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Breaking the Barrier to Alternative Energy Sources

From chemically storing wind power's kinetic energy to generating steam from biomass, developments in automation and supporting technologies are overcoming the obstacles to green power generation.

By James R. Koelsch, Contributing Editor

Waste not, want not! It's a maxim that many manufacturers have been taking to heart in increasingly innovative ways these days. Take the Varo pulp mill operated by Sodra Cell near Varberg, Sweden. Rather than throwing unusable branches, bark and other remnants onto a trash heap, the paper manufacturer has invested in automation for transforming this waste into clean streams of revenue. Not only is the plant now more efficient and profitable, but fossil fuels also no longer fire the boilers that drive its pulp and power production.

Because making pulp requires a lot of steam, many producers, especially those in Scandinavia, divert some of the steam to generating their own electricity. So, besides making enough electricity to produce 425,000 tons of pulp a year, the Varo mill also generates 550 GW-h of surplus energy in the forms of electricity, steam and biofuels. The mill then sells 100 GW-h of its surplus to the national power grid and 150 GW-h of it as heating steam to homes in nearby Varberg, a town of 27,000. The remaining 300 GW-h goes to market as biofuels for power plants and industrial users.

As Sodra Cell and others in a variety of industries are discovering, automation can solve some of the problems that have made alternative energy sources too impractical and unprofitable in the past. For this reason, some businesses are turning to these solutions to deal with the rising cost of fossil fuels, the nagging uncertainty in the global economy, and growing concern for the environment.

Optimizing operations

At the Varo pulp mill, the key was the high level of integration permitted by Extended Automation System 800xA from ABB Inc.'s Process Automation Div. in Wickliffe, Ohio. Approximately 40 controllers oversee some 23,000 input/output (I/O) signals from 56 operator stations and optimize the processes. "The systems are connected in a common interface, which enables us to control what is happening in the various parts of our operations," says Ola Walin, Varo's maintenance manager.

Maintaining optimal settings is no small feat. "Often with alternative fuels, you don't know exactly what their quality will be," explains Marc Leroux, ABB's marketing manager for collaborative production management. "Some of the bark and other remnants from trees might still be green, for example, which produces less usable heat." To accommodate this and other sources of variation not normally found in refined fossil fuels, Varo's control system needed the ability to adjust set points and other operating parameters automatically.

Leroux attributes this flexibility to two kinds of technical advancements. First is the ever-expanding computing power in each successive generation of control systems. “It gives you the ability to process the variables that you’re adding to your equations,” he says. “You also have more access to information for decision-making and a flexible way for creating the necessary models.”

The second advancement is the development of increasingly more sophisticated integrated advanced control software that sits on top of the control system for making decisions. At Sodra Cell’s Varo mill, such software monitors input fuel and its burning characteristics, matches it against the desired output, and either modifies the affected operating parameters or recommends adjustments to an operator. Other software manages the quantity and sale of the excess power.

Click here to read about Simulating Complex Processes for Alternative Energy Production.

Nimble power plant

For similar reasons, load-following software also plays an important role in integrating wind and solar power into the power grid. “When a cloud comes overhead or the wind stops blowing, you’ve got to turn to fossil fuels, ramping up generation [at fossil-fired plants] to make up the loss in order to meet the demand,” explains Gary Woodward, director of business development at Emerson Process Management Power and Water Solutions Inc. of Pittsburgh.

The Minnkota Power Cooperative Inc. ran into this very problem at its Milton R. Young Station Unit 1 near Center, N.D. Once it joined a regional grid spanning 12 states and one Canadian province, the unit was called upon to compensate for the daily variations caused by changing winds at the participating 100-MW wind farm. “The plant didn’t get any advance information,” notes Woodward. “When the voltage started dropping, it had to try to respond instantly to make up the loss.”

Before joining the regional grid managed by the Midwest Independent Transmission System Operator Inc. based in Carmel, Ind., the coal-fired plant had a fairly predictable demand for power from the more than 110,000 customers who constituted its primary customer base. It would ramp up in the morning,

run its base load during the day, and come down at night again.

