



AWC 500

ADVANCED WIND TURBINE CONTROLLER





Turbine controller, AWC 500 Designed to last for more than 20 years

Designed to solve all challenges regarding turbine control, DEIF's Advanced Wind Turbine Controller, AWC 500, can be installed in on- and offshore turbines ranging from small kW up to the biggest 6-8 MW turbines.

Robustness

The AWC 500 is second-to-none the most robust controller fully operational in extreme temperatures from -40 °C to +70 °C and at altitudes of 4,000 metres. Is immune to electrical noise and designed specifically with robustness in mind, the AWC 500 is extremely protective against destroying surge pulses and conforms to CE acceptance tests.

Pitch and turbine control

Applied as both turbine main controller and pitch controller, especially in the Chinese market, DEIF's AWC 500 has been installed in more than 4,000 turbines. Characterised by extremely cold winters and very hot summers, China is perfectly illustrates why controller robustness is crucial.

High-level PLC programming or C/C++

Challenged by premature breakdowns, traditional automation PLCs used as wind turbine controllers result in added spare part and repair costs and, not least, lost production during repairs.

PLCs designed for factory automation were simply not designed for the tough conditions in wind turbines.

DEIF's controller platform conforms to IEC 61131-3 programming with the widely used CODESYS V3 for high-level programming or as embedded controller in C/C++ with full power from our real-time Linux operating system. Via our PLC Link, we deliver support for automatic code generation from MathWorks MATLAB/Simulink & Stateflow.

Park control and SCADA

DEIF applies the AWC 500 unconditionally as the most preferred controller platform for complete control solutions. Delivered as a standard solution for park control, the AWC 500 integrates the complete Park Control algorithm and also serves as a platform for data collection and storage to control large scale wind parks with reliable data gateways.

Controller retrofit

The AWC 500 is a perfect fit for the challenging conditions offered in older turbines due to their less advanced protection and climate-controlled control cabinets. We can deliver complete retrofit solutions including control strategy, software and component package, or open controller solutions.

DEIF collaborates with an open partnership approach and can also provide technology transfer for software.

AWC 500

Designed to last for more than 20 years



Introducing an unprecedented level of robustness within wind turbine control systems, the AWC 500 (PLC-based PAC) is the latest addition to DEIF's range of AWC controllers.

With its ability to execute application software flawlessly under all conditions, the AWC 500 can be applied in all sites, be they located in cold or hot climates, onshore or offshore or at high altitudes.

AWC 500 features

- ▶ Designed for a lifetime of no less than 20 years
- ▶ 5 years warranty
- ▶ 100 % production-tested system units
- ▶ Full traceability
 - Operating temperature: -40 to 70 °C (cold start-up!)
 - Storage temperature : -40 to 85 °C
 - Climate: 55 °C 97 % RH condensing
 - Coated PCBs
 - Altitude: Up to 4,000 m
 - Vibration: 2.1 g (3.2 to 50 Hz) 1.0 g (13.2 to 100 Hz)
 - Shock: 50 g, 11 ms, half sine
 - Bump: 25 g, 6 ms, half sine
- ▶ Fully EtherCAT-based I/O
- ▶ TCP/IP, CAN, CANopen, SSI, RS-422/485 communication interfaces
- ▶ Direct 3-phase 690 V voltage and 1/5 A current measurement, with class 0.5 power measurement
- ▶ Real-time embedded Linux operating system software maintained 100% in-house
 - <5 second startup-time from power on
 - Fail-safe remote update
 - Fault-tolerant file system (self-monitoring and error-correcting)
 - Secure protocols (SSL, SCP, HTTPS, built-in VPN etc.)
 - Hot standby controller redundancy
- ▶ Open software development with Linux, C/C++, CODESYS (IEC 61131-3)



AWC 500

A variety of configurations...

“Defacto” standard communication protocols

The AWC 500 has fully EtherCAT-based I/O architecture:

- ▶ On internally backplane
- ▶ Between distributed racks
- ▶ As fieldbus to external sensors and systems

The AWC 500 supports control loop cycles down to 1 ms.

