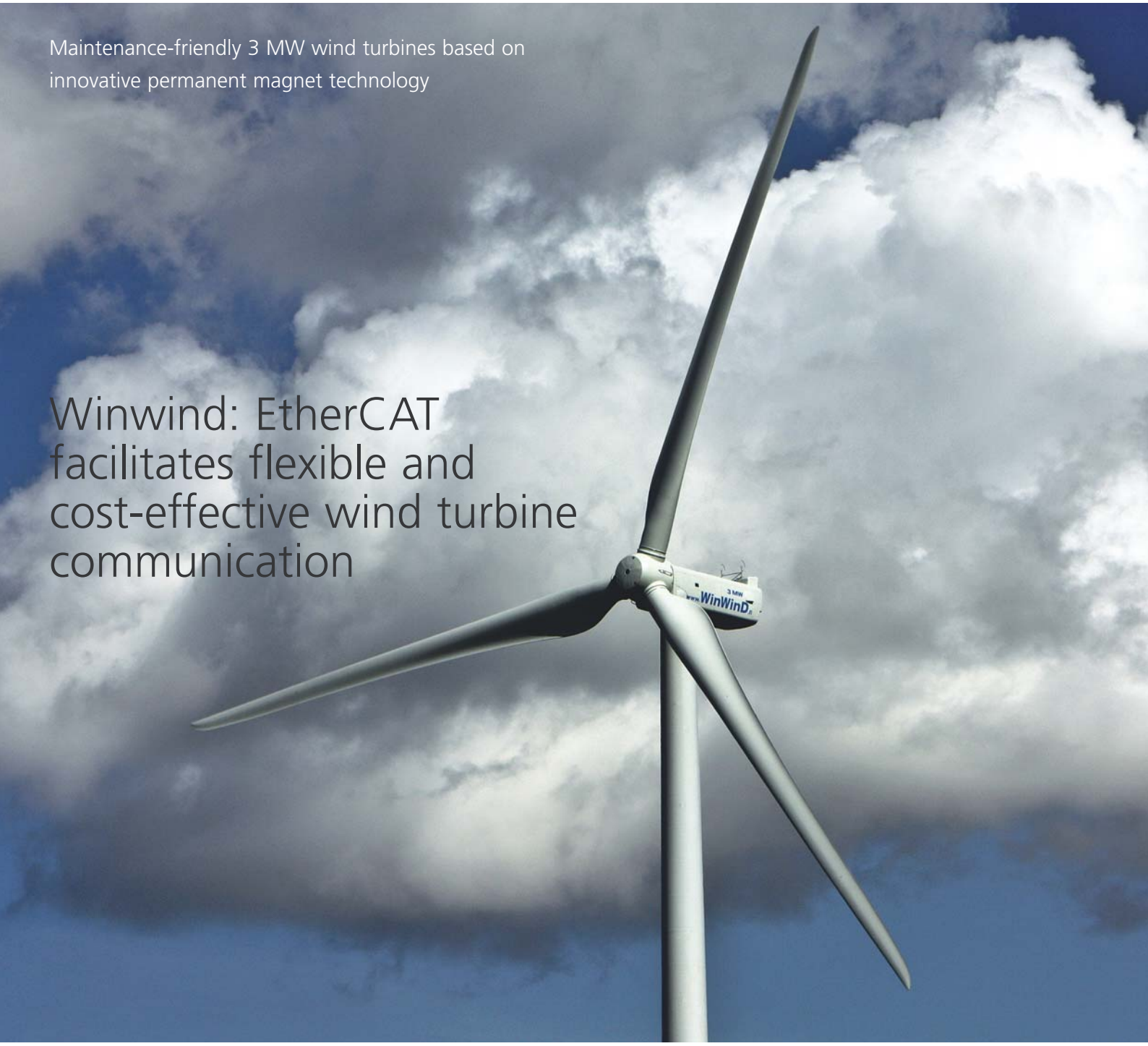
Maintenance-friendly 3 MW wind turbines based on innovative permanent magnet technology

Winwind: EtherCAT facilitates flexible and cost-effective wind turbine communication



During the 10 years since it was established, the Finnish company Winwind Ltd has developed into an internationally recognized wind turbine manufacturer and supplier of wind energy solutions. The key to the company's success was the development of an innovative 3 MW wind turbine with permanent magnet technology, which was superior to the conventional technologies that dominated the market until then. For controlling its 3 MW windmills, Winwind utilizes a PC- and EtherCAT-based automation platform from Beckhoff, which enables the integration of control, visualization and data management on a single PC.

Winwind wind turbines are designed for operation under very adverse weather conditions, from arctic frost to arid deserts.

Winwind Oy

Since it was established in 2000, Winwind Oy, based in Espoo, Finland, has developed from a small start up company to an international wind turbine manufacturer and supplier of complete wind energy solutions.

