DeWind develops new drive system for D8.2 wind turbine

New design for the emerging U.S. wind energy market

The German wind turbine manufacturer DeWind is in the news again with a radically new design. The new DeWind D8.2 is primarily intended for the U.S. market. Beckhoff was the central partner for the development of the control and automation system.

On January 7, 2007 DeWind had cause for celebration. It was the day the new DeWind D8.2 was commissioned at Cuxhaven, Germany. It marked an energetic comeback to the wind sector by the Lübeck-based manufacturer with a fully revised design for its flagship model.

From the outside, the DeWind D8 seems unchanged. Only the windows in the nacelle roof provide a little more insight than in the past. Otherwise, the spectacular Porsche design has been retained: like all large modern wind turbines the system is pitch-controlled. The hub height (80 and 100 meters) and the rotor diameter (80 meters) are the same as in the previous model. With a rating of 2 megawatts, the capacity also remained unchanged.

However, almost everything changed inside. The reason is that DeWind, following the sale of the company to an English-American investor, repositioned its wind turbines primarily for the U.S. market. Accordingly, the special characteristics of the American energy supply system had to be taken into account. To start with, the U.S. grid is operated with 60 Hz, as opposed to 50 Hz in Europe. In addition, the American supplier General Electric has a patent on field-oriented converter systems for wind turbines and was blocking access to the U.S. market.

Breaking new ground for wind energy

DeWind therefore decided to use a radically new design, breaking with its own technological tradition. DeWind had used variable-speed systems since it was established in 1995. In such systems uniform voltage and associated high current quality is ensured by a double-fed induction generator and a converter. Strong variations in wind speeds on the rotor side must be converted to constant fre-

The prototype for the DeWind D8.2 was commissioned at Cuxhaven, Germany, in January 2007.

DeWind D8.2 in the Argentinean Andes at an elevation of 4,300 meters (over 14,100 ft)

quency on the grid side. The design enables DeWind to build systems that can be used economically onshore in areas with relatively low wind speeds. Systems of this type are successfully sold in Europe.

The move into the U.S. market forced the company to find new solutions. These efforts led to a design that is unparalleled in the wind energy sector. At the core of the new design is a variable-speed hydraulic gearbox. The three-stage planetary spur gear unit used in the European DeWind D8 model was replaced with a two-stage gear unit. The third stage was replaced with a WinDrive® unit, a highly dynamic mechatronic drive system from Voith Turbo.

This proven technology has been used for decades in the energy sector, particularly in applications where the focus is on operational reliability, precise control dynamics and low operating and maintenance effort.

With the aid of WinDrive®, the DeWind D8.2 converts the variable speed of the wind rotor into constant speed for the synchronous generator, which is directly connected to the grid. The converter that deals with this task in a double-fed induction generator is no longer required. This means that a complex electronic component is replaced with a low-wear drive system without any power electronics. In this way, DeWind is presenting a technology that is vastly different than the GE patent and can position its systems freely and without additional costs in the United States. At the same time DeWind is able to fully – and more effectively than the competition – meet current and emerging grid connection regulations.

In Germany wind turbines fed nearly 40 billion kWh into the country's electrical grid in 2007, equivalent to more than 7 percent of total German demand. This success leads to new challenges: wind turbines must be integrated into the grid

A 60 Hz version of the DeWind D8.2 was built in Sweetwater, Texas, in March 2008.

management arrangements, which becomes particularly relevant in the event of malfunctions, voltage drops or short circuits. Systems with synchronous generators are better suited for this purpose than systems with other generator systems. More than 95 percent of all electrical energy is generated with synchronous generators, which is why transmission and protection systems are designed for their inherent fault characteristics. Despite elaborate solutions, it is difficult for converter systems to reach the harmonic mains quality of a synchronous generator.

EtherCAT and TwinSAFE help put a new spin on wind turbine control

The redesign of the turbine system also required a redesign of the control and automation system. DeWind had developed the control system for the D8 in close cooperation with Beckhoff. It is based on a Beckhoff Industrial PC and TwinCAT automation software from Beckhoff. The application software was developed by DeWind. The control system analyzes around 350 I/Os. The real-time system requirements are within the range of a deterministic cycle time of 10 ms or around 1 ms with grid feeding and monitoring. The DeWind D8 already used flash drives for mass storage, not least in view of the harsh operating environment. The open Beckhoff control system permits connection via all commercially available PC interfaces.