Supported fieldbuses

- ▶ Ethernet (TCP/IP, Modbus)
- ▶ EoE (Ethernet over EtherCAT)
- ▶ CAN (layer II), CANopen
- ▶ SSI
- ▶ Serial RS-422/485
- ▶ Profibus DP slave
- ▶ Profinet (on request)
- ▶ NTP (Network Time Protocol) client for automatic clock synchronisation

Integrated grid measurement

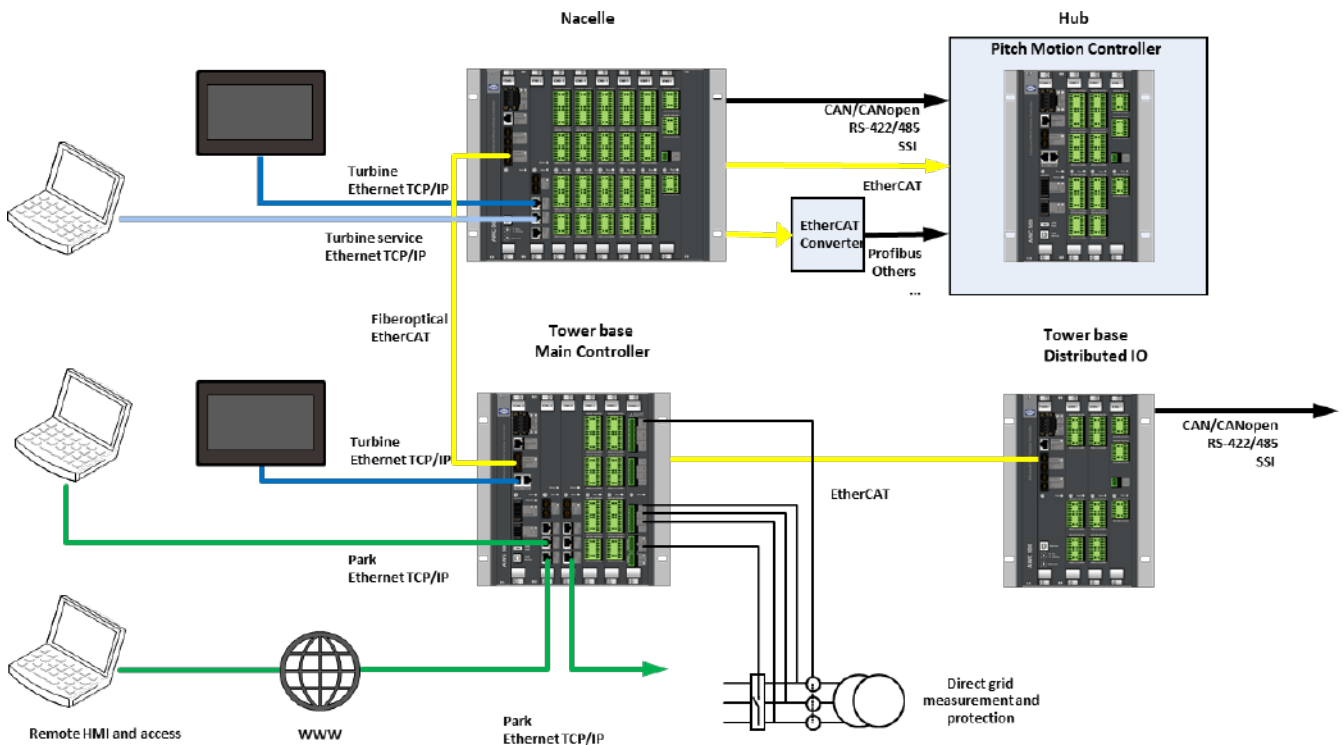
The accuracy of the control algorithms relies on a class 0.5 power measurement which defines a new standard in the wind turbine controller industry. Up until now, the norm has been class 0.5 voltage and current measurements (multiplying to a lower accuracy of the power measurement).

