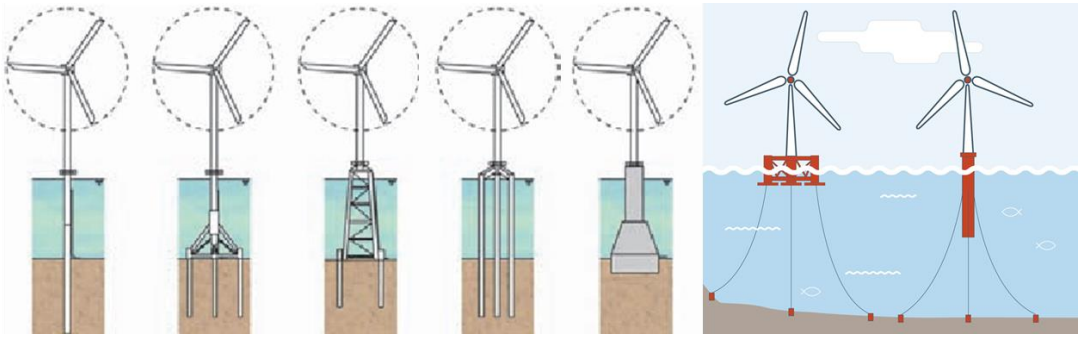
NATIONAL TECHNICAL UNIVERSITY OF ATHENS
School of Naval Architecture and Marine Engineering

A REVIEW OF THE AVAILABLE TECHNOLOGIES AND STRUCTURAL DESIGN PRACTICES FOR OFFSHORE WIND TURBINES



Thesis to obtain the Master of Science Degree in
Naval and Marine Technology and Science

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Olympia-Maria Skourti (2022)

Master's Thesis

A Review of the Available Technologies and Structural Design Practices for Offshore Wind Turbines

School of Naval Architecture and Marine Engineering, National Technical University of Athens, Greece

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MASTER'S THESIS

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ABSTRACT

Nowadays, clean electricity produced by wind turbines makes them stand in the epicenter of green energy transition. The fact that velocities and wind flow are respectively higher and more uniform above sea than onshore renders coastal and offshore grounds more suitable for power production. The growing demand for renewable energy, in conjunction with the continuous development of substructure and foundation technologies to be used in the marine environment, drive wind turbines further and further offshore.

The present work reports on the latest technological advancements in the industry of offshore wind turbines, with emphasis on structural systems and construction practices that are already in use. Both bottom-fixed and floating systems are examined, the selection among which is mainly based on the site depth and seabed soil type. A short overview of the technologies that are currently being developed is also included.

A bottom-fixed offshore wind turbine is analysed on a preliminary level, as a case study. The wind turbine is mounted on a tripod, which in turn is founded on piles. The structure is modeled with two different software, FAST and SAP2000. The operation of the turbine and the dynamic response of the tower and substructure is simulated in FAST, to produce time-series for the loads. Subsequently, snapshots from the time-series, at which critical values of loading are documented, are selected and the corresponding values are assigned to a model of the tower, substructure and foundation built in SAP2000, to enable static analyses for structural optimization purposes.

In order to perform strength checks, estimate exploitation ratios for the members and investigate the extent of the effect of wind loading on the structure, analyses are executed in SAP2000 for three hub-height wind speeds: 7m/s, 11.4m/s (the rated wind speed), and 20m/s, each one for two of the "Power Production" Design Load Cases specified in Part 3-1 of the Wind Energy Generation Systems Standard by the International Electrotechnical Commission (IEC), for the cases of "Extreme Turbulence Model and Normal Sea State" (Case 1.3) and "Normal Turbulence Model And Severe Sea State" (Case 1.6). The exploitation ratios for any wind speed, prove to be in all cases greater, when the wind flow follows the Extreme Turbulence Model rather than the Normal Turbulence Model. Overall, the combination of

Extreme Turbulence Model and Normal Sea State for the rated hub-height wind speed is the most unfavorable loading scenario for the structure.