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# Automation of wind turbine systems

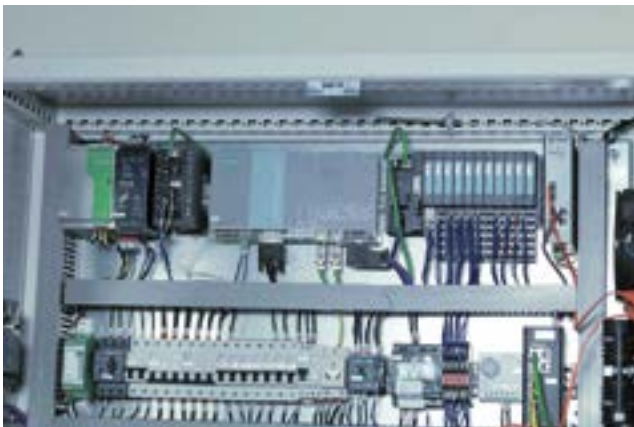
Efficiency package for wind turbines and wind farms

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# User-friendly package for wind turbines: scalable, open, modular, transparent, flexible in the wind

**A Chinese manufacturer is accelerating the engineering and commissioning of its wind turbines significantly with an open, PC-based real-time controller and an application-specific software library “made in Germany”. In addition, a harmonized, modular Wind SCADA system optimizes the operation and diagnostics of individual wind turbines as well as complex wind farms.**

The China Creative Wind Energy Co., Ltd. (CCWE) based in Qingdao is an up-and-coming, innovative manufacturer of wind turbines and an equipment provider to complex wind farms, predominantly in the Chinese domestic market, but occasionally also outside China. To be able to design its wind turbines even more efficiently and to structure their operation optimally, CCWE has made a strategic decision to take Siemens onboard as a second equipment provider for automation engineering. The main requirement was an alternative to the previous main turbine controller, a “black box” that offered insufficient options for modifications or adoptions to different system requirements.



At the heart of the primary turbine control system is a rugged SIMATIC Industrial PC IPC 427C with Windows Embedded operating system and WinAC RTX 2010 real-time expansion for deterministic sequences, in other words, the shortest possible cycle times.

## The search therefore focused on the following

- Maximum openness in hardware and software, as well as in communication, to enable easy connection of proven system components from other manufacturers via different bus systems
- Maximum scalability in functionality and performance to be able to implement different turbines with one and the same system

- Simple integration of one or more turbines into a higher-level, equally open SCADA system for the efficient management of turbines and wind farms. The new components also had to comply with the requirements of Germanischer Lloyd’s GL 2010 (“Guideline for the Certification of Wind Turbines”) to facilitate certification and thus global marketing of the systems. The solution, developed jointly with specialists from Siemens Limited China in Beijing and Headquarter in Nuremberg, meets all these requirements and suits the manufacturer’s budget.



Successful migration: CCWE has converted the main controller of its 1.5 MW wind turbines to an open, PC-based system from Siemens.

## PC-based and open for an individual solution

At the heart of the main turbine control system is now a rugged SIMATIC IPC 427C with Windows Embedded operating system and WinAC RTX 2010 real-time core for deterministic behaviour, in other words, the shortest possible precisely defined cycle times. The hard-disk-free system provides the required ruggedness and reliability for the mostly harsh operating conditions, with extremes of cold or heat.

One requirement of the wind turbine manufacturer was to be able to bring simulation and closed-loop control models created with external software tools as simply as possible to the controller. Siemens meets this requirement with the add-on WinAC Target for Matlab/Simulink (from MathWorks), whereby Simulink models can be transferred quick and easy to the controller under Step 7 and WinAC ODK (Open Development Kit), to be executed in real time.



For the operation of the wind farm, CCWE is placing its bets on the Multilevel Wind SCADA Center from Siemens, which is scalable in terms of functionality and performance and also supports the integration of controllers from different manufacturers.

Another decisive reason for a Siemens solution was the Wind Library, tailored to the automation of wind turbines, and containing around 50 pre-configured function blocks for SIMATIC S7 controllers. The blocks are available in source code, and cover around 80% of the functionality of today's wind turbines. The library contains blocks for fast and simple implementation of system functions such as, pitch and yaw control, tower functions, condition monitoring, and various physical functions. These can be freely combined by the user, modified if required, and thus adapted individually to specific hardware or tasks. Know-how protection is a given here.

