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Wind turbine design: Dimensioning, dynamic forces on large offshore wind turbines

The first generations of offshore wind turbines are designed more or less similar to onshore turbines, with three-bladed rotors mounted upwind of the tower and moderate tip speeds. This design compromise emerged because wind turbines traditionally were made for onshore locations, with corresponding constraints on visual appearance and noise that do not apply to the same degree offshore. Now the offshore wind energy business is beginning to mature and we see that the design trends are starting to change: After stagnation in turbine sizes between three and five MW and rotors up to 126 *m* diameter, we again see larger turbines being presented by the manufacturers, with rated powers ranging from six to ten MW.

Larger turbines make sense as it will reduce the number of foundations and marine operations for a given park rating, and give benefits regarding maintenance. The head mass is, however, one of the largest cost drivers for the turbine, and because the rotor mass generally scales with the cube of the rotor diameter and the energy production only scales with the square of it, it is essential to gain confidence in lightweight rotor designs. To keep the cost down in large offshore specific turbines, one can allow higher absolute tip speeds to reduce the drive train torque and more slender blades to reduce ultimate loads. Others have suggested two-bladed designs for weight savings or more flexible, downwind designs to alleviate fatigue loads. All of these design changes have the potential to reduce the cost of offshore wind energy, which is the ultimate goal, but they also introduce new challenges, for instance regarding dynamic behaviour and aeroelastic stability of the turbines.

This project, which is part of *Work Package 1 - integrated numerical design tools*, deals with the design challenges of very large wind turbines. The objective is partly to develop a design tool for realistic aeroelastic blade design of large wind turbine rotors, and partly to utilize this tool to evaluate the design criteria regarding blade scaling and dynamic stability through parametric studies in aeroelastic simulation tools.