wind loads are dominating, and floater dynamics and interaction with 3P becomes important. The peak at 3p (0.39 Hz) is most dominant for the rigid floater/flex tower combination (black curve), and this also has 12 % increased fatigue loads relative to the flexible floater. The stiffest floater configuration has tower natural frequency slightly beyond 3p (0.39 Hz) and also has fatigue loads similar to the flexible reference. The maximum loads are about the same for all four configurations.

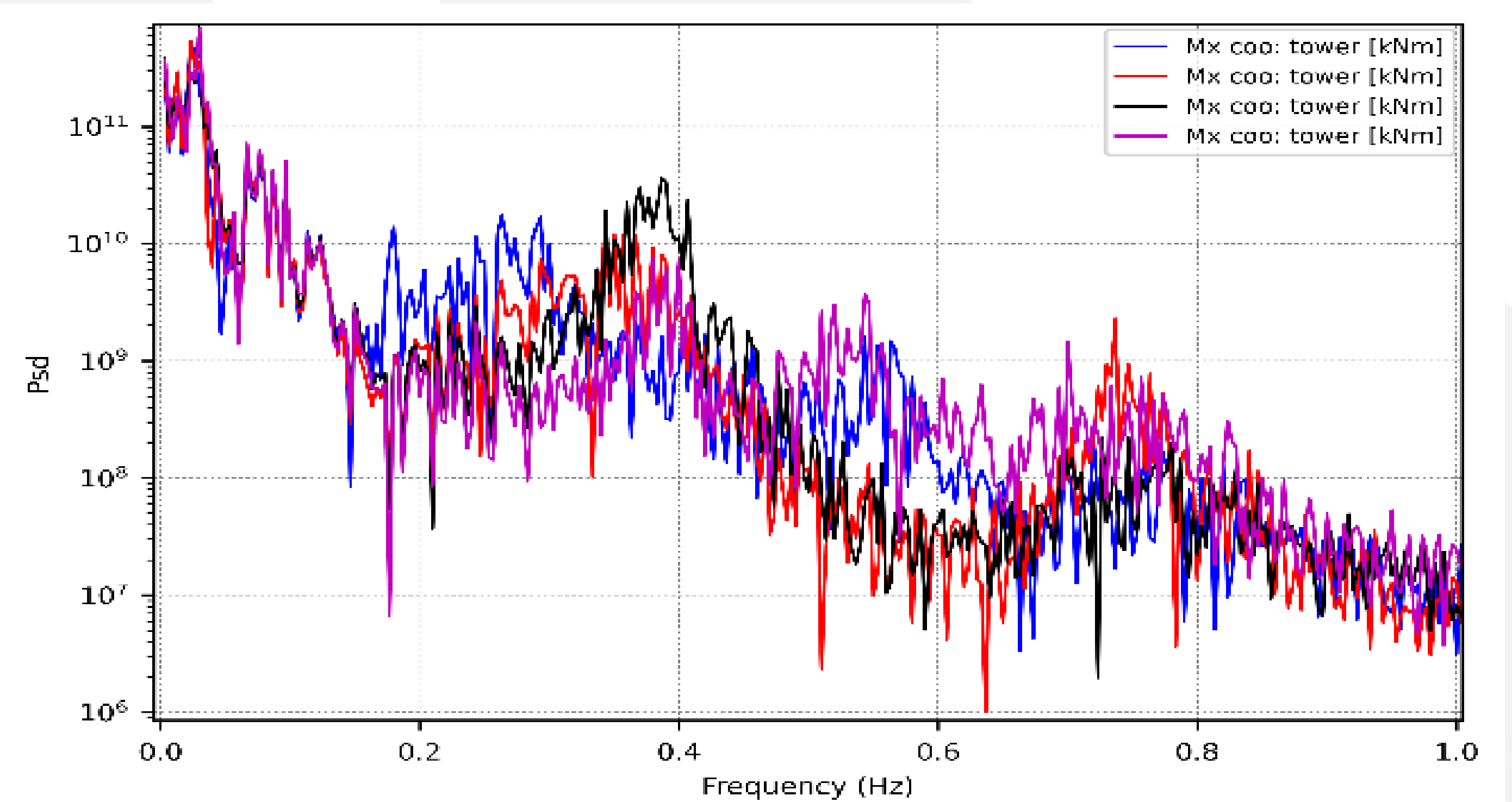
Conclusions

The flexible structure allows for light weight, and for the system dynamics to be tuned. It was shown that the tower natural frequency can be moved away from e.g. 3P by tuning of floater stiffness, resulting in reduced fatigue loads during normal operation relative to a stiffer floater.



Conceptual design

A highly modular design with clear interfaces between the different modules/components, in which all forces are transferred. The tower load absorption point in the floater construction, is at a relatively high level, thus reducing the tower length and correspondingly the maximum bending moment. The horizontal elements of the floater are in principle similar to the lower 2/3 of the tower. The floating buoyancy vertical columns are only connected at one end and pressurized to compensate for external water pressure, and have drag rings at the bottom end. All connection interfaces are bolted flanges as in usual tower connections, and all forces are transferred through them. It is considered that the modular design has benefits concerning mass production. The floater primary steel weight is estimated to be potentially as low as 175 ton/MW.



Frequency response of the tower bottom fore-aft bending moment for different stiffness cases

ReaLCoE's vision is to unleash the full potential of offshore wind energy
€35/MWh LCoE Goal, +12MW WEC Capacity, ~32 mio € Total Budget, 42 month project duration



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