In 2006, the Siva Group of India acquired a majority stake in Winwind. In 2008, Masdar, an investor in renewable and green technology came on board, giving further impetus for development, growth and international expansion.

In 2009, Winwind commissioned two state-of-the-art production facilities: WWD-1 at Vengal, India, specializes in the production of rotor blades, while the WWD-3 assembly plant at Hamina, Finland, is designed for an annual production of 500 MW.

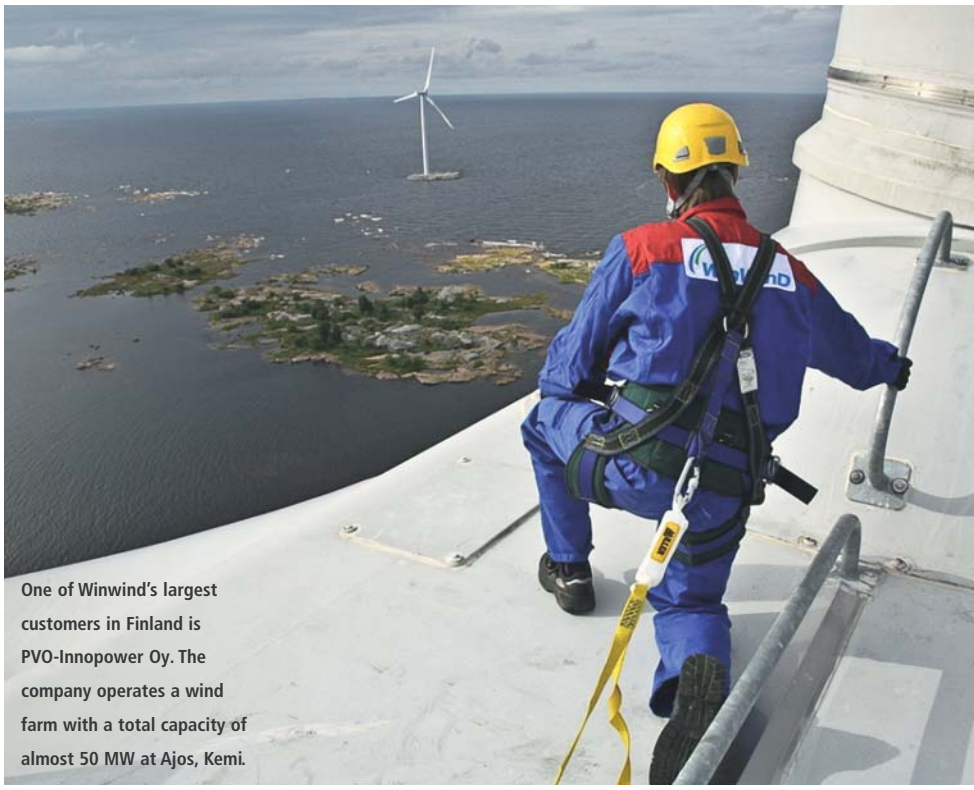
The Finnish wind turbine manufacturer currently has 800 staff, of which 495 work outside Finland in India and in offices in Estonia, Portugal, and Sweden.

In the development of its wind turbines Winwind combines long-standing wind energy expertise with extensive competence in component manufacturing. Over its 10-year company history Winwind has achieved its ambitious goal to develop efficient, reliable and maintenance-friendly wind turbines with a long service life and high returns over the whole life cycle. Winwind 1 and 3 MW wind turbines are used in numerous wind farms in Europe and India. The long-lasting turbines are designed for a minimum service life of 20 years.

From pilot wind turbine to series production

The first wind turbine built by Winwind had a capacity of 1 MW, even though it was already clear at this stage that larger wind turbines would be required in the future. In 2004, the company started developing the 3 MW version based on a Beckhoff automation platform. Series production of this Winwind turbine started in 2006.

In its 3 MW wind turbines Winwind uses Multibrid-based technology in which the stator of the permanent magnet synchronous generator



One of Winwind's largest customers in Finland is PVO-Innopower Oy. The company operates a wind farm with a total capacity of almost 50 MW at Ajos, Kemi.

Meanwhile, Winwind has also become the market leader for wind power in Estonia with a total capacity of more than 100 MW across four wind farms. The first wind farm was Viru-Nigula Tuulepark consisting of eight 3 MW turbines which were supplied as a turnkey solution, i.e. Winwind not only supplied the wind turbines, but also dealt with all structural and electrical works. With its 13 3 MW wind turbines, Aulepa is the largest wind farm in the Baltic countries. Once the second stage is completed, it will have a total capacity of 48 MW with an annual output of 123 GWh. This is enough power to cover the annual electricity demand of 43,000 households and reduces annual CO2 emissions by around 120,000 tons.

is installed directly into the gearbox, forming an integrated unit, where the gearbox casing is part of the load-carrying structure. The rotor is mounted on the output shaft of the planetary gear unit and, as a result, less rotating parts are required than in a conventional geared-type wind turbine drive train. This technology combines the reliability of a direct drive with the compactness of a traditional high-speed gear unit. Low speed in conjunction with optimum mechanical load control ensures low maintenance costs, high reliability and high availability. All these factors play an important role for wind farms which are often located in remote regions. The turbine starts up at low wind speeds or short gusts. Full-load frequency converters and high-quality pitch control guarantee grid-friendly electricity, very advanced FRT capabilities and extensive reactive power production.

