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PC-based control in decentralized wind power generation

Open and modular controller for distributed power generation systems

Feeding power into the energy grid from renewable sources can result in strong fluctuations of network loads. These require intervention by the grid operators, in order to avoid power failures as well as voltage or frequency variations. German company ee technik GmbH has been involved in planning and designing electrical infrastructures of large wind farm projects for many years. They use a DEA controller (distributed power generation system controller), which, based on the openness and high level of integration of the control technology from Beckhoff, can be flexibly adapted to individual applications.

The community wind farm in Emmelsbüll-Horsbüll, Germany, was commissioned in late autumn 2014.

In power generation systems, special controllers direct the active and reactive power output, based on the current requirements of the network operator. Depending on how the actual values deviate from the specifications of the network operator, such a controller determines the respective set point value specifications for the individual power generation units. The challenge is that manufacturers of power generating plants have not yet come to an agreement on a standard protocol to exchange such data. Lack of standardization tends to necessitate a complex system of terminals and IT systems, in order to meet the requirements of the network operator at the grid connection point. A vendor-independent controller, offered by ee technik GmbH, based in Böklund, Germany, provides an efficient solution for the problem at hand. This controller for distributed power generation systems (DEA controller) is open for all common systems and enables the higher-level control of each individual power

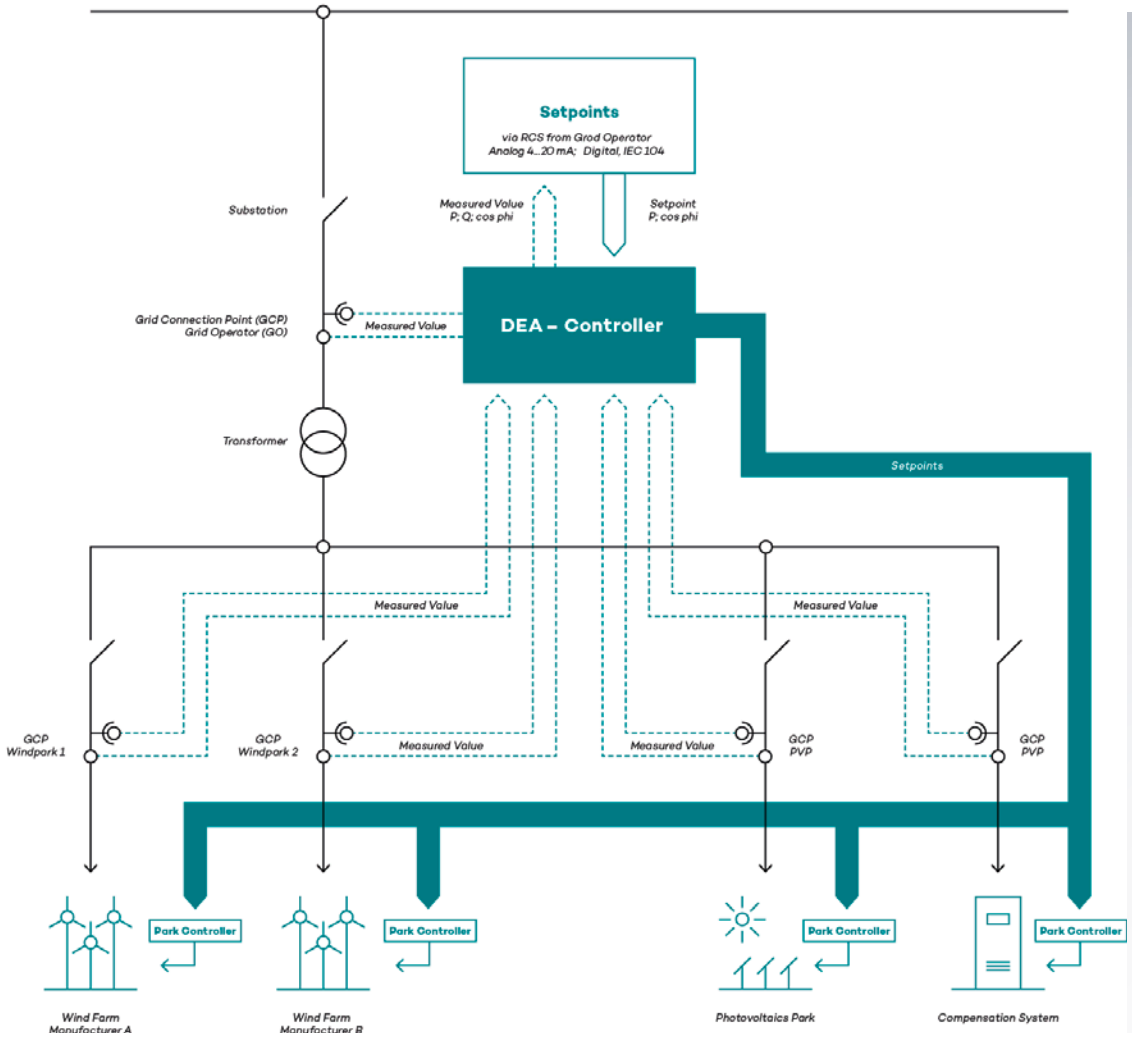
generation system at the grid connection point. In practice, it enables the preferential utilization of wind turbines with better tariff arrangements, for example, which has a positive effect on the yield.