Support for fast and precise LVRT reaction:

- ▶ Direct 690 V voltage, 1/5 A current and power measurement (Class 0.5)
- ▶ No delay reading external transducer
- ▶ Calculates Energy (E), Power (P), Reactive Power (Q), Phase angles etc.
- ▶ All values are directly available on GPM module for use in the software

Simple digital frequency counter interface for HTL sensor and encoders

- ▶ Values directly available on IOM module (DIF input)
- ▶ Only configuration and conversion
- ▶ No module communication required



AWC 500

Designed for robustness in every detail

Unsurpassed durability

The AWC 500 is designed for high durability and verified by HALT (Highly Accelerated Life Test) testing. Built to last for more than 20 years, the controller has been constructed using a selection of highly durable components with a long supply life time. We provide a 5 year warranty on the AWC 500 controller - the longest in the wind industry.

Hot and cold climate

Handling cold starts from a guaranteed -40°C, the AWC 500 secures a safe and controlled turbine start-up in very low temperature environments.

The highest operating temperature for the AWC 500 is 70 °C. This is an advantage to the controller life-time. For every 10 degree the temperature is higher, the life-time is extended - a general rule of thumb.

Surge power on the AWC 500 is DM 2 kV, CM 4 kV. Twice the industrial standards on both power supply and I/O terminals. These high standards improve robustness of the controller enabling it to tolerate for instance lightning strikes on the turbine.

All PCB modules are coated with an eco-friendly protective layer.

High altitude installations

The controller is designed for full operation on all I/Os and communication interfaces without requiring additional cooling in high altitude installations up to 4,000 m.

Tolerance to voltage dips

If the power supply suddenly drops, the complete AWC 500 system including all I/O modules within the AWC 500 rack(s) will continue to operate for a minimum of 50 milliseconds up to 1 second.

If power supply returns within this period, the AWC 500 system will continue uninterrupted operation. If power is still absent after the power-loss protection period, the AWC 500 will enter its safe shutdown cycle in which it will prioritize as clean shutdown amongst writing data to FRAM and dedicated areas of the file system cache to the internal flash. This ensures that all data from the application is sent to the power-loss protected data storage and will be available to the application, when power supply returns.

Watchdogs on 4 different hardware and software levels

To monitor the operation of the AWC 500 system, watchdogs on different levels are featured, from each individual module EtherCAT slaves, EtherCAT master, Operating system services running to application watchdog.



AWC 500

System software



Linux with PREEMPT_RT real-time patch

The operating system completes start-up within 5 seconds from power turned on. The system is based on the latest open source Linux kernels real-time patched with the widely accepted PREEMPT_RT patch, and features Busybox (the Switch Army Knife of Embedded Linux), Dropbear (Secure shell (SSH) client) etc.

Remote update with fault-back

Two OS images are included to ensure fail-safe update of software, both separated from the Application File System.

Secured access and communication

Customer manages all credentials (root and user passwords) and can add individual users.

All access to AWC 500 is authenticated communication using standard communication protocols:

- ▶ Secure Shell (SSH), version 2, server and client
- ▶ Secure Copy (SCP), server and client
- ▶ Secure/SSH File Transfer Protocol (SFTP), server
- ▶ Build-in VPN client
- ▶ Configurable Ethernet broadcast storm rejection filter

Other network protocols supported are:

- ▶ File Transfer Protocol (FTP), server and client
- ▶ Trivial File Transfer Protocol (TFTP), client
- ▶ Network Time Protocol (NTP), client
- ▶ Dynamic Host Configuration Protocol (DHCP), client

Webbased configuration and managed update procedure

The same, simple and safe update procedure is used for:

- ▶ Operating System
- ▶ Firmware
- ▶ CODESYS runtime
- ▶ User scripts and
- ▶ Application

Simply drag and drop the compressed files .updates packages (DEIF updates) to the AWC 500 filesystem, automatically initiating update of the system.

Advanced Wind turbine C x

https://10.1.20.93/sys/tools.shtml

Home Modules Info Tools

DEIF

Update

Here you can update the AWC 500. Select an update file from your computer and upload it to AWC 500.
Browse for a update file to upload:
 Der er ikke valgt nogen fil

Note: An update may reboot the AWC 500. Please make sure that the system is in a state ready for updating.

