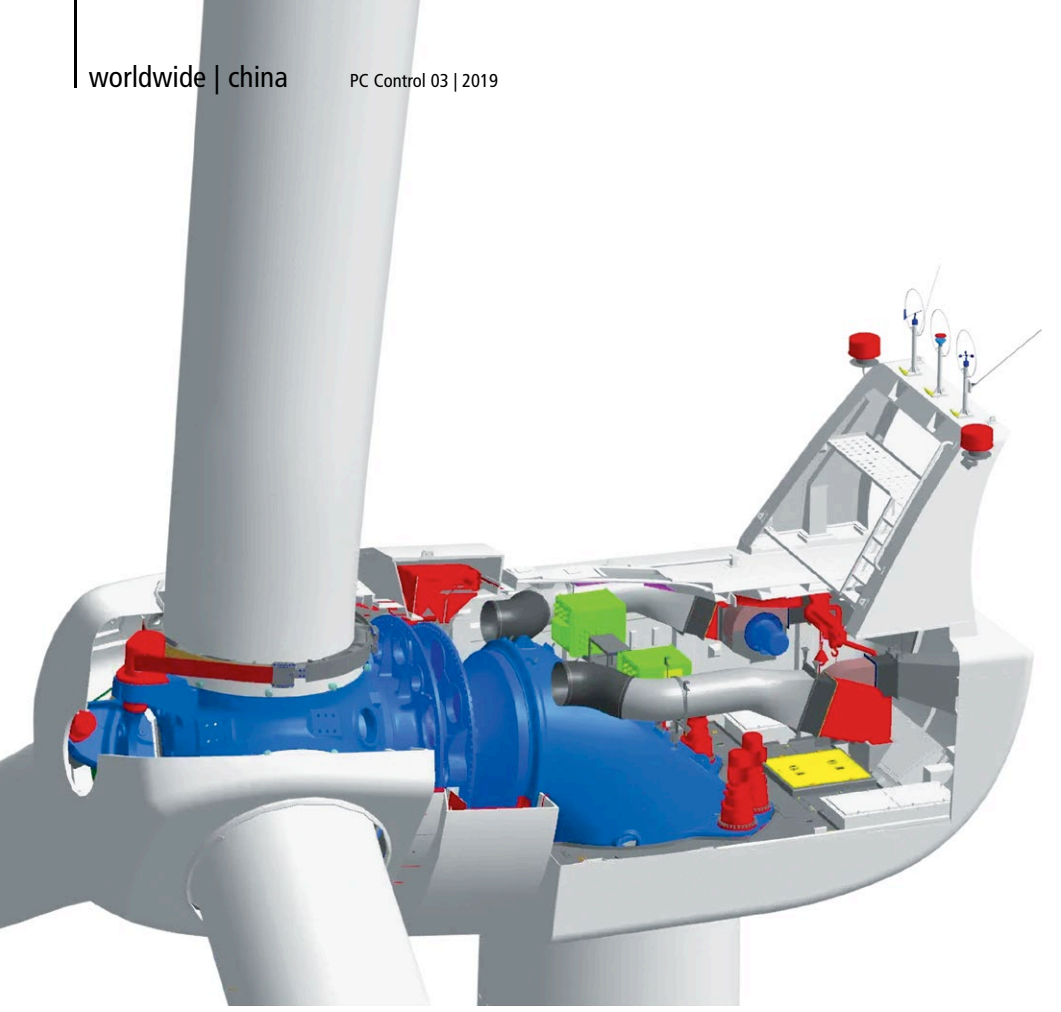
Online fault diagnostics improve wind turbine availability

TwinCAT Wind and oversampling technology enable highly efficient condition monitoring

High availability is a top priority for today's wind turbines, especially if they have a high output in the MW range. Chinese turbine manufacturer Goldwind has therefore developed an online condition monitoring system with all functions based on PC Control technology and EtherCAT from Beckhoff. The control platform communicates in real-time, reduces maintenance costs and increases availability.

The technology for wind turbines implemented by Goldwind and Beckhoff promotes the inexpensive, reliable and sustainable energy generation of the future.

