Quarterly Update

Pacific Northwest SMART GRID DEMONSTRATION PROJECT

Winter 2011

At the heart of our project

Transactive control – a smart grid technique using an incentive and feedback signal that helps coordinate smart grid resources – is the glue that binds the Pacific Northwest Smart Grid Demonstration Project. This technological innovation can help optimize use of the grid and power resources, providing benefit to the region as a whole, utilities and end users alike.

Using transactive control can help eliminate the need to build costly thermal resources, reduce the region's carbon footprint, smooth out peaks in electricity use, help integrate intermittent renewable resources – like solar and wind – and help keep future costs from rising as quickly as they otherwise would.

This issue is dedicated to describing how the project's transactive control technique works and how participants can expect to benefit from it. We'll also describe the project-level infrastructure partners and their roles in making transactive control come to life, with potential to become part of the region's smarter grid.

Of course, we'll give you an update on the project timeline and a summary of recent outreach activities as well. The New Year is getting off to a great start!

Ron

Ronald B. Melton, PhD
Project Director

What's inside

Project Objectives and Attributes

Primary Objectives:

- Develop and validate an interoperable distributed communication and control infrastructure using transactive control signals;
- Measure and validate smart grid costs and benefits;
- Contribute to the development of standards and transactive control; and
- Apply smart grid capabilities to support the integration of renewable resources.

Operational Objectives:

- Manage peak demand;
- Facilitate wind integration;
- Address constrained resources;
- Improve system reliability;
- Improve system efficiency; and
- Select economical resources.

Key Attributes:

- Leave an installed operational base of smart grid assets and successful operational strategies for the region.
- Stimulate the regional and national economy by creating jobs and a vibrant smart grid industry.

Transactive control signal at the heart of the project

In technical terms: The Pacific Northwest Smart Grid Demonstration Project is developing a new approach to managing resources throughout the electric power system. This technique, called transactive control, uses distributed communications to send a transactive incentive signal and receive a transactive feedback signal within the power system's hierarchical node structure.

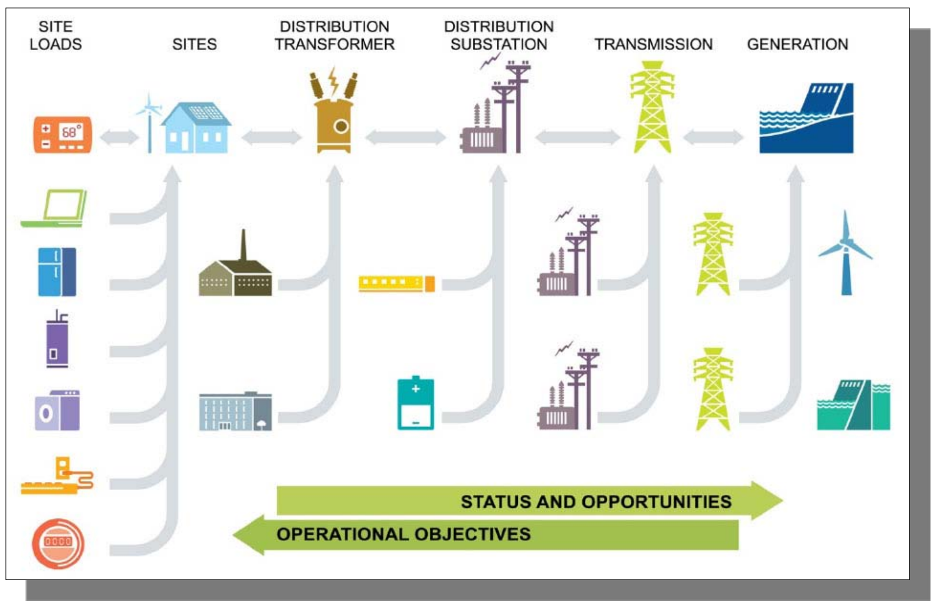
In human terms: The transactive control signals contain information about what power is available (and at what price) and what power is needed by end users. Two-way communication of this information – all the way from the source of electricity, such as dams or wind projects, to your home – allows intelligent devices and consumers to make smart energy use decisions thus bringing benefit to the region, to utilities and to consumers. These benefits include helping improve efficiency of the regions' power system, cost effectiveness, enhanced reliability and a smaller carbon footprint.

Transactive control is the centerpiece of the demonstration project. Its success, combined with the testing of utility-level smart grid assets, will help make a business case for smart grid. That will allow utilities in the region to make wise smart grid investments and create a more robust power system for years to come. If successful, it also can serve as a model for national implementation.

