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Smart Grids – Energy networks of the future

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Students of communications technology, specializing in information electronics, are often referred to as "low currenters" by fellow students from the energy area, because after all, genuine electrical engineering has something to do with high voltages and currents. Today, however, the times when electricity also carried directly with it the data required for its regulation – such as voltage, phase relationship and frequency – are nearing their end. Due to the volatility of the renewable energies, the future supply of power will be able to offer the familiar supply reliability and minimize the resulting cost increases only with the intensive use of information and communication technology (ICT).

The portion of electricity accounted for by renewable energies is approximately 31 %, predominantly generated from wind and sun. This takes the classic transmission and distribution networks to their limits. If the expansion of renewable energy generation continues to increase, main power stations would have to increase their performance bandwidth to a degree for which they were not conceived. To ensure supply reliability in the short to mid-term, use will have to be made of modern gas and steam power plants, water storage and combined heat and power plants as well as biogas plants. In the long term, these will be supplemented by chemical accumulators. Examples are hydrogen from wind power, which can be added to the natural gas in a concentration of up to 5 percent by volume, or redox-flow batteries, which support the grid as seconds reserves.

Optimum simulation, control and monitoring of energy networks

Surpluses in the electricity supply must be removed with expensive negative control energy from the grid. This type of control energy can be offered on the electricity market, for example, as a virtual power station and called off by the grid operator when needed. The application report on Sokratherm (page 53) describes how a combined heat and power plant can be controlled with Beckhoff Embedded systems and additionally integrated into such a virtual power station.

The expansion of the renewable energy generators will continue and the high supply reliability of the European grid will therefore only be maintained through versatile and technologically elaborate measures. Inexpensive grid protection and its monitoring represent a further important aspect for the distribution network operators.

Present-day technology is cost-intensive, since it is based on custom manufacturing. The purpose of the i-Protect project is to demonstrated that inexpensive solutions based on conventional standard hardware can be just as good, reliable and also more flexible. Initial results based on Beckhoff Embedded systems will be presented by OFFIS (Institute of Information Technology) as a partner at our trade show booth at E-world 2015, from 10 – 12 February in Essen. The basis of the research here is the real-time simulation in the "Smart Energy Simulation and Automation Laboratory" (page 56).

PC control technology as a flexible basis

One of the biggest advantages of the Beckhoff control technology is the good scalability of its real-time performance. The computationally intensive control of a wind farm on the basis of MATLAB®/Simulink® modules, as well as the real time calculation of the grid parameters from the raw data of the EL3773 grid monitoring terminal, can be distributed by the TwinCAT 3 automation suite to several CPU cores if necessary. A description of how Alstom controls what is currently one of the largest European wind farms in Scotland can be found starting from page 60. A wind farm must fulfil the demanded grid code at the feed point to the transmission grid, i.e. the measures for grid stabilization required by the grid operator. With EtherCAT I/Os all wind turbines in the Scottish Whitelee wind farm, stretching over many kilometers, are adjusted to the required parameters within a few milliseconds. Conversely, the article on regio iT (page 50) shows how an operational management solution for thousands of properties in the cloud might look. In this case the compact CX8000 Embedded PCs are used, which are networked via OPC UA in the Internet. At the Beckhoff trade show booth at the E-world 2015, regio iT will demonstrate live how the evaluation can be carried by the user via the Internet. A further partner at our E-world booth is Hermos AG, which will demonstrate solutions there for the "Smart Power Building". From page 58 onwards you can read what the building means as an active participant in the Smart Grid.

The topics mentioned so far represent only a small selection of the solutions and technologies that are required for a future Smart Grid – the "Internet of Energy". The high complexity and the various tasks arising from a migration to an ICT-based energy supply will induce many more "low and high currenters" to develop new and innovative solutions together.