Pacific Northwest
SMART GRID
DEMONSTRATION PROJECT

Pacific Northwest Smart Grid Demonstration Project

2011 ANNUAL REPORT

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Introduction

Greetings and Happy New Year! During the past two years, the Pacific Northwest Smart Grid Demonstration Project, or PNW-SGDP, has accomplished several key milestones that allow our region to chart path to a future power system. This year we're preparing to put several of the PNW-SGDP's unique technologies into action for the first time.

The PNW-SGDP kicked off its five year journey in February 2010. With $178 million in funding from the U.S. Department of Energy and project participants (at a 50% cost share), and 60,000 participating consumers across five states (Idaho, Montana, Oregon, Washington, Wyoming), the PNW-SGDP is the largest smart grid demonstration project in the nation. Our objectives are to:

- Quantify smart grid costs and benefits;
- Facilitate the integration of renewable resources;
- Validate new smart grid technologies and business models;
- Advance standards for interoperability and cyber security approaches; and
- Provide two-way communication between distributed generation, storage and demand assets, and the existing grid infrastructure.

In 2011, we made strides towards accomplishing these goals. At the heart of our efforts is the advancement of the project's transactive control methodology, a novel, two-way system that will enable responsive assets and energy generation across the region to produce and use electricity more efficiently. Imagine, for example, the problem of electric cars recharging their batteries during peak times of energy demand. Uncoordinated charging can lead to transformers overloading and general strain on the grid. With transactive control in place, responsive assets from plug-in hybrid electric vehicles to water heaters can respond to the system's economic incentive and feedback signals and charge batteries and heat water without straining the grid.

Our technology provides incentives that allow consumers to benefit from adjusting their electricity consumption while improving overall system efficiency, reliability, and reduce operating costs for utilities. In aggregate, these changes help reduce 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. We are excited that our project is a first step towards achieving these objectives. A key element of the project is the collection and analysis of data to better understand which benefits may be realized through wide spread deployment and further development of the method.

In April, we successfully connected key system software and hardware components from the project's technology partners: 3TIER, Alstom, IBM, Netezza, and Quality Logic with Battelle's Electricity Infrastructure Operations Center, or EIOC, and demonstrated communication connectivity to several of our utility partners. Establishing these connections is getting us a lot closer to that vision.

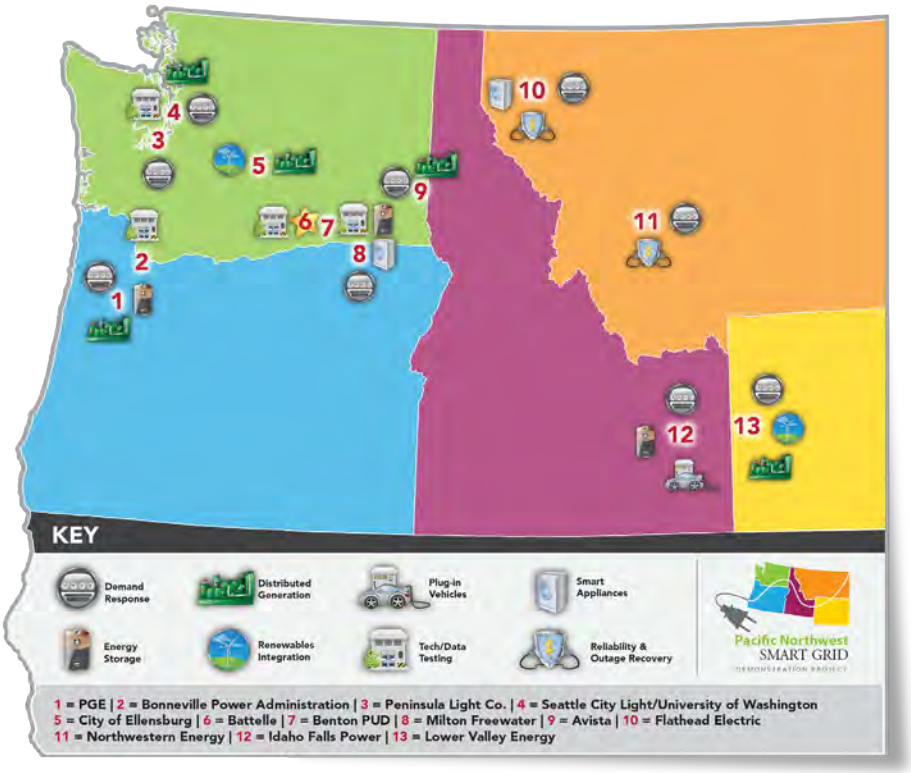
At the same time, our utility partners are transforming the region's grid by installing 80,000 smart grid enabling assets, such as smart meters, and 12,000 smart grid-responsive assets, which include water heater load controllers, solar panels, battery storage units, and backup generators. From smart water heaters on Fox Island, Wash., to in-home displays in Libby, Mont., the PNW-SGDP already is creating a significant technological footprint in the region.

With all system architecture in place and utilities finishing up installing smart infrastructure across the region, we are looking forward to the fall of this year, when the transactive control system will "go live" and allow the installed assets to start responding to electric power system conditions. The data we gather from this two-way communication system will help us better understand how our power system can operate more efficiently, and what types of technologies will best suit our region. Starting this fall you also will be able to see transactive control in action across the region by logging on to the interactive tool on our website at www.pnwsmartgrid.org. We look forward to sharing our insights with you and with others throughout the country.