EtherCAT was selected as the communication system: the DeWind D8.2 is equipped with two separate high-speed EtherCAT communication circuits for system and wind farm networking. The communication is based on optical fiber. System safety and availability are guaranteed via a redundant configuration.

The safety chain, which is usually hard wired in wind energy applications, was integrated in the automation hardware with TwinSAFE, the safety solution from

WinDrive® is a highly dynamic mechatronic drive system from Voith Turbo and replaces the IGBT converter. In this way, DeWind is presenting a technology that is vastly different than the GE patent and can position its systems freely and without additional costs in the U.S., while at the same time being able to fully meet current and emerging grid connection regulations.

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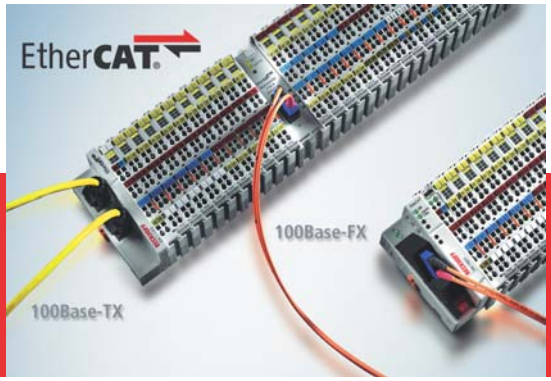

Besides its high performance and low system costs, EtherCAT also stands out due to its flexible topological characteristics. The maximum distance between two stations is 100 m (328 feet) using a standard Ethernet cable (100BASE-TX). With the new fiber-optic modules, greatly extended networking up to 2 km (1.24 miles) is possible (100BASE-FX).

DeWind D8.2: a proven solution thanks to real-time test environment

Beckhoff. Beckhoff makes safety systems more flexible through streamlined expansion and adaptation options, without loss of reliability in the event of an emergency.

Rapid development propels DeWind

The kick-off meeting between DeWind and Voith Turbo, the supplier of the WinDrive® drive system, took place in December 2005. Only twelve months later, in December 2006, a prototype was built at Cuxhaven, Germany, and commissioned in January 2007. DeWind is pleased: only one year passed between the decision to use Voith's WinDrive® solution and commissioning of the system. This would not have been possible without a motivated, competent and bold team.
In the meantime, DeWind built two additional systems of this type, one of which is installed at a record elevation of 4,300 meters (over 14,100 ft) in the Argentinean Andes. The third system, a 60 Hz version, was built and commissioned in Sweetwater, Texas, in March 2008.
This third system was built by DeWind's strategic production partner Teco Westinghouse at Round Rock, Texas. Teco Westinghouse is currently setting up a production line with a capacity of five systems per week. The company expects to build and install up to 80 systems in the United States during 2008.

→ DeWind Inc. **www.dewind.de**
→ Voith Turbo Wind GmbH & Co. KG
www.voithturbo.com/wind-technology

In order to complete the D8.2 project in such a short time, DeWind decided to take a new development route. The physical elements of the wind turbine and the drive system were simulated, tested and adapted to each other based on an advanced computer model. In this way, the turbine had already run in simulation for several hundred hours and mastered all conceivable operating situations before the power switch between the turbine and the grid was closed for the first time. As part of this development process WinDrive® was equipped with a separate Beckhoff control, into which controller systems were downloaded directly from the simulation during the trial phase. After the test phase, the WinDrive® control system was integrated into the turbine control system.

With support from Beckhoff, the development team also designed a real-time test environment for simulating the physical forces acting on the turbine and the real response of the turbine: the D8.x Real-Time Test Environment (RTSim). Both sides of RTSim consist of Beckhoff components and are, just like the real turbine, wired to the turbine control terminals. With RTSim it was possible to carry out detailed simulations of the dynamic system characteristics in advance of the installation and commissioning. The option of "dissecting" the model at any point in order to test various components and devices in the hardware loop is a tremendous advantage. The simulation not only replaces the actual test operation, it also enables existing turbine operation experience to be taken into account in advance of a new development in order to test the system characteristics and optimize the design. In this way, pilot production becomes much more reliable than in the past.