Operating System

Image	Current	Default	Version
A	<input checked="" type="radio"/>	<input checked="" type="radio"/>	3020-rc.1
B	<input type="radio"/>	<input type="radio"/>	2004

Reboot

Alternative OS:

Version: 10.2.0-rc.1 Temperature: 27 °C Hardware: awc500/030m_03 Time: 2016-09-17 00:56:29 40000

AWC 500

System software

Robust data storage

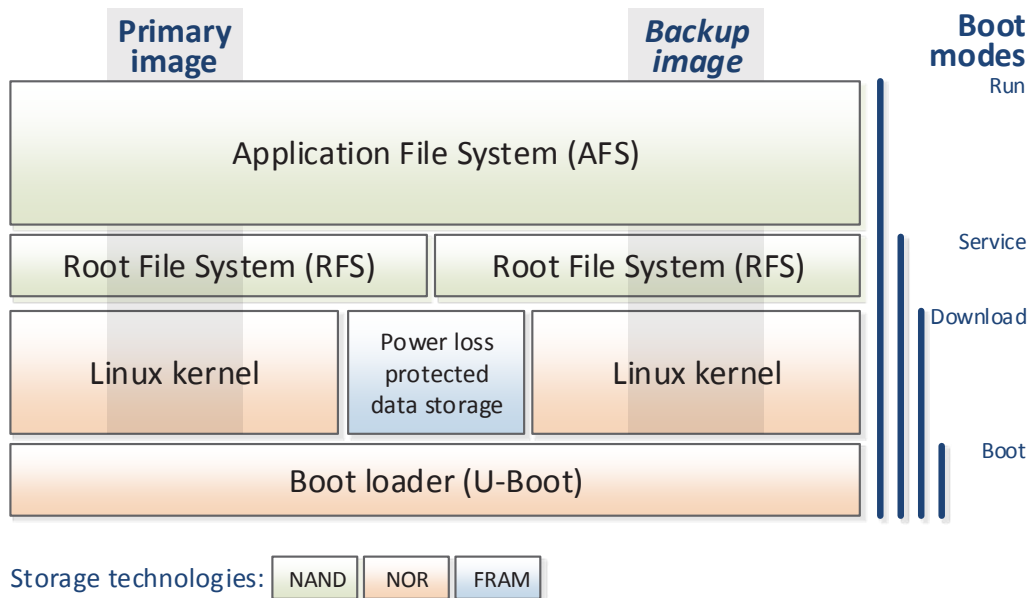
Proven fail-safe file system (UBIFS – Unsorted Image File System) to ensure data on the AWC 500:

- ▶ Tolerates sudden power interrupts and unclean reboots
- ▶ Recoverability – May be fully recovered if the indexing information gets corrupted.
- ▶ Ensures data integrity – Everything written to the flash media gets checksums.

Instant and long life storage of persistent variables is ensured with FRAM (ferro magnetic RAM) as NOVRAM :

- ▶ High Endurance type guaranteeing 100 trillion read/writes cycles
- ▶ 10 years storage without battery power necessary

Our new PCM5.2 relies on the ext4 file system and features a filesystem cache that is written periodically every few seconds, and a dedicated data area of persistent variables is guaranteed to be persisted automatically to the mass storage on power loss.



AWC 500

Software development and customized production

Software development

Choose your software packages:

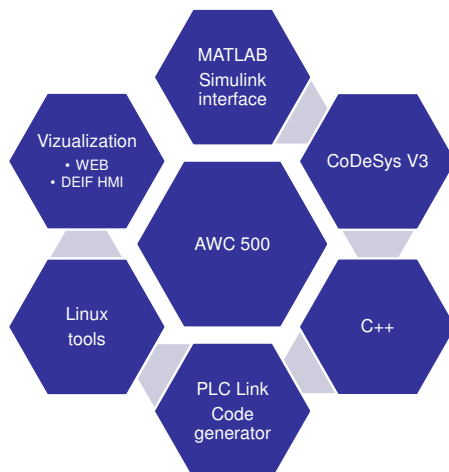
- ▶ CODESYS (IEC61131-3 PLC)
- ▶ ANSI C/C++
- ▶ Linux scripting (BASH)
- ▶ Web server-side programming (CGI/BASH)
- ▶ Create pages in HTML, HTML5, JavaScript
- ▶ PLC Link (MATLAB/Simulink Interface)

