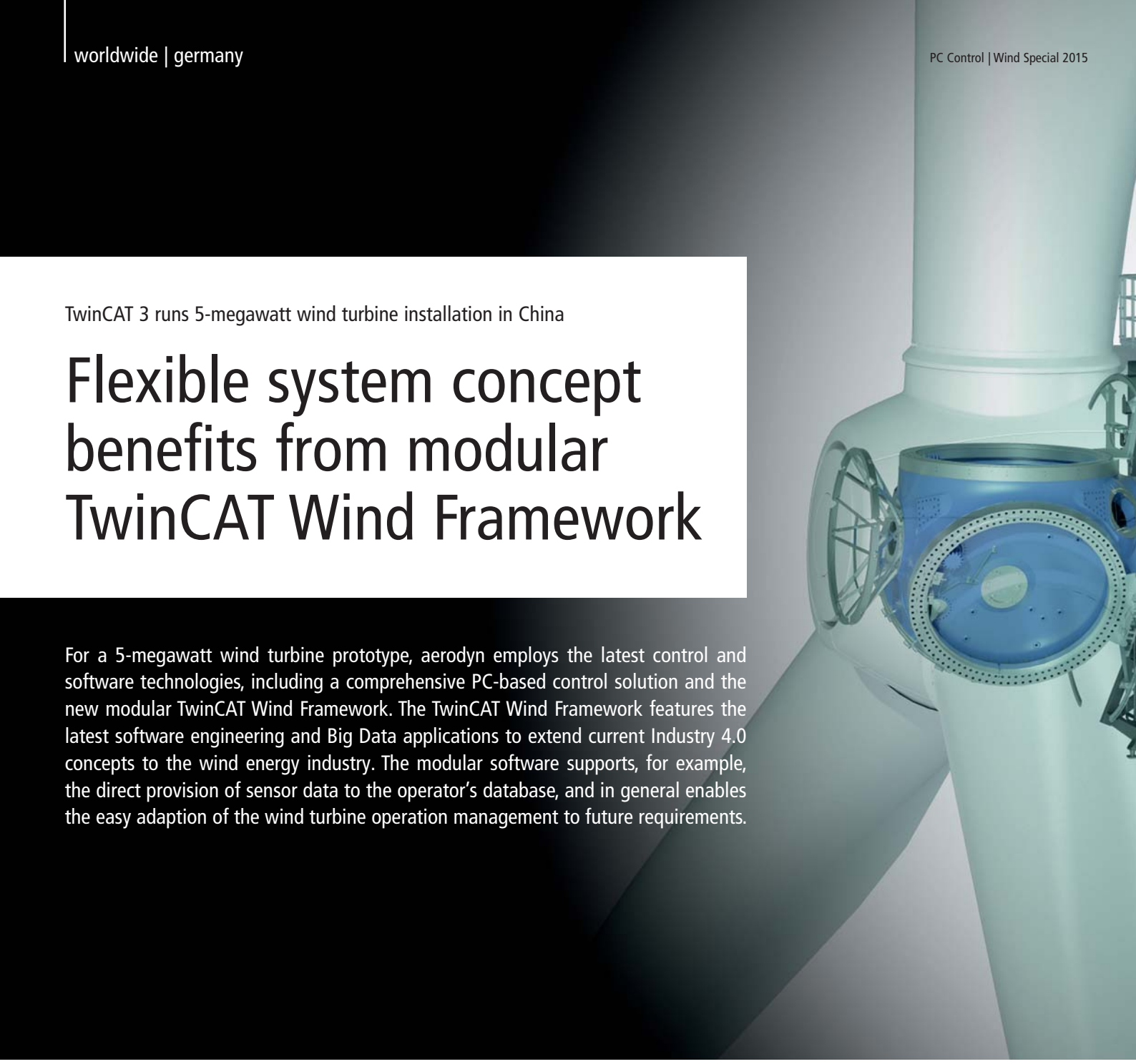
TwinCAT 3 runs 5-megawatt wind turbine installation in China

Flexible system concept benefits from modular TwinCAT Wind Framework



For a 5-megawatt wind turbine prototype, aerodyn employs the latest control and software technologies, including a comprehensive PC-based control solution and the new modular TwinCAT Wind Framework. The TwinCAT Wind Framework features the latest software engineering and Big Data applications to extend current Industry 4.0 concepts to the wind energy industry. The modular software supports, for example, the direct provision of sensor data to the operator's database, and in general enables the easy adaption of the wind turbine operation management to future requirements.