How does it work?

So what is the transactive control signal, exactly? The transactive control signal represents the monetary value of power in terms of dollars-per-megawatt-hour, at a given point in time and specific location, in an electronic form. The signal moves through the system (see graphic below), incentivizing the use and movement of power. It's a forward-looking signal, meaning that it forecasts days ahead and is updated every five minutes.

Data for the signal originates with the power generators. From there it propagates downstream through the network, following the flow of power, and corresponding to physical locations in the electrical system called nodes. These nodes can be anything (from appliances to a customer meter or a substation) that can receive information and transmit it, either up or downstream, so that other assets on the system can respond appropriately.



Two-way communication about the status of the power system, its opportunities and operational objectives can help the region create energy efficiency, cost effectiveness, enhanced reliability and a smaller carbon footprint.

At each node, a decision is made to increase the incentive signal value if less electric load is needed below that point, or decrease the incentive signal value if more load is needed.

Flowing in the other direction, starting with end-use points such as homes, information is accumulated and forwarded about expected energy use over the next day. In this way the transactive control system is a closed loop.

Generators see what the expected load will be and plan accordingly – end uses of electricity see what the expected price and availability will be and likewise plan their use. Over time, the incentive signal and the load signal converge, with planned supply of electricity matching planned use. In the figure on page 2, the incentive signal is shown as "operational objectives" and the load signal as "status and opportunities."

What are the benefits?

This two-way communication maximizes opportunities for the region to optimize the use of resources, such as renewable energy, and helps the system meet operational objectives, such as reliability. For example, if the wind is blowing and producing a lot of power in a particular locality or region, the transactive control system would make using that power locally a priority through pricing incentives.

Conversely, if a particular area were experiencing congestion on their transmission system, a feedback signal from the nodes would help move power to other parts of the system to help prevent a blackout.

Utilities can use the signal to optimize their own resources, including reducing peak load, reducing phase imbalance on a transformer or preventing overloads on a transmission line. Eventually the incentive signal will let consumers make educated choices about how and when to use electricity, and even at what price.

Forty-one of the test cases in the demonstration project involve the transactive control signals. Although the demonstration project will use simulated price incentives instead of actual changes in wholesale power prices, the structure of the project is intended to provide for a realistic scenario at a scale that can be applied regionally, and even to other parts of the nation. The transactive control system is slated to be up and running by September 2012.

The demonstration project also can shape national interoperability standards. This aspect is, in fact, one of the four main goals of the project. The next edition of the Quarterly Update will focus on this interoperability goal.

Project-level infrastructure partners

Who will bring the transactive control system to life and make sure it works? The demonstration has assembled an expert team of technical partners to help with system design, communication, computation, interoperability, cyber security, renewable energy integration and analysis.

Battelle's Pacific Northwest Division, located in Richland, Wash., is leading the project. This non-profit organization is responsible for providing technical leadership, data management and overall project management. Battelle is responsible for the project's allocation and expenditures, schedule and quality control. They also are putting together the cyber security plan, in collaboration with the other partners.

The Bonneville Power Administration, a federal agency in the U.S. Department of Energy, represents the project-level transmission, generation and renewable energy objectives of the region and will link the project together from the power system point of view. BPA has primary roles in business case development, outreach and external communications, system data input and design input.

Alstom Grid will define and calculate the simulated wholesale power price that will serve as the foundation for the transactive control signal. To that end, they will provide operations software, and provide services that will enable real-time dynamic pricing and renewable energy management in the project.

IBM is building the infrastructure to disseminate the signal and interlace it with the responsive assets. They are contributing servers and software that will allow for effective streaming of data.

Netezza's data storage appliance will provide processing speed and power to analyze and understand the project's data.

QualityLogic will develop tools to test the transactive control system's conformance to specifications and interoperability, and they will perform testing to confirm that the signals are correctly communicated along the nodal hierarchy. QualityLogic co-leads the investigation and adoption of national smart grid standards into the control signal. Testing and standards influencing efforts undertaken by QualityLogic and other project participants will help establish the nodal transactive control technology as a national standard.

3TIER will serve as the weatherman of the project, forecasting wind and solar resource availability at hourly intervals, days ahead and at five-minute intervals within the hour. These forecasts will affect the region's incentive signals to encourage variable renewable energy consumption when and where the resources are available.