C/C++ programming

- ▶ Eclipse based
- ▶ GNU C/C++ compiler
- ▶ GNU gdb debugger
- ▶ AWC 500 SDK
- ▶ Programming templates

CODESYS (IEC 61131-3 programming)

- ▶ IEC61131-3 PLC programming (ST,FDB,SFC,IL,LD)
- ▶ CODESYS V3.5 based (compliant with other PLCs.)
- ▶ Integrated HMI/Webvisualization
- ▶ Graphical PLC configuration
- ▶ Online debugging
- ▶ Multilanguage programming editor and help in Chinese, German, Russian, French and English
- ▶ Integration of C/C++ libraries with DEIF External C lib development package



Customized production – 100 % production-tested system units

Controllers are delivered as ready-to-install, assembled and configured according to customer specifications. You will benefit from optimum logistics and maximum quality as each controller delivered has been subjected to a cyclic burn-in test in climate chambers with -40 to 70 °C for 6 hours before being delivered, testing CPU, memory, communication, I/O. During the complete temperature cycle all measurements must be within listed specifications. This guarantees hassle-free commissioning of our controller. We provide a 20 year supply guarantee based on our decades of experience from the marine industry.



Product traceability

DEIF secures full traceability on all units in all production steps from sourcing of components to customers configurations. And each modules unique id-code and software versions can be read out from the system software in the controller.

Ready-to-install controller

The AWC 500 provides compact, flexible and service-friendly solutions. The controller is delivered: tested, assembled and ready to install in the turbine even preinstalled with the customer applications software, if required.

