# The way has been cleared for mega wind turbines of 20 MW

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The present largest wind turbines have a capacity of 5-6 MW. Following five years of research at the joint European project UpWind, led by Risoe National Laboratory for Sustainable Energy, the Technical University of Denmark (Risoe DTU), scientists now can present the first design basis for developing mega wind turbines of 20 MW.

The EU project UpWind started five years ago with an ambitious plan: more than 120 wind scientists' efforts and a budget of 23 million Euro were to provide the answer to the big question: Is it possible to build a 20 MW wind turbine using the methods and materials we know today? One single wind turbine of this type in the North Sea would provide electricity for 15,000 to 20,000 dwellings.

## Is it technically possible and economically feasible?

There are 16,000-20,000 components in a wind turbine, and they're obviously not all analyzed in the project. The researchers focused on the main components in wind turbines to find answers to two fundamental questions: Is it technically possible to build a 20 megawatt wind turbine? Is it economically feasible to build it?

"The overall conclusion we can draw from the UpWind project is that if you built a 20 MW wind turbine based on existing technologies and methods, it will be 15-20 percent more expensive than today's wind turbines. I find that far from discouraging, for immediately I would

expect that such a simple upscaling would give even higher energy prices, "says Peter Hjuler Jensen, Risø DTU, who has been in charge of the project.

## An intelligent wind turbine blade is one of the solutions

Risø DTU and DTU Mechanical Engineering has significantly contributed in the development of aeroelastic design methods for wind turbines of up to 20 MW. Aeroelastic methods are used to calculate the wind turbine's dynamic response to turbulence in the wind. In the UpWind project, Risø DTU and DTU Mechanical Engineering studied aeroelastic methods, materials, management and regulation and many other technologies to be developed for designing a 20 M wind turbine.

Risø DTU has contributed very significantly to UpWind through the development of smart rotor blades with trailing edge-regulation. That means that the trailing edge of the blade can move up and down like flaps on an airplane.

"We have worked on developing several different types of sensor systems such as pitot tubes which are also used to measure the wind speed of aircrafts. Should we introduce these innovations to existing wind turbines, they would probably be more expensive, but if they are implemented on very large turbines the savings from load reductions probably would be competitive. Our conclusion is that upscaling opens up for new technologies, "says Peter Hjuler Jensen.

Various types of movable trailing edges for turbine blades and different mechanisms for activating the trailing edge movement have been tested, and the aerodynamic properties of the movable trailing edge have been studied in wind tunnels.

# Laser technology to measure wind conditions

The second area in which Risø DTU has been making a substantial contribution to UpWind, is in the development of LIDAR technologies. A LIDAR measures the properties of the wind by means of laser beams. When UpWind started, Risø was the only research institution with a prototype of LIDAR to measure wind speed and with applications in wind energy research.

"During the five years of the UpWind project we have succeeded in developing the technology from this first prototype to a total of more than 200 LIDARs, of which 40 have been calibrated at Risø DTUs test station in Høvsøre in the western, more windy part of Denmark. LIDARs has now been developed into a stage where they easily can compete with the traditional anemometers used to measure wind speeds, and in amazingly short time, we managed to start using this new technology, says Peter Hjuler Jensen.

"You can imagine the difference between the two methods by thinking of a football field. With an anemometer you can measure the wind conditions in an area corresponding to the dot in the middle of the football field. The LIDAR is able to measure the wind on the whole football field in one go," says Peter Hjuler Jensen. It will open up new opportunities to gain insights into the wind turbulence, which affects wind turbines. Risø DTU has further explored the possibility of placing the LIDAR in the hub of a wind turbine, where it will be possible to let the LIDAR regulate the trailing edge. This would reduce fatigue and extreme loads on wind turbines.

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