Case Studies in Wind Turbine Testing and Validation

Reliability and performance of wind turbines, both offshore and onshore, has risen in importance in the renewable energy industry. Not only are these factors crucially important for the ease of operation and maintenance, robust wind farms are a necessity if wind energy is to compete with other sources of energy, both renewable and non. As such, more time and money is being invested in the production and testing of prototypes of wind turbines and their components. The following is an overview of two test cases currently in process.

Vestas V164-8.0 MW Blade and Drivetrain Testing

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Vestas recently started testing their 80 metre blade, which is the longest blade produced by this Danish company. The blade is constructed using a structural shell design rather than the spar at the centre of the blade to ensure loads are carried by the shell. The blades, when installed on the turbine, will have a swept area of 21,124m2.[i]

Testing of the 33 ton blade will take over approximately six months during which time 25 years of wind conditions of the North Sea will be simulated. [ii] The turbine on to which these blades were mounted was installed at the Danish National Test Centre for Large Wind Turbines in Østerild, north Denmark, with testing to start the first quarter of 2014. [iii] Three blades were transported from the Isle of Wight research and development facility in the UK to the onshore test facility in late 2013.[iv] Testing assistance will be provided by Dong Energy.[v]

According to the chief technology officer of the company, Anders Vedel, "Moving as much of the verification process as possible into our state of the art test centre ensures the blade, the bearing and other components perform to the high standards our customers expect."[vi]

As the world's largest turbine, the mammoth structure is projected to provide enough electricity for 75,000 European households. At the same time, the design and manufacturing process are expected to reduce both operational and maintenance costs in part because of the sheer size of the machines and

the amount of energy they each will produce.[vii] In addition to testing the blade, the prototype will also be used to test the wind turbine's drivetrain.

That said, the drivetrain has already completed in-house evaluation on the 20-MW test bench at the Vestas Aarhus harbor-based testing facility. This is part of the company's aim to reduce downtime and increase reliability in order to cut lost production factor (LPF).[viii]

As with the current prototype, the test bench, which is the largest and most powerful in the industry, is able to validate performance, reliability, and robustness of a nacelle, simulating 25 years of wear and tear. Measuring 42 metres in length and 9 metres long, the test bench weighs 700 tons including the motors, wind simulator, and generators. It required the installation of a 50 metre deep concrete foundation to support the weight. [ix]

Vedel explained that, "Vestas has invested in the industry's most powerful test bench to ensure the turbine will perform in challenging conditions for 25 years. The superior testing expertise we have accumulated over the last decade is a key part of giving confidence to our customers that the machine is of the high quality that they expect from Vestas."[x]

Image Via Flickr: Garycycles4

The controlled test environment of this powerful dynamometer is able to reproduce the harsh conditions of the North Sea. To run the simulator, the test bench was fitted with a 26,820 brake horsepower equivalent energy in order to produce 20 MW. This will accurately simulate the torque applied to the turbine components in real life, which can measure up to 19 meganewton metres.

Simultaneous to this testing, the Vestas V164-10 MW drivetrain will also undergo simulations at the Lindoe Offshore Renewables Centre (LORC) nacelle testing facility on the island of Funen in eastern Denmark. With tests starting the summer of 2014, the drivetrain will undergo further evaluation for two and a half years there.[xi]

Hyundai Heavy Industries' 5.5 MW Wind Turbine Testing

Another interesting test project is that of the Hyundai Heavy Industries' (HHI) 5.5 MW wind turbine. When fully operational, it is estimated that one of these 5.5 MW

offshore wind turbines will be able to power 1,100 households annually.[xii]

The drivetrain is a compact design comprised of a cast main carrier as main structural element. It is designed with a flanged three-stage gearbox and a main shaft with a semi-integrated assembly. A high speed generator is mounted separately using a bolted-on generator frame. [xiii] The hope is to market this particular drivetrain to the Chinese offshore wind power market.[xiv]

The prototype of this machine was recently installed in in Jeju Island, South Korea. The 100 metre hub height of this turbine accommodates a rotor diameter of 140 metres, and is the largest wind turbine every installed in South Korea. It will be tested in particular to withstand harsh winds of up to 62.5 m/s as well as the corrosive impacts of sea water. [xv] The purpose of the current testing is to have the design certified and authenticated by UL/DEWI-OCC before the end of 2014.[xvi]

However, prior to the installation of this prototype, Dongfang Electric (the original designer and developer) conducted testing of the system. It was put through full-load testing by Dongfang as well as a low-voltage ride-through test at the Deyang, Sichuan province factory. The drivetrain passed the tests, running fault-free for 7.5 hours with a maximized operational load of 5.134 MW. [xvii]

“We not only plan to supply the three same size offshore wind turbines to the South-Western 2.5GW Offshore Wind Farm Project in Jeolla province, South Korea, but also to accelerate marketing campaign overseas including Asia and Europe on the basis of ample experiences and knowhow we have accumulated from a variety of offshore plant projects,” said an HHI official. [xviii]

Though costly to construct and test, more and more of these prototypes are likely to be used in the perfection of wind energy in the years to come as manufacturers push to produce the most cost-effective solutions.

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