Networked Power

Today's power plants are dynamic facilities that can be supervised and managed via the Internet. One of the most powerful control systems on the market is made by Siemens. It consolidates all of a plant's functions and is easy to use, thereby increasing efficiency and cutting operating costs.

At Vienna's Spittelau plant, a Siemens wireless communication system helps control heat generation facility. The T3000 control system (small picture) can be operated online via a web browser.

It's half time during an international soccer match. Throughout Germany, demand for electricity soars as people go to the rest room or to the kitchen to get a bite to eat. But such demand spikes are no problem since operators have made sure that their power plants have sufficient reserves to deal with such situations.

Careful preparation is required to deal with peak loads. Conveyor belts have to supply more coal so that boilers can generate more steam, which in turn, results in more electricity. In some cases, such sequences have to be carried out with rigorous precision in which every second counts. "A human being could barely manage it," says Dr. Rainer Speh, CTO for control systems at Siemens Power Generation (PG). However, a fully automated control system can easily handle the task.

Seamless integration and communication are essential for power plants. After all, in the energy sector a fast decision can be worth millions of euros. This is the case, for example, with Vienna's Spittelau plant, which incinerates waste to generate district heating. The plant has a wireless communications system that allows it — along with several other facilities — to be operated from a remote central control room.

One of the most modern control systems on the market at present is Siemens' Power Plant Automation SPPA-T3000, which was developed by PG. This fourth generation system starts up the plant and provides an up-to-date overview of its operating status. When used in a 1,000-megawatt block of a large modern power plant, for example, the SPPA-T3000 continuously monitors up to 100,000 process inputs and outputs. "Customers quickly notice if something isn't running properly and can take countermeasures," says Speh. Thirty of these innovative systems are already in use worldwide, and 200 more are on order.

Up to 150 programmers worked on the new control system, whose special architecture is similar to the three-tier system used for the Internet. And that's a big advantage. The first tier manages data. It consists of a network of sensors and actuators that covers the entire power plant. The next tier is the processing level. This is where plant control takes place. Here, sensor data is processed and commands are sent to the actuators that control the operation of pumps, motors, and valves. The plant's data is stored on an integrated web server. All user data and access rights are centrally managed and each user receives only relevant data. The third tier is a presentation level. This is where interaction with power plant processes takes place. Unlike other systems, SPPA-T3000 does not require users to install special software. Instead, control room operators can access the system via a web browser.

The system's intuitive navigation feature makes it easy to operate. "We can process data and functions more efficiently by using templates," says Frank-Peter Kirschning, head of the Rheinhafen steam power plant in Karlsruhe. This is crucial when a fault occurs, because malfunctions have to be quickly located and diagnosed. Once the source is discovered, the control system indicates its location. The SPPA-T3000 system was recently installed at the Karlsruhe plant as part of a comprehensive upgrade. "We used to have many different systems that were linked through interfaces — a set-up that often caused faults," says Kirschning. "The new control system is completely homogenous and a lot simpler to use." As a result, plant operation is more efficient and less costly. Another advantage of SPPA-T3000 is that it has been designed to serve as a platform that can be expanded through the addition of further software modules.

For customers with long-term service contracts, Siemens offers a remote monitoring service. Here, operating data related to turbines and other systems is transferred via the Internet to Siemens' Power Diagnostics Centers in Erlangen, Mülheim an der Ruhr, Germany, or to Orlando, Florida (*Pictures of the Future*, Fall 2004, p. 67 / Spring 2005, p. 48). The underlying software for this service was developed by PG's Dr. Hans-Gerd Brummel together with a team headed by Dr. Claus Neubauer, project manager at the Intelligent Vision & Reasoning Department at Siemens Corporate Research (SCR) in Princeton, New Jersey. Known as PowerMonitor, the diagnostic software can detect hidden faults in any of a turbine's key components early on by continuously evaluating data supplied by hundreds of sensors.

Extreme Stresses. It's pretty hot in the interior of a gas turbine. Exhaust gases with temperatures of 1,500 degrees Celsius are thrust into the turbine from the combustion chamber at pressures of more than 15 bar. The gases cause the turbine blades to rotate at up to 3,600 rpm. Such thermal stresses can create cracks and fissures, and, in extreme cases, even cause metal parts to break off. These parts would severely damage the turbine if they got inside, causing up to a week's down-time.

"But if a crack is discovered early, the damaged part can be replaced when the turbine is not in use," says Dr. Hans-Gerd Brummel, manager for R&D at Power Diagnostics. "If the repair is carefully planned, it can be performed within two days." To detect faults, the turbine is continuously monitored by about 500 sensors. The resulting data is analyzed by PowerMonitor. To make all of this possible, the self-adaptive software is first trained on the turbine. During this phase, PowerMonitor calculates expected values for all of the sensors. These values are then compared with current measurements and deviations are reported. "In the past, such malfunctions appeared without any prior warning," says Brummel.

Such surprises are no longer possible, since remote diagnostics allow operators to determine precisely where a turbine fault is about to occur. Siemens currently monitors 260 gas turbines worldwide. In addition to early detection of faults, Siemens specialists assist plant operation — for example, when turbines undergo periodic vibration analysis to ensure that they are perfectly balanced. Here, PG's power plant team works with Power Diagnostics, particularly following installation of new turbine blades. Until recently, such analyses were performed by specialized technicians on location. But today, with the assistance of the plant's own technicians, such evaluations can be performed remotely.

Good communication is also essential for distributed power generation. This is the case, for example, when a wind turbine, a landfill gas facility and a geothermal power plant are linked to create a virtual power generation facility. Such a network can supply energy in a particularly economical and reliable manner and helps to conserve resources (*Pictures of the Future*, Spring 2002, p. 58). To control the network, operators can use technology such as the Decentralized Energy Management System (DEMS) from Siemens.

The first step is to make an in-depth plan of the facility's operation. To determine what kind of load the virtual power plant has to cover, a day of operation is divided into a grid of 15-minute periods and loads are calculated for each of these. Other relevant factors are known times of peak demand and weather conditions, which affect photovoltaic facilities and wind turbines. Everything else is taken care of automatically. The DEMS uses the resulting data to draw up a plan of operation for the distributed power plant. The network is controlled automatically, and the DEMS transmits the commands to the individual power generation facilities via data lines or mobile radio. Much of the data that is collected is not transmitted, however, because DEMS does not need to analyze the operation of the individual facilities as closely as does the SPPA-T3000 system. "The focus in the virtual power plant is not on the optimal operation of the individual facilities but on the overall power generation network," says Dr. Thomas Werner, DEMS Product Manager at Siemens Power Transmission and Distribution (PTD).

At present, only large-scale facilities can be economically integrated into virtual power plants. However, PTD and energy utility RWE recently developed a new model for organizing the technical and economic aspects of virtual power plants. This new concept will make it possible to integrate facilities that are not owned by the network operator. Once a uniform communications standard has been established, it will even be possible to feed electricity into virtual power plants from private homes. "That's the vision we're working on," says Reinhard Remberg from the Strategic Marketing Department at PTD. ■ *Werner Pluta*