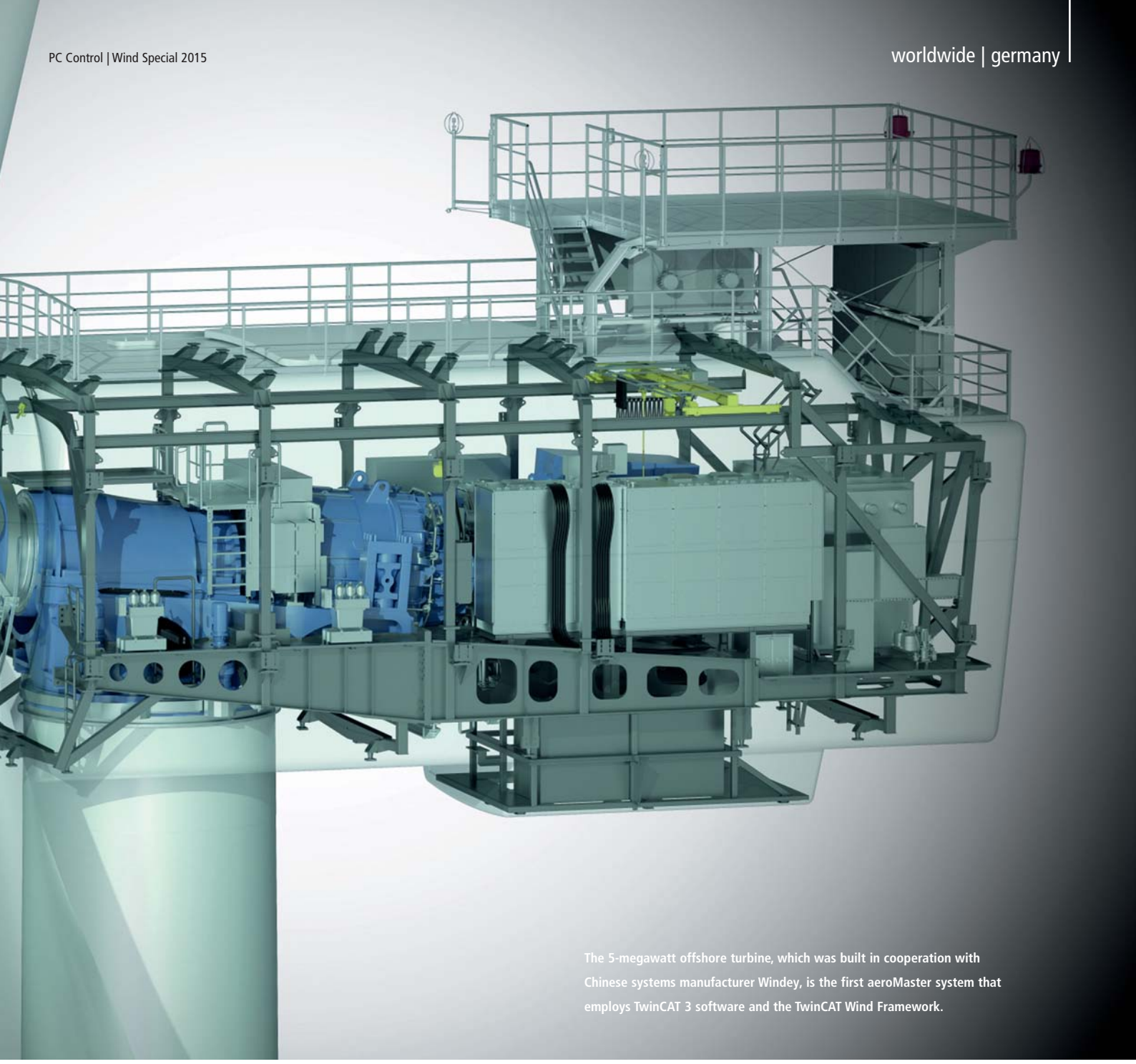
The engineering specialists of aerodyn Energiesysteme GmbH, based in Rendsburg, Germany, develop wind turbines and rotor blades. The company also offers redesign and improvement services, as well as licenses for existing system designs. The company's products are based on its modular aeroMaster technology, a three-blade rotor with electric blade adjustment and a variable-speed generator/inverter. The aeroMaster is available in three versions for different climate types, as well as for special wind categories, which enables worldwide turbine operation even in extreme wind speeds.

Intended for offshore installations and featuring a rotor diameter of 139 meters with a nominal power output of 5 megawatts, the new aeroMaster 5.0 was designed for wind conditions according to GL 2009 TC 2B, i.e. average wind speeds of 8.5 meters per second and a turbulence intensity of 16 percent, as well as for the highest requirements in terms of energy production and operating safety. The prototype, which was built in collaboration with Chinese systems manufacturer Windey, also features redundant systems for more reliability, special ventilation, and climate control technology to prevent corrosion in the nacelle, as well as a rope-down platform for maintenance technicians.

5-megawatt installation requires extensive control technology

The electrical installation consists of three switching cabinets:

- The tower control cabinet contains the operating controls, the visualization system, the TwinSAFE-based safety system, and the equipment linking to the higher-level wind farm communication system, which is designed as an EtherCAT slave, ready for subsequent series applications.
- The control cabinet in the nacelle manages all nacelle and hub sensors and actuators, as well as the pitch control and inverter.