AWC 500

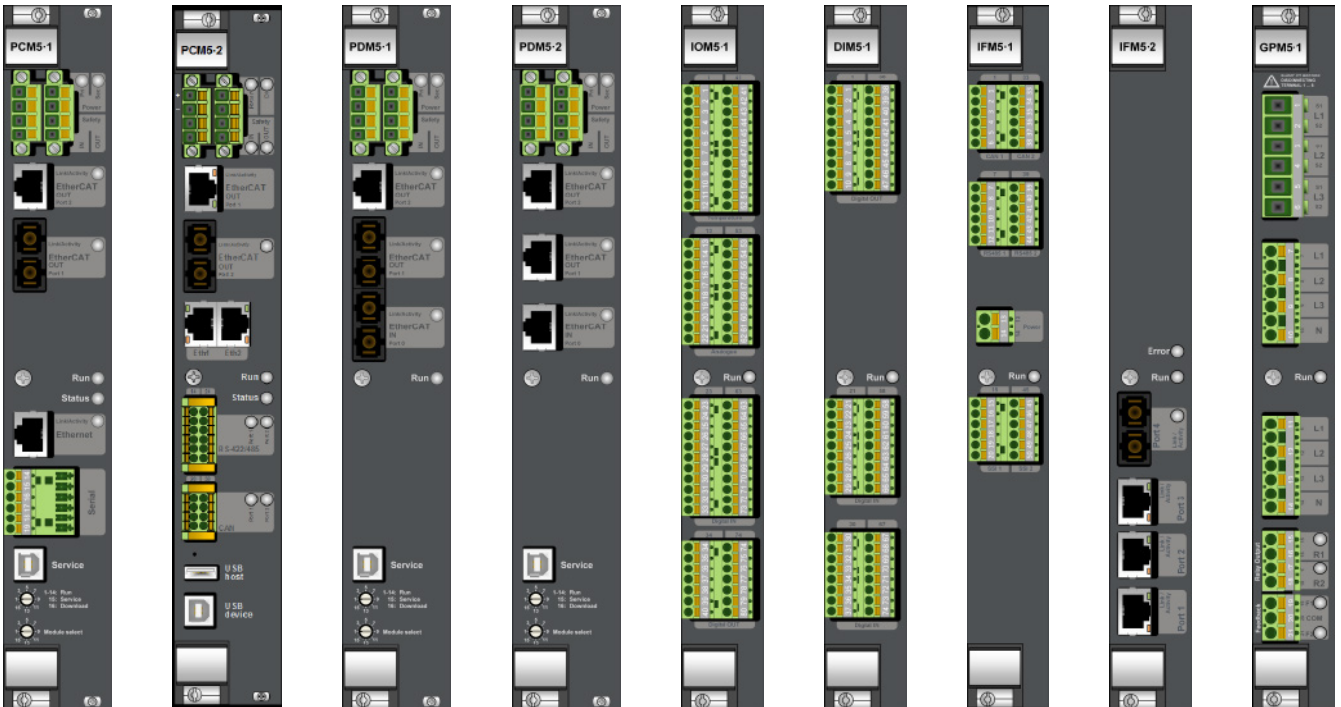
Product line

Rack sizes

Available rack sizes are from 0 (PCM module only) to 8 modules:



Module overview



Power and Control module

PCM5-1 – Industrial grade 333 MHz Power-based CPU with real-time patched (PREEMPT_RT) Linux OS

PCM5-2 – Extreme temperature (-40 to 70 °C) 1 GHz dual core NXP CPU with real-time patched (PREEMPT_RT) Linux OS

PDM5-1 - Power and Distributed communication Module for EtherCat network - Fiber

PDM5-2 - Power and Distributed communication Module for EtherCat network – Electrical

I/O modules

IOM5-1 - 40 channel multifunction I/O module

DIM5-1 - 46 channel digital I/O module

Communication modules

IFM5-1 - RS-422/485, CAN, CANopen, SSI interface

IFM5-2 - 4 port Ethernet router

Grid protection module

GPM5-1 - Direct 690 V 3-phase voltage, current and power measurement (class 0.5)



Control technology for 75 MW Wind Farm in Sweden

Cross-cultural project partnership

DEIF Wind Power Technology has taken part in the project of commissioning 30 new GL certified turbines with a total capacity of 75MW for one of Europe's largest wind farms Blaiken Wind in Sweden.

