Integral Design of Light Weight Tower

Publieke samenvatting / Public summary

The offshore wind industry is growing rapidly, figuratively speaking in market size but also literally speaking in turbine and structure size. In April 2017, Danish energy giant Dong won a German offshore wind auction by bidding at zero subsidy, delivering electricity to the grid at market prices without subsidies given by the German government. A pricing breakthrough which was reasonable according to Dong because of two industry trends: turbine capacity will keep increasing up to 15MW per unit and operational lifetime will increase to 25-30 years. For both trends a smart, reliable and efficient support structure is important. Since 2015 the R&D project C-Tower has investigated the feasibility of a composite tower structure, which has proven to be a potentially successful concept. After two years of study, the project partners Jules Dock, Knowledge Centre WMC and ECN will work together on IDL-Tower: the integral design of lightweight composite towers.

Objective

Introducing composite towers in the offshore wind industry will benefit the profitability of offshore wind by reducing installation costs (less weight), reducing maintenance costs by using less corroding materials and improving operational lifetime using the positive damping effects of composite materials. It is also an opportunity for The Netherlands to develop its component-production industry and may make the feasibility of floating wind turbines worldwide more realistic. The IDL-Tower project builds on the research in C-Tower and aims to optimize the existing composite tower by choosing

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an integral design approach. In C-Tower a first concept of a composite tower was constructed using a 10MW DTU-turbine case, resulting in a lightweight and flexible tower of which installation and maintenance costs are lower compared to steel equivalents. In IDL-Tower the case study will be re-evaluated and used in an integral design study. The effects of a lighter, more flexible composite tower, with substantial lower eigen frequencies than a conventional steel tower, will influence the operating conditions of the turbine (controller), the loads on monopile and joints and the overall lifetime.

Short description

During IDL-Tower the first objective is to develop a composite tower using an integral design approach including optimizing the power control algorithm. Also the effects on the monopile, wave impact and ground/soil effects will be investigated, as will other relevant parameters. Secondly, a smaller case study looking at an existing ECN test site will be part of the research, including the selection of a suitable test turbine and blades. This pre-study is a first step towards demonstration and testing of a composite tower with a working turbine.
Besides both the case studies, the impact of a lightweight tower during the entire operational lifetime will be researched. Subjects like Operations and Maintenance, Levelized Cost of Energy and Life Cycle Analysis will be addressed.

Results

The integral optimization will result in a lighter composite tower design. The control of the turbine will be optimized for load reduction for the much more flexible tower with lower eigenfrequencies. It is outside the scope of the project to redesign the rotor blades. Part of the investigations will deal with scaling effects: Will the benefits increase or decrease when towers and turbines become even larger? What is the best production technique for composite towers with a length of +100m length and 8m diameter? What is the best O&M strategy? How can the FRP towers be useful at the end of life? This project will answer these questions, clearing

the way for a first 1:1 demonstration of composite towers.

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