ClimateWire

1. TECHNOLOGY: A national lab develops grid controls to handle renewable energy *(11/23/2010)*

Peter Behr, E&E reporter

RICHLAND, Wash. -- In an experimental control room at the Energy Department's Pacific Northwest National Laboratory (PNNL), small blips dart left and right on a display screen, recording distant signals from key points on the Western high-voltage grid at 30 times each second. Should the blips migrate past a security boundary on the display, an alarm would immediately warn that the grid was in jeopardy.

Such an early alert could have helped operators avoid the 1996 Western power blackout, which knocked out 30,000 megawatts of power -- equivalent to darkening 30 cities the size of Seattle. The advanced monitors in PNNL's Electricity Infrastructure Operations Center (EIOC) could also have averted or at least minimized the 2003 Northeast blackout, which cut off power to 50 million people, says Carl Imhoff, PNNL's electricity infrastructure manager.

Michael Davis (left) and Carl Imhoff (second to left) confer with two engineers in the Pacific Northwest National Laboratory's new grid laboratory. Photo courtesy of PNNL.

"You would have seen Cleveland beginning to pull away from the rest of the system" more than an hour before the final cascading power loss, he explained.

The intermittent nature of wind and solar power now make the grid operators' world more complex. The looming emergence of electric vehicles and the need for ways to store more electricity and to get electricity consumers to reduce peak demands will add still more complexities, Imhoff said. "The grid is going to be changing a lot over the next 10 years. We want to anticipate that and to some extent, to guide it. Right now, I think we're kind of backing into the future," he said.

PNNL's ambitious aim is to manage at least some of that future by investing in innovations like the EIOC, and then carrying technology advances into the marketplace with its industry partners, its leaders say.

The result is a federal laboratory, funded by Congress, that seeks solutions in areas of climate policy, renewable energy integration and electric vehicles -- areas on which a clear political consensus has not been reached in Washington.

Peering over the political horizon

Imhoff and other PNNL leaders are eager to offer the EIOC as an example of the lab's commitment to tackle issues that lie over the horizon, even if it had to get started on its own.

PNNL, which falls under DOE's Office of Science, is authorized to set aside a few percent of its $1.1 billion annual budget from Congress -- about $50 million per year -- for its Laboratory Directed Research and Development (LDRD) program. That funded development of the EIOC.

"This laboratory invested its own money and partnered with industry to create the EIOC five years ago. Nobody knew that you needed it except us, because we gave it enough thought and understood what the scientific gaps were," said Terry Walton, energy and environmental sector manager at PNNL. "We are thinking about this laboratory in terms of decadal challenges."

The display in the EIOC is driven by synchrophasor technology, the hottest front in the management of transmission systems. The Energy Department awarded $147 million in American Recovery and Reinvestment Act smart grid grants to 10 phasor projects nationwide last year, matched by the grant recipients, in a major expansion of the government-industry North American SynchroPhasor Initiative.

The phasor units' split-second measures of power flows are time-stamped via satellite to synchronize readings from generators, even units hundreds of miles apart. Then the sea of data must be translated through high-speed computing into displays that can guide grid operators' actions.

"Over the course of the last 10 years, the lab has chosen to invest in initiatives to build new capabilities or result in discoveries that lead to more long-lasting benefits for DOE and the country," said Suresh Baskaran, PNNL's manager of energy efficiency programs.

'You guys are different'

PNNL's initiatives have been welcomed by DOE under the Obama administration, Walton says. The message from DOE: "You guys are different. We like it. Don't lose it."

"I sound like I'm selling, but I'm really excited about what we're doing," Walton said.

The sales pitch is apparent during a visit to PNNL, which must vie with other national labs for DOE funding and has a big stake in how warmly Congress responds to its research initiatives. "We are a $1 billion laboratory. But in fact, nobody gives us that money. We have to compete for that," Walton said.

The laboratory, with 4,900 employees, is outside Richland's center in southeast Washington. Its roots go back to the Manhattan Project in World War II, when the lab was part of the Hanford Site, where the Columbia River's water cooled reactors that produced plutonium for the Nagasaki atomic bomb, and later for the U.S. Cold War nuclear arsenal. PNNL was separated from the Hanford Site in 1965, but still does a relatively small amount of geological research related to the contamination risk from radioactive wastes stored below ground at the adjacent Hanford Site.