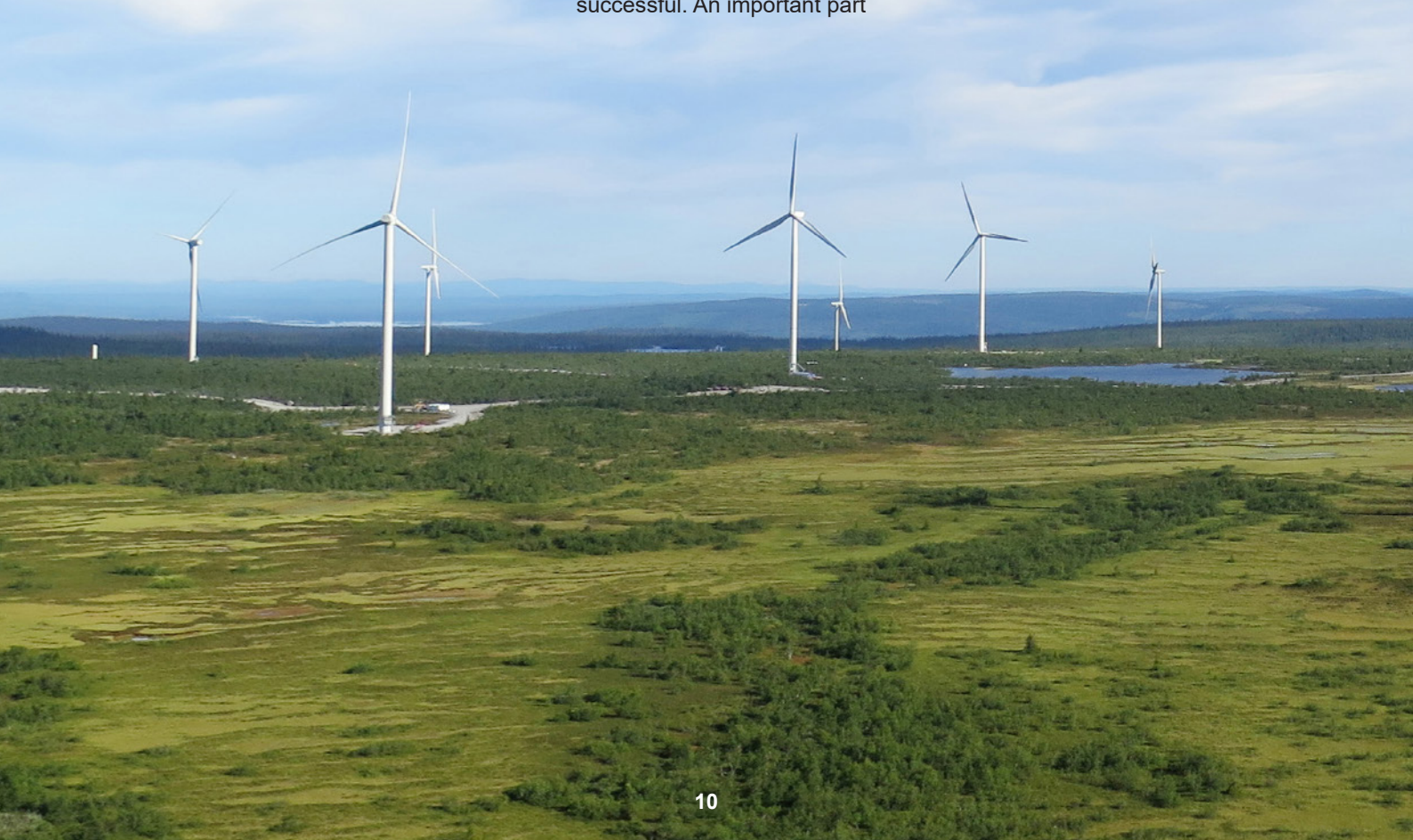
Together the partners Dongfang, the utility Skellefteå Kraft and DEIF Wind Power Technology have efficiently commissioned 30 turbines within a year. The complete electrical system is delivered and integrated by DEIF Wind Power Technology and Dongfang has delivered the turbines, which have been GL certified in China, based on a collaboration between DEIF and


TÜV SÜD certifying body. With the technological know-how, DEIF on-site team of engineers have integrated the pitch and turbine control system including a de-icing system for sustaining full functionality in very cold temperatures.

Complete system integration & technological know-how


DEIF Wind Power Technology constitutes a strong competence in securing the turbine components for the complete system in Dongfang's turbines for the wind park. The entire system is built on integration of DEIF Wind Power Technology's: Turbine and Pitch Control, Park Control and SCADA for successful. An important part

of the integrated technology is the Wind Park Control System, which secures a stable and reliable power production to be transferred to the grid after the commissioning of the turbines. In order to secure this, the Wind Park Control System has been built to comply with the Swedish criteria and local grid code demands for energy production and integration to the electrical grid. The entire purpose is to secure a safe and reliable production of clean energy for thousands of households in Northern Sweden.





Our business model is typically where DEIF Wind Power Technology delivers critical key components such as the pitch drives and the main turbine controller. We make a big difference for our customers by being an active partner in designing and approving the electrical system in the turbine. A process that should be fast and fulfill all new safety standards, but without adding unnecessary cost or delays».



– Christian Nielsen, Managing Director

FACTS, DEIF Wind Power Technology:

- Develop and build State-of-the-art solutions for complete integration of the electrical system in wind turbines
- Commission 1500 turbines per year World Wide, that makes 4 turbines a day!
- Commission wind parks with the capacity of >200 MW
- Supply turbine control system designs for turbines of 50 kW up to 7 MW
- Global partner in Europe, US and Asia





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LEARN MORE AT DEIFWINDPOWER.COM