Flexible DEA controller with PC-based technology inside

The DEA controller is available in different versions and is configured from a selection of core components. A high-performance PLC is used for storing, processing, and visualizing data. Next, a measurement transducer at the grid interfacing point provides actual value acquisition. The system is rounded off by analog and digital I/O components and Ethernet interfaces for reading the set value specifications of energy supply companies, for transmitting the control values to the power generation system and for integrating a visualization solution via OPC UA.

A flexible hardware and software configuration is implemented through a PC-based control system from Beckhoff. The open and integrated solution provides a cost-effective, system-integrated platform for the DEA controller, offering high computing power and modular expandability as key benefits. Karl-Friedrich Stapelfeldt from the Beckhoff branch in Lübeck, Germany explains the original selection criteria: "One of the decisive factors at the time was the high-performance CX2030 Embedded PC with Intel® Core™ i7 processor (1.7 GHz, dual-core). Because of its multi-core CPU architecture, it can easily run process visualizations and database applications in parallel with the PLC software on the same system, without any restrictions. An additional benefit was the high flexibility, due to fact that the system can be easily expanded. Key components here are the modular I/O system and the internal, PCI Express-based expansion bus, through which the system interfaces are connected with the full bandwidth of a PCI Express lane. In addition to two standard network connections, the CX2030 can be expanded via system modules with up to eight additional network adapters. In this way, the goal of implementing a customized network configuration for each wind farm is easily achievable."

Devices used at the I/O level include analog Beckhoff EtherCAT I/O Terminals of the types EL3024 and EL4024 (4 to 20 mA) for capturing and feeding back analog set values from the network operator, and for transferring control signals to the wind farm. The digital EtherCAT I/Os EL1008 and EL2008 pick up the stepped stop signals and provide feedback via ripple control receivers. Additional system modules for the CX2030 include the dual Gbit Ethernet interface CX2500-0060, and the slide-in HDD/SSD CX2550-0020 unit. A CP2916 multi-touch Control Panel with 15.6 inch display is used for visualization. According to Karl-Friedrich Stapelfeldt, this flexible system is



A DEA controller can be used wherever generating units from different system manufacturers share a common grid connection point, e.g. in situations with a shared medium-voltage transmission line or a substation for high-voltage connection.

