VISION STRATEGY REALITY

The Colorado-Denmark connection

+ ENERGINET.DK FINDS COLORADO PARTNERS TO HELP MANAGE DISTRIBUTED GENERATION

By Mike Breslin

NOTHING SAYS THE FUTURE OF A GLOBALIZED, MORE INTELLIGENT GRID than the collaboration between Colorado State University (CSU), the Danish power grid operator Energinet.dk and Spirae, Inc., a Colorado-based team of experts on power grid modeling, simulation, control system engineering, wind power and distributed energy. Together they have gone beyond smart grid modeling and simulations and are now in the midst of field testing a solution with about 8 MW of generation out of a 4,800-MW load grid in one of the most advanced distributed energy networks in the world—Denmark.

Essentially, the group is overlaying Energinet's legacy system with smart, distributed-control software and multi-level software and hardware interfaces down to substations, small combined heat and power (CHP) plants and individual wind turbines. "Energinet deserves all the credit for actually moving in this new direction, doing demonstrations and bringing significant power management to a distribution system," said Sunil Cherian, CEO of Spirae.

DENMARK'S DEMAND FOR GRID INTELLIGENCE

Consider the challenges posed by Energinet's structure. It operates through two wholly owned subsidiaries, Eltransmission.dk A/S and Gastransmission.dk A/S, and operates a 400-kV electricity transmission grid and a gas transmission grid correspondingly. The company also owns and operates 132-kV and 150-kV power grids, is co-owner of the power interconnections with Sweden, Norway and Germany and holds a 20 percent stake in Nord Pool Spot AS, which sets the daily physical electricity prices in the Nordic market.

Over the past 20 years, Denmark has transitioned from 15 large CHP plants and spread distribution to hundreds of small CHP plants plus 5,500 wind generators with a total capacity of 3,100 MW. The spark that ignited this transformation happened in 2003 when the country went to a competitive system that enabled consumers to buy electricity from their supplier of choice. As a result, the Danish Wind Industry Association projects that 25 percent of the country's electricity will be generated by wind in 2008 and 35 percent by 2015.

With this rapid growth of widely distributed generation, over three years ago Energinet searched the world for the latest thinking in smart grid technology and found it in, of all places, Fort Collins, Colo. Energinet contracted with Spirae for the research and development work and then Spirae and CSU worked together to build a laboratory, which is heavily utilized for developing and testing smart grid solutions. Wade Troxell, associate dean for research and economic development at Colorado State University's College of Engineering elaborated: "Working with Spirae, together we developed the joint-owned, joint-use facility, the InteGrid Laboratory, a megawatt-scale reconfigurable infrastructure to do physical testing of smart grid configurations."

Rather than a small lab with modeling and simulation equipment, InteGrid is connected to the grid and enables technologists to conduct physical tests that can be validated in a real-world environment. That is how the larger-scale solution now being tested in Denmark was developed.

"Right now we have several Spirae people on site in Denmark carrying out Phase 1 testing. The tests have been

going very well. After that, the expectation is that the test area will be increased to 50 MW over the next two years," Cherian said. Multiple stakeholders are involved in this complex initiative. Spirae works with Energinet's research and development team and transmission operators, with Syd Energy, an independent distribution network company, and with several owners of generating assets such as CHP plants and wind turbines. This team meets quarterly, but is constantly in contact coordinating the

project via telephone and e-mail. According to Cherian, solar is slowly increasing in Denmark and wind power is expected to grow rapidly in order to meet national targets. Wind power in the test area ranges from 0.5-MW to 2.5-MW turbines and can come from a single turbine on a farm to a cooperative with several turbines.

Spirae believes the most ambitious test will be running the system in a wind-only condition in the test area using four wind turbines and being able to carry the load with the new power control technology. This will require unprecedented coordination between the new software installed for the project that interfaces with supervisory control and data acquisition (SCADA) systems at the distribution company and software systems that control dedicated hardware at substations, smaller substation equipment and feeders serving end users.

"When you have a large, heterogeneous mix of distributed generation and many ways in which loads can participate into the electric systems, not simply serving it, but in terms of demand side management and other ways, you can begin to configure services around distributed energy resources," Troxell pointed out.

Equipment at the InteGrid Lab, jointly owned and operated by Spirae and Colorado State University, in Fort Collins, Colorado.

Spirae team members Oliver Pacific, Biju A.S., Larry Adams and Brendan Keogh prepare for field tests at the Hejnsvig substation in Denmark.

TRANSLATING TECHNOLOGIES FOR NORTH AMERICA

Troxell also believes that this partnership is at the leading edge of smart grid management. Knowledge gained through the Energinet implementation will help the InteGrid Laboratory advance other grid improvements incorporating green energy in other partnerships under way in both Europe and the United States, including the Fort ZED (zero energy district) project. This 50-MW load pocket around Fort Collins includes the CSU campus, the city's historic downtown area known as Old Town and the Cache la Poudre River corridor. When implemented, it may distinguish Fort Collins as a world leader in alternative energy development and grid control. Leveraging CSU's energy technology leadership, local leaders, Fort Collins Utilities and the Northern Colorado Clean Energy Cluster are creating a zone that generates as much energy as it consumes. Fort ZED requires the energy to be clean, balanced and employ efficiency and conservation to achieve the goal of self-sufficiency. "We developed a demonstration around the zero energy district where we are actually showing a high level of distributed energy resource penetration below the substation and how it's coordinated and controlled. We have some of the generation in place at our Engines and Energy Conversion Laboratory, which is part of our InteGrid Laboratory," said Troxell.

The project recently received from its partners and the U.S. Department of Energy an $11-million grant to fully implement the demonstration project.

During the campaign, our new president pledged energy independence from imported oil in 10 years. If this goal is to be achieved, thousands of new sources of clean, widely distributed generation will have to be absorbed into the regional grids. This will require not only massive improvements in transmission infrastructure, but also the kinds of grid management innovations being developed in Fort Collins and implemented in Denmark.

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WHAT ABOUT ELECTRIC VEHICLES?

Electric vehicles are not included in the current test, but Energinet's smart technology is designed to be extended to these and other generation and storage sources—controls can be plugged in as new technologies become available. That may be soon. Early this year, the Danish government announced a pilot program with Project Better Place to set up an electric car program aimed at supporting a nationwide, subscription-based infrastructure with open-source battery and vehicle standards, automated battery-switching stations, and widely deployed charging spots to keep batteries topped off so they always have 100 miles of driving capacity. Both Denmark and Israel have enacted policies that create tax differences between zero-emission vehicles and traditional cars to accelerate the transition to electric cars. Because most electric vehicles will be charging at night while parked at homes, batteries will become distributed storage for clean electricity. In Israel, the plan is to store excess power from the growing solar industry in car batteries. Similarly, in Denmark, surplus energy from the country's wind turbines could be stored.

Check out Mike Breslin's in-depth look at Project Better Place in the March/April issue of *Intelligent Utility*.