FLOATING OFFSHORE WIND TURBINES

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After the acquisition of IMS in 2012, Ramboll has built up a highly competent team of experts for the design of floating wind turbine foundations by pooling the know-how and expertise of Ramboll and IMS in integrated load simulation, structural design and hydromechanics of floating offshore systems, mooring design and optimization, steel fabrication and offshore installation.

Floater analysis and design
Lately Ramboll has developed a fully integrated tool for the coupled aerodynamic/hydrodynamic analysis of floating wind turbines in the time domain, where we make use of the in-house turbine simulation tool LACflex including controller in the time-domain solver.

Our team of experienced offshore engineers and wind turbine experts covers all aspects of floater design and analysis. We can offer multidisciplinary and independent services (from cradle-to-grave) throughout the life cycle of floating offshore wind turbine projects. Due to our strong expertise in bottom fixed as well as floating structures, Ramboll can offer unbiased evaluation and advise on which concept is best suited for a specific site.

Choosing the right design
There is a large variety of floater designs, reflecting various approaches. In the effort to optimize the motion characteristics of the floater, the steel weight of the floater structure and the costs of the mooring/tension leg system, it is tempting for the designer to make use of the large number of floater design possibilities at his disposal. In many cases, this can be a trap leading to designs which are overcomplicated in fabrication, installation and operation. A contradiction to what offshore designs should be.

We at Ramboll follow the principles of a simple but efficient and reliable design, since cost optimization is even more critical for the design of wind turbine floaters than for bottom fixed foundations. In comparison to fixed foundations, the floating systems are more complicated in their dynamic response to the combined loads of wind and waves.

Floater optimization
The simultaneous action of the cyclic loads from the wind turbine and the stochastic wave loads, the motion characteristics of the wind turbine floater have to be optimized regarding the accelerations at the level of the nacelle and the rotor and not at the level of the topside as for offshore oil & gas floaters.

Accordingly, optimization of a wind turbine floater does not mean optimization of the motion of the floater but of the nacelle and rotor. That minimizes the effect of apparent increase of wind gustiness acting on the rotor and minimizes the inertia forces acting on the blades, the hub and the generator components.

Mooring and tendon design
The layout and characteristics of the mooring or tension leg system are strongly influenced by the water depth. Even if the sites for which floating wind turbines are selected are “deep water” in terms of offshore wind, the water depths are still relatively small compared to the use of floaters (semisubmersibles, SPARs, TLPs) in offshore oil & gas projects. These relatively small water depths (between 50 and 150 m) are a specific challenge to the design of the mooring or tension leg system. In the last decade we have developed innovative mooring and tendon designs, which are sturdy and simple and cut the costs by 40 to 70%.
Our references in floater design
• Detailed concept study (2009-2010) for different designs, WTG of 3.6 and 5.0 MW, water depths between 50 and 250 m.
• FEED study (2010-2011) for semi-submersible and SPAR-type floaters incl. cost-parametric models covering locations in the North Sea, Baltic Sea, Atlantic and Mediterranean Sea.
• Mooring studies (2010-2011) for conventional and innovative systems (basic design level) incl. cost analysis.
• Detailed cost analyses (2011) covering floater fabrication, based on detailed scantling of floater structure (steel and hybrid), mooring system, offshore transportation and installation.
• Sensitivity studies (2011) to assess impact of variations of hub height, rotor diameter, mass of rotor nacelle assembly.
• Design study (2012-2013) for semi-submersible floaters (3.6 and 6.0 MW) on conceptual and basic design level, incl. integrated dynamic analysis based on time-domain simulations.
• Design of a floating demonstrator (2012-2013) including mooring system for a selected test site with reduced water depth.

Our competences in floating offshore wind turbines
• Wind turbine simulations, load calculations, controller development
• Hydromechanic floater design
• Structural design under consideration of fabrication process and costs
• Mooring system design optimization and analysis
• Integrated system simulations and structural analysis (ultimate and fatigue limit states)
• Interface management during fabrication and installation
• Planning and supervision of offshore installation
• Operation and maintenance
• Technical and financial risk assessments

Ramboll is world leader in the design of fixed offshore foundations for wind turbines. We have currently performed detailed foundation designs for 37 offshore wind farms around the world resulting in more than 2,100 individual designs and totaling more than 65% of installations.

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Ramboll is a leading engineering, design and consultancy company founded in Denmark in 1945.

The company employs close to 12,500 experts in the Nordics, North America, the UK, Continental Europe, Middle East and India, supplemented by a significant representation in Asia, Australia, South America and Sub-Saharan Africa.

With more than 300 offices in 35 countries, Ramboll combines local experience with a global knowledge base constantly striving to achieve inspiring and exacting solutions that make a genuine difference to our customers, the end-users, and society as a whole.