270 MW installed wind capacity worldwide

Meanwhile, Winwind windmills are used in wind farms in the Czech Republic, Estonia, Finland, France, India, Portugal, and Sweden. One of the largest Finnish customers is PVO-Innopower Oy. The company operates a wind farm with a total capacity of almost 50 MW at Ajos, Kemi. The 1 and 3 MW windmills are built on land and on artificially created islands. The windmills reliably produce electricity despite very adverse weather conditions with temperatures down to around 25 °C below zero (-13 °F). A solution developed by Winwind prevents the icing up of the windmills and guarantees consistent operation, even under arctic conditions.

Innovative system design meets PC Control

The 3 MW wind turbine is controlled by a Beckhoff CX1020 Embedded PC with Windows XP Embedded operating system and TwinCAT PLC automation software. A user-friendly human-machine interface (HMI), which provides the user with an overview of the system state, is integrated into the control platform. Kimmo Kaappola, Automation and Electrification Manager at Winwind explains the reasons why the company decided to use the Beckhoff Embedded PC as the basis for the control system: „For us, the decisive argument was the fact that the same control platform not only deals with supervisory control and dynamic control of the wind turbines, but can also be used as HMI and for data logging," he said. "And thanks to the versatile and highly efficient TwinCAT ADS communication, it is possible to use the same HMI interface within the wind farm to link

all the wind turbines with the park control system. Moreover, the use of ADS communication substantially simplifies logging of the data from the different wind turbines within a wind farm."

EtherCAT cost-effectively networks tower base to nacelle

Winwind uses EtherCAT as the primary communication system for its wind turbines. In addition to its high performance, the fast bus system offers a high degree of flexibility. The EK1501 EtherCAT coupler and the EK1521 junction terminal for the Beckhoff EtherCAT Terminal system permit flexible topologies based on glass fiber technology and cost-effective communication between the tower base and the nacelle. "The option of integrating other bus systems such as CANopen into the EtherCAT I/O system via convenient gateway terminals was another key factor in our decision to use the Beckhoff control platform," said Kimmo Kaappola. "In addition, EtherCAT is also very suitable for diagnostic purposes, unlike traditional bus systems. Since more and more manufacturers offer EtherCAT interfaces for wind turbines, we are possibly en route to a single bus solution for the industry. This makes wind turbine control simpler and more robust." One of the latest developments at Winwind was the integration of ABB converters with the EtherCAT fieldbus.

Winwind Oy **www.winwind.com**
Beckhoff Finland **www.beckhoff.fi**

ABB converter systems with EtherCAT interfacing

ABB's full-power converters for wind turbines offer system manufacturers a high-performance, reliable solution that meets the requirements of long service life and simple maintenance. Due to their modularity the ABB converters are suitable for installation in the nacelle or the tower and can be operated in conjunction with all common generators. The converter system not only supplies the required current frequency and voltage, it also supports weak grids by feeding in or absorbing reactive power. In this way wind turbines can operate at their optimum duty point and feed energy into the grid with high efficiency.

Winwind uses ABB low-voltage converters for its 1 MW turbines and medium-voltage converters for its 3 MW turbines. Winwind recently successfully tested interfacing of the converter via EtherCAT in a 1 MW prototype system, thereby replacing the previous Canopen fieldbus solution. EtherCAT interfacing offers clear benefits for system manufacturers: Sub-bus systems and associated master connections are no longer required, and the system is faster and the control architecture leaner.

Optional converter cooling with air or liquid enables optimum adaptation of the wind turbines to different locational and climatic conditions. The liquid-cooled converters with fully encapsulated control cabinets are designed for operation under extreme conditions, such as offshore or in the desert. Liquid cooling offers additional benefits: In view of the ever increasing wind turbine generator outputs it enables more power to be produced within the same cabinet volume. It eliminates heat losses from the converter and therefore prevents the surrounding equipment and electronics from heating up.

Wind turbines are generally equipped with a built-in monitoring unit. The converter can provide additional data for analysing error states or the turbine output. ABB offers a remote monitoring system that offers the windfarm operators direct access to the converter and parameters such as DC and AC voltage, output, reactive power, temperature and speed.