The 5-megawatt offshore turbine, which was built in cooperation with Chinese systems manufacturer Windey, is the first aeroMaster system that employs TwinCAT 3 software and the TwinCAT Wind Framework.

– The inverter cabinet, which is also installed in the nacelle, houses the inverters for certain fans and pumps, as well as the azimuth drives.

The control cabinet in the tower, which also provides easy maintenance access, houses the core of the control system. A Beckhoff CX2030 Embedded PC with an Intel® Core™ i7 processor controls everything independently, i.e. without any remote access. What is remotely accessible, however, is the Beckhoff C6930 control cabinet IPC, which features an Intel® Core™ i5 processor and an optional 256 GB solid-state drive. In addition to providing a remote maintenance access point, it handles monitoring and visualization functions via a Beckhoff CP2915 15-inch Control Panel. With its significant solid-state drive capacity, it also represents a powerful data storage system. Markus Rees, Managing Director of aerodyn, explains: "This is especially important with a prototype, for which we must collect much more data than would occur in normal operation. The control cabinet IPC and the Control Panel used for visualization purposes in the nacelle control cabinet are, however, exclusive to this prototype and will not be required for the regular turbines."

The flexibility of the PC-based control solution delivers additional benefits, says Rees: "We benefit from the extremely broad and modular I/O spectrum. All in all, we cover 408 data points, which are recorded and processed via 218 EtherCAT digital I/Os, 110 EtherCAT analog I/Os, nine CAN masters, and two RS485 interfaces, as well as 31 IO-Link terminals, five encoder terminals, and two power metering terminals. In addition, 33 TwinSAFE terminals are used for the personnel and machine safety systems, including emergency-OFF, overspeed protection, vibration protection, and azimuth limit control. TwinSAFE has proven to be the ideal safety solution for wind turbines, because the TwinSAFE communication via standard EtherCAT can handle the long distances involved,

Both the tower control cabinet (right) and the nacelle control cabinet (left) of the turbine prototype use a Beckhoff CP2915 multi-touch Control Panel with a 15-inch screen for easy operation.

The Beckhoff CX2030 Embedded PC (left) in the tower control cabinet controls the entire system, while the Beckhoff C6930 control cabinet IPC (right) handles visualization, monitoring and remote access in the prototype installation.

including the option to use fiber optic cabling. Integrating the systems is also easy, because all safety data is available in the controller automatically and without any additional hardware."

EtherCAT has proven its value in wind turbines, not only because of the ease with which it handles the long distances between the tower base and the nacelle, which often exceed 100 meters. Also important, according to Rees, are the cabling redundancies and the extensive diagnostic capabilities, which make troubleshooting easy. The combination of all these features delivers high-performance communication capabilities for the core turbine components. Even the wind farm communication can be seamlessly integrated, as it was in the single prototype just installed, Rees notes.

TwinCAT Wind Framework supports modular concepts

The aeroMaster 5.0 from aerodyn is the first wind turbine installation that employs the TwinCAT 3 software generation and the new TwinCAT Wind Framework. With its modular design, the TwinCAT 3 Wind Framework fully supports the turbine's modular hardware design, which can include pitch systems, converters, and generators from different manufacturers, because it provides control technology and wind industry expertise from Beckhoff in encapsulated modules and in an application-specific template. These modules include a wide range of services for wind turbine automation, as well as real-time access to all data and long-term database management. The application template provides a modular architecture that allows for quick and efficient engineering.

Markus Rees: "We use the full range of the TwinCAT 3 Wind Framework and have it linked to a Microsoft SQL Server database. Since the framework already comes with essential operating tasks, you no longer have to implement, modify, and maintain them. Our engineers can therefore focus fully on the actual turbine functions without worrying about basic operating functions. Also, the integrated and permanent data storage in real-time simplifies analyses and diagnostics considerably. In addition, the modular architecture of the TwinCAT 3 Wind Framework makes it possible to substitute individual software modules. We can easily reuse existing functions, as well as add new ones."

As Markus Rees explains, aerodyn also leverages the typical benefits of TwinCAT 3: "To determine extreme and regular operating loads, the controller algorithms from the wind turbine simulation can be easily taken from the source code and integrated as C++ modules. In addition, the integration into Visual Studio®, coupled with source code management support using Subversion, has made project management and the collaboration among engineers in Germany and China considerably easier."

Further information:

www.aerodyn.de

www.beckhoff.com/TwinCAT-Wind

The aeroMaster rotor bearing of the 5-megawatt turbine combines the benefits of a dual shaft bearing with a clearance-free bearing design, which for the industry is a very compact nacelle – although its size is still quite impressive.