A test center for wind turbines in northwestern Jutland

August 17 2010

The national test centre for wind turbines at Řsterild is vitally important for consolidating and expanding Denmark's leading position within the wind energy sector.

At the same time, Řsterild will pave the way for more wind energy in the Danish energy system, thereby contributing to making Denmark independent of fossil fuels. At the national test centre at Řsterild in north-western Jutland, tomorrow's mega wind turbines measuring up to 250 metres in height can be tested, and it is therefore here that the wind turbines of the future will be developed and produced. The test centre will thus help to safeguard lots of Danish jobs within the wind energy sector, both at the wind turbine manufacturers and at the numerous subsuppliers to the wind energy sector.

The national test centre is going to be big. On a more than 4-kilometre-long site, seven mega wind turbines up to 250 metres in height will be erected for testing purposes. Moreover, 150-metre-high measuring masts will be constructed to perform measurements on these massive wind turbines, as well as two 250-metre-high light masts which will also be used for meteorological measurements. The measuring masts will thus almost rise as high as the pylons on the Great Belt Link. Mega wind turbines will cost in the region of several hundred million Danish kroner each.

"This initiative is vitally crucial to preserving Denmark's leading position within wind energy R&D and thereby safeguarding the Danish wind

turbine industry's dominant role in the global wind turbine market," says Peter Hjuler Jensen, Head of Risø's Wind Energy Division.

The Ř sterild test centre will supplement Risø's existing test station for large wind turbines at Høvsøre in western Denmark south of Lemvig. At Høvsøre, it is only possible to test wind turbines up to 160 metres in height, and there are also significant topographical differences between Høvsøre and Ř sterild. The new test centre opens up completely new vistas for wind research:

"Unlike Høvsøre, Ř sterild has both an open landscape and woods so that of the seven test stands, two of the test sites will be for testing wind turbines in conditions which are prevalent in wooded areas," says Peter Hjuler Jensen, and adds: "This is why Ř sterild is a fantastic supplement to Høvsøre, which is an open, flat area. Ř sterild provides a perfect mix of open stretches of countryside as well as woodland. It gives us far more varied measuring possibilities, which will contribute many new facets to wind power meteorology."

He points out that the wind turbines at Ř sterild will be placed in an area with a higher degree of 'roughness' than Høvsøre, which, in addition to being able to site two turbines in a stretch of woodland, translates into unique possibilities for testing wind turbines under greatly varying conditions.

The idea is that wind turbine manufacturers can buy or lease a test stand and erect their wind turbines, after which Risø DTU's researchers can, in collaboration with the industry, carry out a wide range of complex measurements in connection with the testing of the wind turbines. A number of private companies that perform measurements on commercial terms will also assist the wind turbine manufacturers.

New and important knowledge for wind power

meteorology

The extremely varied landscape at Ršterild presents new opportunities for examining the dominant wind conditions present in different types of terrain. "We will exploit this to expand our theoretical knowledge within wind power meteorology, and we can then verify the theories through measurements at Ršterild. Ršterild therefore presents unique possibilities for improving our calculation models," says Peter Hjuler Jensen.

Researchers will also study the wind conditions at different heights, because not that much is known about wind conditions in the air strata above 250 metres where the wind turbines operate. "There hasn't really been a need for it before now," says Peter Hjuler Jensen. Together with Light Detection and Rangings (LIDARs) the new 250-metre-high measuring masts allow wind measurements at considerable heights. This will ensure less uncertainty in the calculation models, giving the wind turbine manufacturers a higher degree of certainty that they are designing wind turbines correctly in relation to the conditions, which leads to increases in operational reliability and lifespan as well as cost-effectiveness

"Moreover, we get a much more precise determination of wind resources, which makes it more certain that the major investments in wind turbines will generate the expected returns," says Peter Hjuler Jensen.

Improved design basis for mega wind turbines

The marked differences in the landscape between Høvsøre and Ršterild also make it possible to study how the wind turbines react to such differing wind conditions. For example, there is far more wind turbulence at Ršterild than at Høvsøre. This knowledge can be used to

improve the so-called aeroelastic models, which are models for aerodynamic design and wind turbine optimisation. They are used, among other things, for numerical wind tunnels where wind turbine designs are tested virtually in supercomputers. "There will be far less uncertainty when designing wind turbines in future," says Peter Hjuler Jensen. He also says it presents completely new possibilities for getting a better insight into the wind turbines' aerodynamic response to the wind conditions, while very precise measurements can be conducted on the entire transmission system from the rotor to the generator that produces the electrical current. This will greatly decrease the likelihood of errors and breakdowns in mega wind turbines.