CCWE used the Wind Library for the first time when re-engineering the main turbine control of its mass produced 1.5 MW series, and in doing so they were able to implement around 75% of the functionality immediately using the blocks from the library. The remaining functions were modified or re-programmed and implemented by Siemens in close cooperation with the manufacturer. This significantly accelerated the engineering and commissioning time right from the first implementation, and will continue to do so to an even greater extent in the future.

Another contributory factor here is the flexible download function of WinAC that enables simple transfer of the control program to the controller via copy and paste from a USB stick, so that engineering tools can be dispensed with in the field. The same applies to the transfer and download of operator interfaces for the SIMATIC WinCC visualization system enabled by the Pack&Go function. The manufacturer, who strictly forbids intervention by the commissioning personnel in the software during commissioning, describes both features as extremely user-friendly and practical.

## Open communication in all directions

An essential requirement to be met by the new solution was open communication, to enable smooth connection of different components from third-party vendors. This includes the pitch system that exchanges data via CANopen, using a slip ring system. It was possible to implement the connection simply via a 1 SI CANopen module of the Siemens partner company HMS Industrial Networks from Karlsruhe, Germany. This company's module expands the SIMATIC ET200S family and enables direct connection between CAN and CANopen-based field devices. Via a further 1 SI module, it was also possible to integrate vibration sensors into the new control system using Modbus.

The control cabinets in the nacelle and the tower base are connected via two SCALANCE X206-1 switches and fiber optic cables. Via the switch in the tower base the new IPC main controller as well as the Wind SCADA system (see below) is supplied with data. A SENTRON PAC3200 power monitoring device from Siemens and a converter from another supplier are connected to the ET200S station in the tower base. Whereas the power monitoring device records all the important electrical variables here (currents, voltages, frequency, power, etc.) and transfers these to the SCADA system for evaluation and archiving.

## Upgrading to state-of-the-art engineering

For the manufacturer, it was a matter of course to get started with the latest state of the art control technology, which also means counting on the engineering framework Totally Integrated Automation Portal (short: TIA Portal). The company could benefit from the integrated engineering of PLC and HMI devices, autotracking of variables in all editors, and as a result did achieve their goals even faster and more convenient. They are optimally equipped for the future and can be sure to receive spare parts and support for many years to come.

## Open, modular SCADA system for efficient wind farm management

The second focal point of the migration was the changeover to a SCADA system that is open and modular, and thus also scalable in performance and functionality. The solution from Siemens for the wind industry is the "Multilevel Wind SCADA Center" ((possibly Fig. 6)) based on SIMATIC WinCC Open Architecture (OA). As the name says, the system can be used at different levels, so it can be scaled up as service portal for individual wind turbines, through optimized operations management of an entire wind farm (as implemented in this case), all the way up to centralized monitoring/visualization of widely distributed wind farms. A decisive criterion for such a system is the possibility of a seamless

integration of controllers from other manufacturers, something that is fundamentally supported by the Siemens solution.

Amongst others the data management has been adapted for CCWE to previous processes in order to allow a cyclic exchange of bundled data from the wind turbines to the SCADA system.

The open system platform allows the implementation of any kind of report to improve system diagnostics, and thus optimize service and maintenance. In the future, load management shall be implemented via the SCADA system as well.

## Successful migration and premiere

Like the migration, the first practical implementation based on the new automation solution could be completed successfully. In a 50 MW wind farm, the typical size for the Chinese market, in Shaanxi Province Central China, the first 33 turbines with a rated power of 1.5 MW each have been commissioned with the support of specialists from Siemens Beijing. The technology has proven itself under extreme conditions in a desolate mountainous area. Thus nothing stands in the way of CCWE to use this in further wind turbine generators and already planned wind parks. The manufacturer can although count on his applied know-how and simply transfers large parts of the configuration into new developments. The library concept of the TIA Portal supports this better than ever, and enables user-friendly, repetitive use of almost all PLC or HMI functions by simply copying from one project to another.

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