For many years, Goldwind has been using online condition monitoring in its wind turbines to enable remote monitoring and determine the operating status of individual system components. Using appropriate sensors, the Condition Monitoring System (CMS) acquires and analyzes noise, vibration and temperature data, among other things, and warns of the possible failure of individual components in a timely manner. Anomalies that occur during wind farm operation are visualized for operators and maintenance staff on a convenient HMI. Impending faults can thus be predictively recognized and quickly rectified. As a result, wind turbine availability is increased and costly damage is avoided. This is particularly important for offshore systems on account of the poor accessibility at sea.



Predictive maintenance with TwinCAT Wind Framework software uses ultra-fast EtherCAT communication to monitor the main components in a wind turbine nacelle (in this case with direct drive), such as rotor blades, hub, pitch system, generator rotor, generator stator, gear system, wind measurement system along with the foundation plate and tower frame.

Goldwind: focus on sustainable power generation

Goldwind, a Chinese provider of wind energy solutions, was established in 1998 and has delivered 28,500 wind turbines worldwide to-date, corresponding to more than 44 GW of installed wind capacity. Today, the company, which is a licensee and now majority shareholder of wind turbine manufacturer Vensys, stands out as a technology provider for renewable and green energy. Goldwind has been selected several times as one of the 50 most innovative companies in the world and was in the Top 100 list of the Global Challengers in 2016.

For the user the original CMS was merely a "black box", because the software offered only limited openness. Another shortcoming: vibration data and condition values of the plant – such as wind speed, generator speed, gear or pitch angle – could not be recorded synchronously. Moreover, the trend towards increasingly high outputs and intelligent operational management of wind turbines made data evaluation for system optimization purposes more challenging. The consequence: the systems no longer met the present-day requirements with regard to technology and market needs.

Significant improvements of wind turbine availability

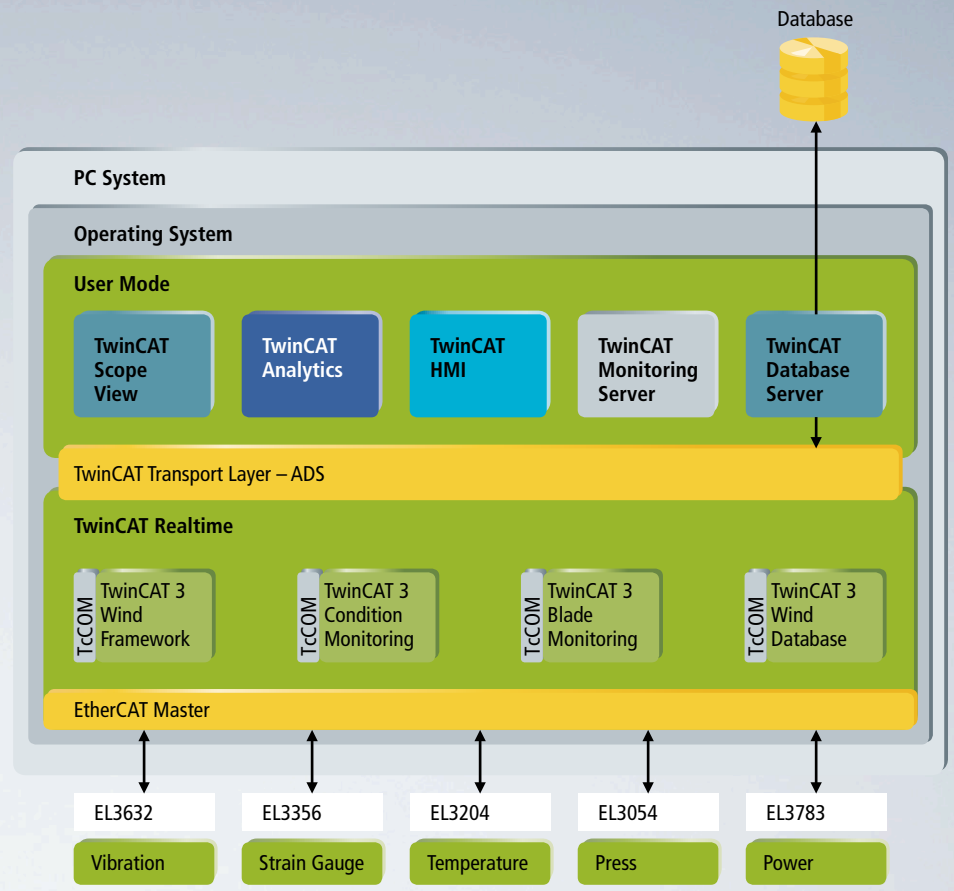
Goldwind has been using open automation technologies for years. Accordingly, when the Chinese wind turbine manufacturer started development of a new online monitoring system in 2014, they turned to PC-based control technology from Beckhoff for the implementation. The goals at the time included the ability to operate a wind turbine over its entire lifecycle with competitive costs and lower susceptibility to faults. It was also important to reduce maintenance costs and downtime. The first and foremost goal was to meaningfully improve wind turbine availability.

