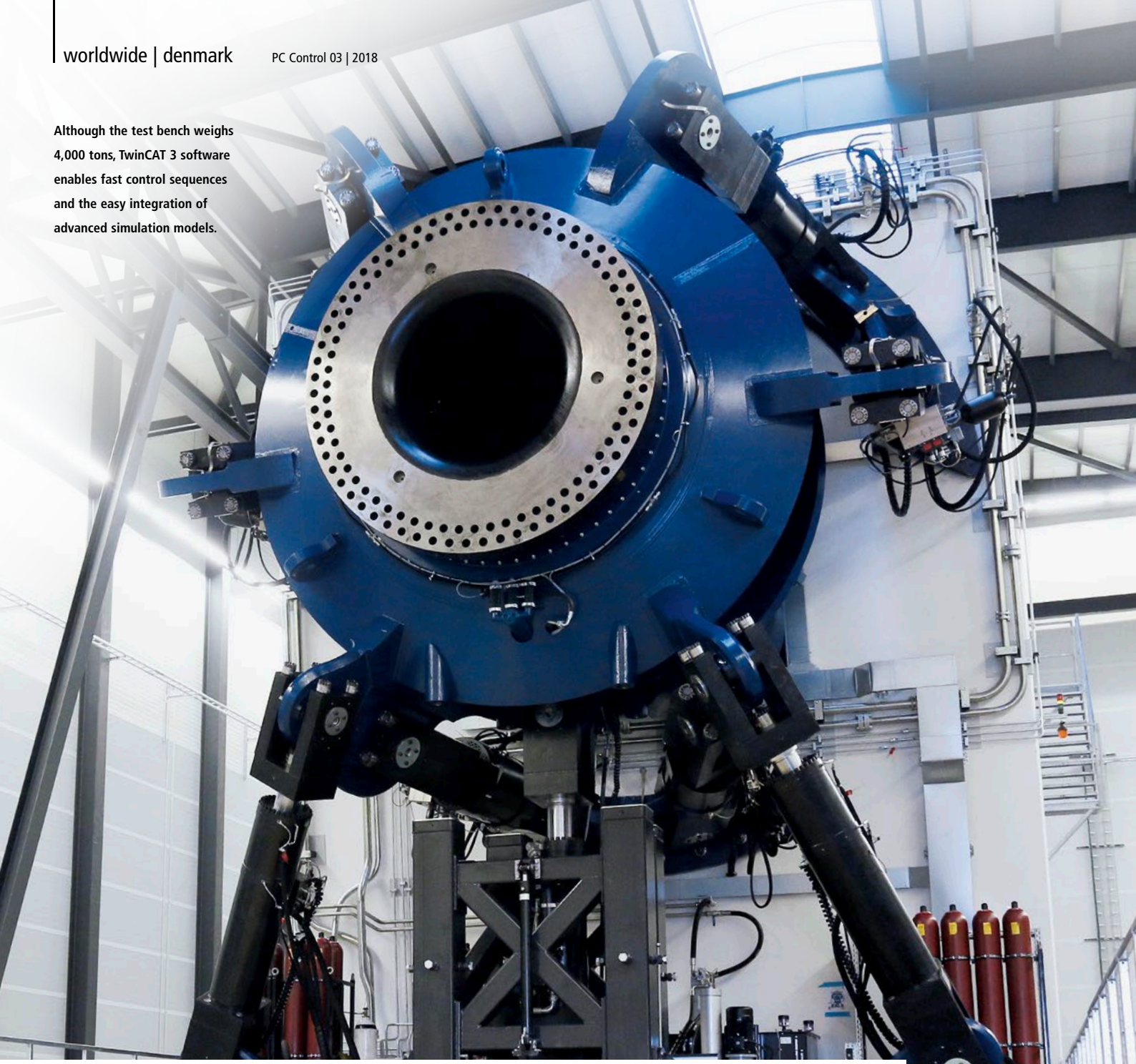

Although the test bench weighs 4,000 tons, TwinCAT 3 software enables fast control sequences and the easy integration of advanced simulation models.

TwinCAT 3 controls a HALT test bench for wind turbines up to 10 MW

# Wind turbine HALT enables rigorous testing

Denmark is setting a new standard for wind turbine testing technology. The Lindø Offshore Renewables Center (LORC) is capable of testing the nacelle of a wind turbine for all possible wind and torsion loads it will be subjected to during its service life of more than 25 years. The automation technology for the control of the test bench was supplied by Beckhoff.