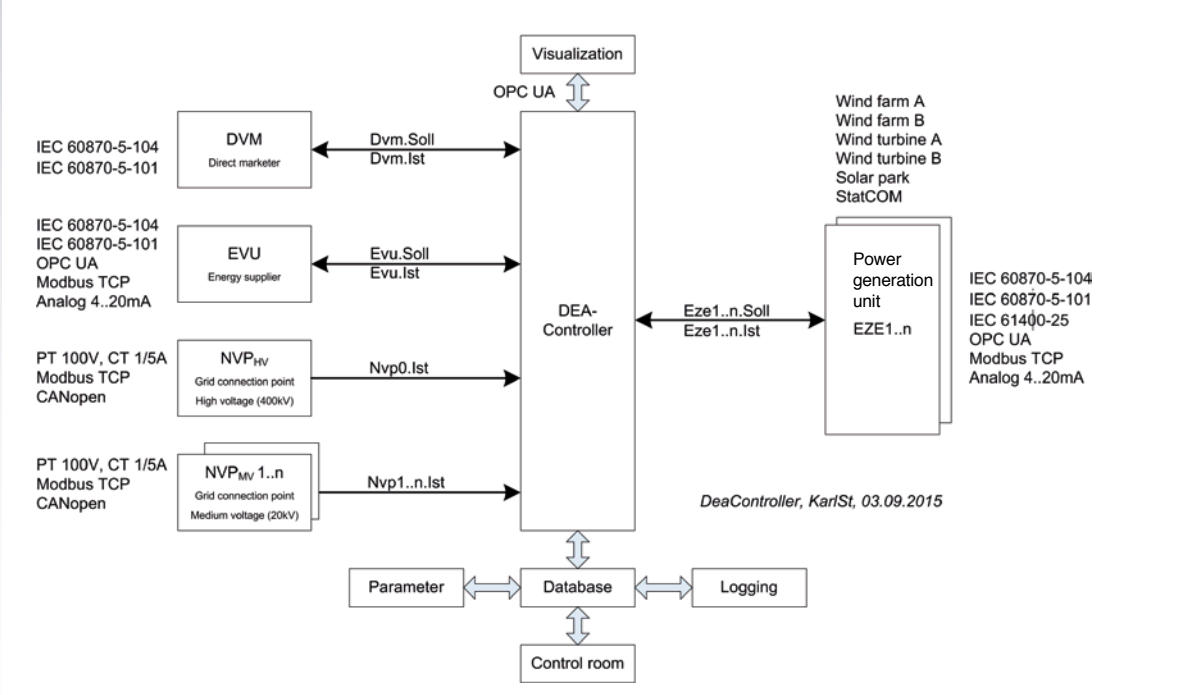
perfect for mastering the challenges inherent to the application: "Different standards and data point lists are used, generally analog 4-20 mA signals and established fieldbus protocols such as CANopen or Modbus. Telecontrol protocols such as IEC 60870-5-104, which are common in network control technology, are also becoming increasingly widespread. In addition, there is the IEC 61400-25 protocol – derived from IEC 61850 – which was specifically developed for wind power applications. As part of the TwinCAT 3 software platform, Beckhoff already offers ready-made function libraries to support all these communication protocols."

TwinCAT 3 with open communication and Wind Framework

In addition to the TwinCAT 3 functions for standardized communication via Ethernet (e.g. via Modbus, OPC UA) and the common telecontrol protocols (e.g. IEC 60870, IEC 61400-25), the recently developed TwinCAT 3 Wind Framework offers further major benefits. It builds on the modular architecture of TwinCAT 3 and supports the development of modular and object-oriented operational management software. Higher-level system services are provided via TcCOM modules. One example is a Status module, which enables monitoring of all components based on event management, error detection, troubleshooting, and reporting. Parameter and Command modules provide services for configuration and interaction with the system. The Capture and Statistics modules enable logging of signals and their statistical evaluation. The User module checks, manages, and records all user interactions. The Database module, which is based on an SQL database, documents all events and signals and is used for storing and loading the whole configuration.

The tool environment integrated into the TwinCAT 3 Wind Framework enables online and offline monitoring of recorded wind farm data, plus the inputs and outputs of the DEA controller. Database-driven offline analysis enables the display and combination of signal curves with a resolution up to 1 s. Trace logs with the resolution of the PLC task enable additional detailed analysis of the controller behavior, e.g. in the event of step changes in set values. ScopeView, the software oscilloscope integrated into TwinCAT 3, is ideal for ultra-fast logging into the µs range.

Further information:
www.eetechnik.de



On the software side, each interface of the DEA controller is implemented as a modular function block with identical input and output interface. On the hardware side, various EtherCAT Terminals enable interface configurations that are optimized for the respective application.