Its expertise in chemistry contributes to research on advanced batteries for power storage, a crucial application for managing wind power. The lab's background in geology feeds into research on underground storage in mineral form of separated carbon from coal power plants.

PNNL's interest in grid controls began in 1992, says Imhoff. The 1996 blackout, the 2000-2001 California energy crisis, and the 2003 blackout added to the urgency of the effort.

"We said, we need a laboratory for our grid work. We want to work with phasor data. It's very hard to get, and when you get it, you've got to aggressively protect it. ... That's why we wanted this room, so we could work on full system models with live new data sets, and on the new visualization tools."

Helping an industry that is slow to lead

Another EIOC display shows the concentration of electrical power loads and the weak points in the transmission network where the grid would break apart in a severe outage. "You can't buy any of these right now. It's being beta tested," Imhoff said. Testing and training are the main EIOC functions. It isn't used for day-to-day grid management, but it could be, Imhoff says.

"There is going to be an explosion of data [on the grid], just like in every other aspect of our life," Imhoff said. "And the data isn't worth anything. What you need is information. The question is how to distill the right information for operators, and give it to them at the right time, with security and privacy. This is one of the big challenges we face.

"Congress doesn't spend a lot on the grid," Imhoff said. The view in the recent Bush administration was, 'If it's so important, industry will step up and do it.'" But with some notable exceptions, the utility industry has been slow to lead, he added.

"When I hear people bad-mouthing stimulus money, saying we got no benefit out of it, well, they just don't understand. There's a huge transformation going on." The industry money was slow in coming to the table until they got that push, he said. The technological advances "are really accelerated by these stimulus dollars that everyone is so upset about. And it's going to deliver substantial value that most folks will never even hear about," Imhoff said.

PNNL was launched in 1965, managed by the nonprofit Battelle Memorial Institute, based in Columbus, Ohio. Walton said it is this connection to the private sector that also sets the laboratory apart. "We realize the value and necessity of partnering with the private sector to deliver solutions," said Walton.

CO2 capture and great big batteries

One such collaboration, with Babcock and Wilcox, the Massachusetts Institute of Technology, and the Electric Power Research Institute, aims at defining concepts that could dramatically lower the cost of separating CO2 from power plant emissions and storing it safely below ground and at a manageable cost.

Michael Davis, who heads PNNL's Energy and Environment Directorate, says the key may be modifying existing coal plant emissions scrubber systems to separate CO2 along with the oxides of sulfur and nitrogen. Step two is to contain the CO2 in underground basalt formations where it could safely convert to mineral form for safe, long-lasting storage. PNNL sees evidence of it working in the lab. If it does so in practice, it could be an answer to worries that CO2 sequestered under pressure below ground might accidentally leak to the surface with possibly dire consequences.

"We're investing $50 million over five years, a very large investment for us, in development of breakthrough technologies for the capture of CO2," said Walton. "We're building the right kind of teams" for that.

Another venture links PNNL with EaglePicher Technologies, a division of OM Group, in a quest to produce a cheaper storage battery system for utilities, to help back up wind and solar generation. EaglePicher has made its name producing advanced batteries for U.S. military and space applications. A grant from DOE's Advanced Research Projects Agency-Energy funds the effort.

The Japanese firm NGK is now the only major commercial manufacturer of sodium-sulfur batteries being purchased now by some utilities. Its units have a thick tubular design, suited to sealing in the dangerously volatile sodium. If the battery could be

made in a thinner, flattened form, battery efficiency could jump by 30 percent and manufacturing costs could drop dramatically, says senior research scientist Gordon Graff.

PNNL's mission is to direct research at potential breakthroughs that would keep the nation on a path toward meeting 10-, 20- and 50-year energy and environmental goals -- goals that Imhoff says are not much in doubt. "I hear virtually nobody debate whether the changes in carbon concentrations are effected by human behavior. I hear very few people argue that there's not going to be climate change," Imhoff said.

"The nation needs to be asking, what power system do we want? How do the new technologies enable us to get that in a way that maintains our global competitiveness and cyber security and meets our energy goals around carbon and energy imports?" he added.

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