Outreach calendar:

- Nov. 2 - 3 – Co-hosted the Smart Grid Road Show in Portland and conducted panel discussion comprised of PNW-SGDP thought leaders. BPA and Battelle co-hosted the event, made presentations and developed a panel discussion of PNWSGDP thought leaders
- Nov. 2 - 4 – Participated in US Department of Energy's Office of Electricity Smart Grid Peer Review meeting in Golden, Colo..
- Jan. 8 – Discussed policy, economics and electric infrastructure at the Energy Future Montana conference in Helena.
- Jan. 18 – BPA met with master's students from John Hopkins School of Advanced International Studies to discuss a national study on smart grid.
- Jan. 24 – Avista kicked off its project in Pullman, Wash., with a community open house event.
- Jan 26 – Discussed regional workforce development at the Green Professional Conference in Portland.
- Feb. 1 – Presented to the energy and telecommunications sub-committee of the Affiliated Tribes of the Northwest Indians, in Coos Bay, Ore.
- Feb. 2 – Will discuss the project during a presentation at the Technology Innovation Forum at BPA Headquarters in Portland. In addition, participants will present at a special morning session organized by BPA's Chief Technology Innovation Officer.
- April 12 – Will present to the Mission Valley Power Consumer Council in Palmo, Mont.

Milestones:

- Completed detailed definition of the dataflows to Alstom Grid.
- Completed project communication and outreach plan.
- Submitted benefits and metrics plan to DOE.
- Met all National Environmental Policy Act requirements.
- Conducted cyber security review of proposed datastreams, and updated cyber security plan.
- Prioritized data needed from wind producers.
- Articulated key drivers for the six benefit categories defined in BPA's business case analysis and mapped them to data needs and subproject level test cases.
- Proposed next steps to build computational model and coordinate data collection.

Upcoming milestones:

- **Project infrastructure**
  - Finalize agreed cyber security protocols with Battelle and Alstom, and begin file transfer.
  - Organize permission process with independent power producers, and engage IPPs and BPA contacts who work with these entities.
  - Release Cycle 1 of the Transactive Control System is scheduled for June.
    - This release will establish basic communications between 43 nodes.
  - Release Cycle 2 will begin in late June:
    - Adds transactive functionality to the nodes.
    - Will implement initial nodes at utilities.
  - Dataflows from BPA will begin to the Electricity Infrastructure Operations Center at Battelle's campus in Richland, Wash.
  - Finalize metrics and benefits plan, data collection plan and business case approach.
  - Install and test Multiple Assets at utilities.
  - On-going outreach activities – local, regional, and national – meet with each subproject team to discuss their respective communication plan.

- **Regional business case**
  - With Battelle, finalize scope of work for fiscal year 2011, refine data collection and develop oversight committee.
  - Review and comment on the next version of the Battelle Data Collection and Analysis Plan.

In the news:

- October 2010: Metering International magazine features authored article by Battelle project leads Ron Melton and Don Hammerstrom.
- November 2010: ClimateWire and the New York Times highlighted the PNW-SGDP: Integrating Wind and Water Power, an Increasingly Tough Balancing Act
- November 2010: Clearing Up features Alstom Grid's John Lelivelt in an article about the PNW-SGDP panel discussion at the Smart Grid Roadshow in Portland.
- January 2011: Several Pullman, Wash.-area media attend and report about the Avista community kick-off event

Project description

The Pacific Northwest Smart Grid Demonstration project is a regional endeavor funded by the Department of Energy under the American Recovery and Reinvestment Act of 2009. The goal is to verify the viability of smart grid technology and quantify smart grid costs and benefits. This information will help validate new smart grid business models at a scale that can be adapted and replicated nationally. With the 50 percent DOE matching funds, this project has a $178 million budget.

Smart grid can help meet increasing power demands, reduce greenhouse gas emissions, promote energy independence, enhance reliability and help improve national security. It is a system that uses technology to enhance power delivery and use through intelligent two-way communication.

Power generators, suppliers and users are all part of the equation. With increased communication and information, smart grid can monitor activities in real time, exchange data about supply and demand and adjust power use to changing load requirements. Smart grid technology includes everything from interactive appliances in homes to substation automation and sensors on transmission lines.

The regional project, the largest smart grid demonstration project in the nation, is led by Battelle Memorial Institute, Pacific Northwest Division. Participants include the Bonneville Power Administration, utilities, universities and infrastructure partners. It includes 112 megawatts of responsive resources and will last for five years.