Wind turbines connected to the electricity grid using highly advanced technology

With Denmark on its way to a fossil fuel-free future, there is a pressing need for suitable facilities for testing how best to connect wind parks to the electricity grid without the risk of grid system failure.

Ršterild is expected to offer unique possibilities in this respect. An advanced grid-connection facility is planned, which will make it possible to test the wind turbines under varying conditions without affecting the overall electricity grid. It is vitally important to study this aspect in depth as an ever-increasing proportion of electricity production is coming from wind power, and wind turbines therefore need to make a greater contribution to maintaining a reliable grid.

With Risø as the lead partner, a consortium has been set up with e.g. Vestas, Siemens, Suzlon, Gamesa, DONG Energy, Vattenfall and ABB, which has received funding from the Energy Technology Development and Demonstration Programme (EUDP) for a preliminary project. This is expected to be completed at the beginning of 2011. The EUDP

preliminary project will help to assess the possibilities for building an advanced grid-connection facility.

Once the preliminary project has been carried out, the grid facility can be ready for use by early 2013. The test centre is designed for seven 16 MW wind turbines, or 112 MW in all, a huge amount of electricity, so the test facility therefore needs to be connected to the overall 150 kV grid.

"Basically, we will be able to insert a filter between the wind turbines and the electricity grid by switching between DC and AC and back again. This enables us to test things on the wind turbines which the electricity grid is unable to 'see' or 'feel', which is a basic requirement for being able to experiment with the connection of wind turbines to the grid. After all, we do not want to see the test centre at Ršterild causing power cuts in the grid as a result of the researchers' experiments," says Peter Hjuler Jensen.

With the new grid-connection facility, researchers can, for example, subject the wind turbines to changes in grid frequency and observe how they react. And they can identify methods for preventing the wind turbines from disconnecting in the event of grid frequency variations. "In the wind turbine industry, an important competition parameter is that wind turbines are tolerant to errors and frequency variation in the electricity grid," says Peter Hjuler Jensen, and continues: "All in all, we expect Ršterild to become a unique test facility worldwide and to give researchers and the wind turbine industry a broad palette of unique experimental possibilities so in fact this represents a strong card in the efforts being made to maintain Denmark's leading position within wind energy research."

He is proud that Risø DTU is involved here with something unique, which also catches people's interest abroad: "No one I have met is in any

doubt that this is the way ahead, but that we have come as far as we have in Denmark surprises everyone," he says.

Now that the legislation is in place, the project is a significant step further towards becoming a reality. Peter Hjuler Jensen is very confident that the project will run smoothly because it is in the hands of the same people that helped to build Høvsøre, including Freddy Mortensen from DTU Campus Service who managed the Høvsøre construction project, as well as Poul Hummelshøj, Head of Programme at Risø DTU's Wind Energy Division, who is now responsible for running Høvsøre. "Given all the competencies and experience at our disposal, I am convinced that this will be a test centre that fully lives up to all the very high expectations. Throughout the entire process, a strong, interdisciplinary team of all sorts of experts, from lawyers to hard core researchers at DTU, has steered the project steadily through the negotiations," says Peter Hjuler Jensen. "As Denmark's National Laboratory for Sustainable Energy, we are obviously obliged to launch this initiative which can secure Denmark's leading position within wind energy research and wind turbine production. We are justifiably proud to take on this important, national task," he concludes. The task is one which the former Risø would have found difficult, but following the merger with DTU, has the size to take on such big challenges.

In addition to testing mega wind turbines, Řsterild will also make it possible to study CO_2 exchange between woods, the landscape and the atmosphere, a central element when assessing tomorrow's climate changes. It has also been agreed that the test centre will be home to a monitoring programme that can help Denmark to become world-leading, not just within wind energy research but also regarding the impact of wind turbines on the natural world.

Provided by Technical University of Denmark