As wind turbines become ever larger and more expensive, the need to minimize the risk of damage over their entire service life increases as well. This requires the execution of load tests on real turbines prior to starting series production of a new wind turbine. Providing the most rigorous Highly Accelerated Lifetime Test (HALT) possible is the mission of LORC, one of the world's largest test benches for wind turbines with a capacity of up to 10 megawatts, which went online in December 2017 in Munkebo, Denmark. The large wind simulator uses mechanical, hydraulic and electric functions to generate as many stresses and strains in six months as a wind turbine is subjected to over its entire 25-year service life. Such tests help identify weaknesses in design and construction so that any necessary changes can be made before the turbines are manufactured in volume.

**Test bench with realistic conditions**

As the facility's turnkey supplier, Danish engineering company R&D Test Systems was responsible for the entire project from designing and developing the mechanical components to programming and commissioning. The complex development and implementation processes took many years to complete. To ensure a smooth commissioning process and guarantee reliable test bench performance, all functions had to be thoroughly simulated and tested. The simulation models and test results were used for further software development and operator training.

At the testing center, the mechanical components of a wind turbine are subjected to realistic fatigue tests based on wind and weather data from wind farms all over the world. "The ability to simulate real-life conditions is becoming increasingly important for the wind power and other industries employing heavy-duty solutions. Manufacturers can save many resources over the long term if they know in advance how a wind turbine will react in real-world use," explains Michael Nielsen, General Manager, Beckhoff Denmark. With TwinCAT 3 software, powerful Industrial PCs and numerous EtherCAT I/O terminals, Beckhoff supplied the foundation for specification and monitoring of all test scenarios. Danish control cabinet supplier Tricon Electric A/S installed the components.

Each newly developed wind turbine must undergo testing as a complete system. Since this is very difficult considering the dimensions of modern turbines, manufacturers test the nacelle by itself, simulating the effects of the rotor, the electrical circuitry and other environmental conditions as realistically as possible on the test bench. To map all the forces and torque factors that affect the main turbine shaft and nacelle, the new HALT test bed required a unique design. Building the facility, which is 31 meters long, 8 meters wide and 13 meters tall, required 310 tons of steel, and 107 concrete pillars that had to be buried 16 meters deep into the ground. Weighing 4,000 tons, the test bench features a hydraulic bending system that can apply bending moments of up to 25 MNm to the turbine being tested. It generates these forces with hydraulic cylinders. A drive system with a torque of 14.5 MNm generates the wind force applied to the rotors.

When wind shears, gusts or turbulences impact the rotor, this generates additional bending moments and thrusts. The test bench recreates these forces via hydraulic cylinders in a hexapod construction. Since the tower and rotor are missing, however, the system must model these real-life conditions as precisely as possible, which is why simulation models calculate the interactions occurring between nacelle and rotor in real time and send the corresponding signals to the hydraulic cylinders. The system is capable of simulating the widest possible range of operating conditions, such as the nacelle's behavior in gales or after grid failures and emergency stops.

**Simulations in the millisecond-range**

During test runs, the sensors must be able to acquire, process and transmit vast data quantities in the shortest possible time, which is why all test bench components and test objects were modeled in MATLAB®/Simulink® prior to commissioning. "Since the software must be able to respond to diverse test scenarios as quickly as possible, we wanted to achieve the shortest possible cycle time," says Allan Mogensen, Software Manager at R&D Test Systems. "We selected Beckhoff systems because the TwinCAT 3 automation software enables us to achieve a cycle time of 1 millisecond."

The MATLAB®/Simulink® software interface in TwinCAT 3 is another benefit, adds Allan Mogensen: "To ensure excellent operability and performance, we simulated all testing functions on a computer by creating MATLAB®/Simulink® models of all physical components of the test bench and test objects that LORC customers wanted to test in reality. The MATLAB® model simulations act as a benchmark for later real-life tests on the real physical mechanic system, without posing risks to the mechanic system. This enabled us to reach our goal faster than originally planned."

Allan Mogensen summarizes: "The test bench is a lighthouse project for Denmark and the Danish wind power industry. We delivered a HALT facility that enables us to test wind turbines faster and more effectively. Having sufficient computing performance was particularly important for our implementation. The hardware and software from Beckhoff satisfied these requirements in an ideal way." Morten Hauge, Sales Engineer at Tricon Electric, agrees: "Supplying such an advanced solution for a project as large as this one was an interesting job. Beckhoff hardware feature the level of intelligence you need for such demanding tasks."

**Installed in six control cabinets supplied by Tricon Electric, the Beckhoff hardware components communicate with each other over the powerful EtherCAT network.**

Further information:

www.lorc.dk
www.rdas.dk
www.tricon.dk
www.beckhoff.dk