To help Minnkota to react to the new dynamics, it installed Emerson’s SmartProcess Unit Response Optimization (URO) software on top of the Emerson Ovation expert control system that was already on Young Station’s Unit 1. The control scheme relies on process-based dynamics and a model of the response rates for the machinery and controls in the plant. Exploiting the computing power available today, the optimizer solves a matrix to determine how quickly it can change the various control set points without generating oscillations and other forms of instability.

The calculations enhance the responses of both the boiler and turbine, making the unit much more nimble. Besides boosting the original 2-MW/min ramp rate to 7 MW/min, the technology also tightened the overshoots and undershoots by 2 MW. Variations in throttle pressure, moreover, fell by an average of 4 psi. Not only does the ability of the unit to react more quickly and accurately improve the plant’s competitive position, but it also reduces its fuel consumption.

Clean carbonless combustion

Rather than trying to ramp up coal-fired plants when the wind dies, the Sotavento Virtual Power Plant in

Galicia, Spain is taking a different tack. It has been experimenting with storing the wind's kinetic energy chemically. The wind-driven turbine powers an electrolyzer that splits water into hydrogen and oxygen, so the hydrogen can be stored in a tank farm and burned to generate electricity. Not only does the process not rely on any fossil fuels, but water is also the only byproduct of this combustion.

The Spanish energy company Gas Natural SDG designed the plant in cooperation with the Galician Regional Government (Xunta) and the Sotavento Foundation to study the feasibility of using hydrogen as a fuel. The Sotavento plant is producing 38,500 MW-h annually, which is enough to serve the needs of about 11,000 Spanish households. Estimates are that the process eliminates about 36,000 tons of carbon dioxide that would have been emitted into the atmosphere every year.

These results are due in part to the tight integration and seamless communications provided by the automation overseeing the equipment. Gas Natural contracted Optomation Systems, a Madrid-based systems integrator, to build a supervisory system based on the SNAP programmable automation controller (PAC) platform from Opto 22 of Temecula, Calif. Through a mix of analog and digital I/O connections, the PACs communicate with the equipment and instrumentation directly or otherwise interface with other SCADA systems.

The Opto 22 controllers communicate to each subsystem or machine using the native protocols originally specified by the manufacturer—Profibus for handling production data from the electrolyzer units and Modbus for the hydrogen compressors. An RS-232 serial link connects the motor-generator units to report analog and digital measurements. The SNAP controllers aggregate all data and serve it to a Sotavento database that authorized personnel can access over a secure Internet connection.

The secret to successful implementation of this project is to define the communication protocols at the hardware purchase stage, well before writing the first line of code, according to Fabio Alberini, a project manager at Optomation Systems. "Trying to design the communication links after the equipment is chosen and installed is more difficult, costly, and beyond the core competencies of the supplier," he says.

Harnessing the sun

Although Sodra Cell's Varo mill, Minnkota's Unit 1 and the Sotavento Virtual Power Plant all sold power to a grid, not every investment in alternative energy is for selling power to others. This is particularly true when it comes to solar power. "Nearly 80 to 90 percent of the solar photovoltaic projects in the U.S. are installed for residential and commercial applications," explains Chris Davidson, senior manager for solar at Siemens Industry Inc. in Alpharetta, Ga. Rather than contributing to the grid, these applications tend to be aimed at reducing one's dependency on the grid and achieving a measure of energy independence.

A case in point is the aggregate mining facility that Granite Construction Co. operates in Coalinga, Calif. A solar field there generates 1 MW of electricity for the site. "Our solar initiatives at our Coalinga facility will offset approximately 50 percent of our power requirements," reports Sean Kilgrow, Granite's director of renewable energy business development. "The clean energy generated to support our operations is equal to the amount of electricity used to power 191 average American households annually."

Granite Construction is using Siemens' Sinvert PVS1051 UL inverter and a 1,000 kVa oil transformer. Besides converting the direct current from the photovoltaic generators into three-phase current, the inverter helped to solve the biggest problem facing the application—monitoring the performance of the field of solar cells. Operations management needs to know when to send someone in to clean the dust and other debris from the glass panes covering the panels. “The Siemens inverter will do that to some extent,” says Kilgrow. “In our Coalinga solar system, we have the granularity to monitor the performance of every four panels.”

This technology, like the others, is helping engineers break down the barriers that have been making green energy too expensive to be practical and profitable.

Companies in this article:

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