After completing detailed calculations and analyses of the operating behavior of large wind turbines, Goldwind researchers produced clear findings: In order to acquire all condition data synchronously from the generator bearings – including high-frequency acceleration data – the existing drive train monitoring system had to be developed into a state-of-the-art CMS. The new system records not only the acceleration and strain of the rotor blades and hub, but also those of the main bearing and the tower. These values are forwarded by the system to the database server via the network of the respective wind farm.

Real-time solution for intelligent wind turbines

The online CMS from Goldwind operates autonomously and is based on TwinCAT 3 automation software from Beckhoff. With regard to controls architecture and functionality, the CMS is built with the following functional components:

- The heart of the CMS is the CX5130 Embedded PC, which uses the 64-bit operating system Windows Embedded Standard 7 and an Intel Atom® multi-core processor with a clock frequency of 1.75 GHz.
- The oversampling-capable EL3632 XFC EtherCAT Terminal for Condition Monitoring (IEPE) records vibration and acceleration signals from the generator bearing with a sampling rate of up to 50 ksamples/s as well as a synchronization accuracy of < 100 ns per channel. The sampling rate and oversampling factor can be parameterized as required.
- All condition data of the wind turbine are acquired simultaneously via TwinCAT ADS communication.
- Raw data and condition data are collected synchronously via the TwinCAT Wind Framework in the controller. The original data and the results calculated from them are saved by the TwinCAT Database Server directly in the local relational database.



The TwinCAT-based CMS acquires and analyzes vibration data from the online generator bearing and saves it at high speed in a local database via TwinCAT Wind Framework.

Application at a glance

Solutions for sustainable energy generation

– online condition monitoring for wind turbines

Customer benefit

– reduced maintenance requirements and increased system availability
– continuous acquisition of vibration and strain data incl. remote access capability

Applied PC Control

– CX5130: Embedded PC out of the finely scalable PC Control portfolio perfectly adapted to the application
– EL3632: highly precise signal data acquisition using oversampling technology
– TwinCAT 3 incl. Wind Framework, Condition Monitoring, Database Server: synchronous real-time acquisition of all data

– Streaming algorithms within TwinCAT Condition Monitoring analyze data such as power spectra and moment coefficients online and in real-time. The analysis results are also written to the database in real time and reported back to the main control system. In this way, meaningful diagnostic data can be generated for smart wind turbines.
– All information can be saved in a local or remote database. The Condition Monitoring Server can read the raw data and computed results for each wind turbine via remote access – a function that does not exist in a traditional CMS, according to Goldwind.

The openness of the software and flexible expansion of the Beckhoff control technology offer particular benefits for any condition monitoring system. This is incredibly important, because no two wind turbines are designed alike and it must be possible to adapt the functions of the turbine-specific control software to the respective needs quickly and optimally. Modularly expandable functions further simplify commissioning, because individual software functionalities can be added quickly in this way. Synchronous data acquisition can be implemented just as quickly as real-time communication and fault location tracking. All these features significantly simplify the creation of database structures and data storage functions.

PC-based control: the ideal platform for condition monitoring

Huang Xiaofang, Senior Engineer at Goldwind, who is responsible for the CMS development, summarizes: "The functions of the condition monitoring system based on Beckhoff technology facilitate future system expansions and upgrades. The CMS integrated into the main control system is cost-competitive and an ideal solution to support intelligent wind turbines."

Huang Xiaofang continues: "The CMS can communicate with wind turbines in real-time. Performance data from wind turbines and condition monitoring results can be acquired synchronously, which improves the scope of analysis and data insights. Due to the extremely high performance of the Beckhoff platform, the condition monitoring data can be acquired, stored and analyzed in real-time. Therefore, it is possible to implement continuous equipment health monitoring and real-time warnings for the state of key components in wind turbines."

Further information:
www.goldwindglobal.com
www.beckhoff.com.cn