European Wind Energy Master
Offshore & Dredging Engineering

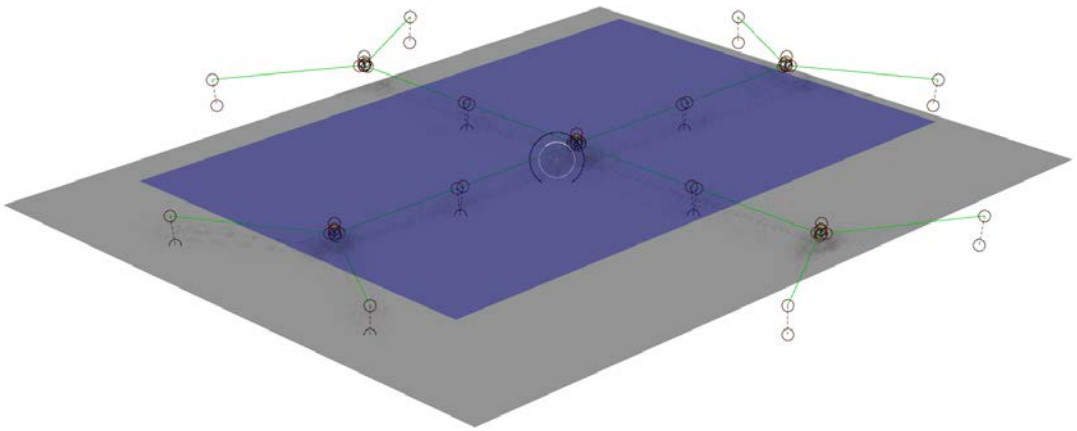
Technische Universiteit Delft

Mooring system design for wind farm in very deep water

Offshore floating wind turbines are one of the newest technologies in the renewable markets today. The world's first floating wind farm, the Hywind Scotland Pilot Park, was commissioned in October 2017 and has been competitive with fixed bottom offshore wind turbines. There is a global push to make more renewable energy available, but less desire to have wind turbines cluttering the coastline. Floating wind turbines enable the developer to take advantage of unused offshore space, at depths where traditional fixed bottom structures are impractical and at locations that do not spoil the vista of the coastline.

This thesis project aims to develop a working mooring system at depth of 600 m in the Norwegian North Sea, and then investigates the possibility of shared anchors in a wind park with this mooring system. The DTU 10MW reference wind turbine atop a classic spar substructure is used. First, the mooring system at 320 m is tested under decay and environmental loads. Then a chain-polyester-chain mooring line with a bridle was developed for 600 m so that the surge offset is limited to<60 m for 3 load cases. A simplified model of the wind turbine was then developed for these three load cases. The simplified model was then used to create a wind farm arrangement with 5-6 turbines each. Each wind farm varied in layout and in the number of shared anchors.

It was found that while the mooring system designed passes the surge offset and natural frequency requirements, and the normal ULS safety class, it failed the high safety class in some cases. For shared anchors with multidirectional loads, the resultant force on the anchor is significantly less as long as the lines are distributed equally around the anchor point. The resultant force does not increase with two lines 120◦ apart. The footprint of a single turbine with the designed moorings larger than the footprint of the entire Hywind Scotland Farm, so suggestions are made for improvement and further work.



Student
Megan Chan Chow
2019-01-09

Sponsor
Delft Technical University
NTNU

Thesis committee
Prof.dr. A. Metrikine
Ir. J.S. Hoving
Dr. P. Wellens
Dr. E. Bachynski