Over the next eight pages you will find selected PNW-SGDP highlights from our participating utility and technology partners. Please follow our exciting journey that will move the nation closer to a more efficient, sustainable and resilient power system by subscribing to our newsletter on our website at **www.pnwsmartgrid.org**, and following us on Twitter @ PNW_SmartGrid.

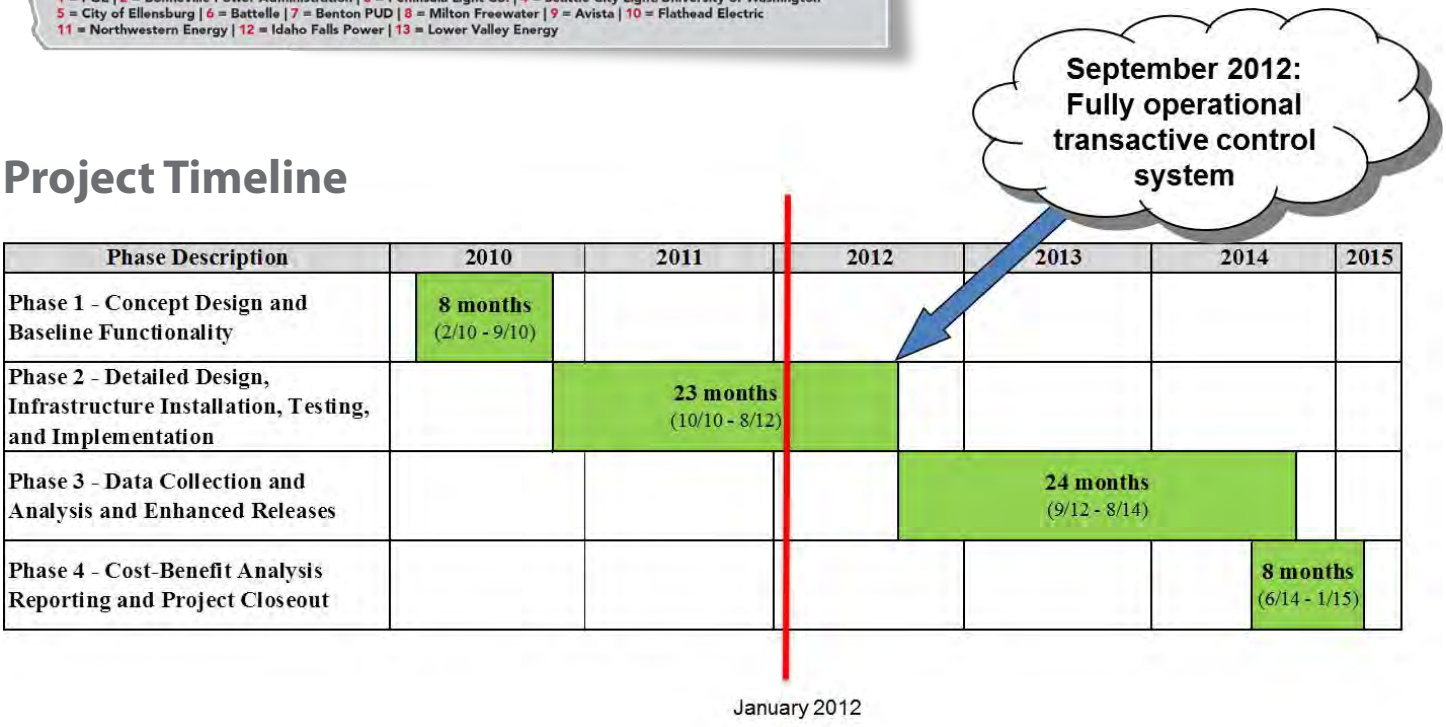
Ron

Project Map



The PNW-SGDP involves the Bonneville Power Administration, five technology providers, the University of Washington and 11 utilities across five states, Idaho, Oregon, Montana, Washington and Wyoming. The project is managed by Battelle's Pacific Northwest Division located in Richland, Wash. Battelle is a $5 billion non-for-profit organization that benefits mankind by helping solve some of the world's toughest science and technology based challenges.

Project Timeline



During the current Phase of the Project, several technical milestones are categorized by "Release Cycles," or RCs. We measure the progress of the RCs with several metrics, including monitoring, data collection, system management and testing. RC 1 drew up the topology and interfaces of the system model, enabled monitoring and data collection processes and tested several pieces of the transactive control system's infrastructure. RC 2, which started in June, 2011, builds on the work done in RC 1 by expanding transactive control functionality and building and testing the entire system. RC 3, which will end with the beginning of Phase 3, allows public and stakeholder monitoring of transactive control in action and establishes continuous operation of the system.

PNW-SGDP 2011 Progress Reports

Bonneville Power Administration

Making the smart grid business case

The Bonneville Power Administration will use a computational model to review the costs and benefits of a smarter grid for the Pacific Northwest

Are smart grid investments a wise choice economically? Figuring that out is one of four primary objectives of the Pacific Northwest Smart Grid Demonstration Project. The Bonneville Power Administration, or BPA, is participating in the project with a key focus on developing a business case for a smarter grid. BPA's $10 million contribution to the project is the largest commitment in BPA's Technology Innovation portfolio.

The most recent milestone in BPA's development of the business case is creation of a computational model – a calculator of sorts. This will help show whether major infrastructure and technology investments will pay off in the long run, informing decision makers as they determine if the region should move forward with the large expenditures and capital that will be required to build out a smarter grid.

The computational model is basically a complex spreadsheet that takes all of the assumptions about an asset, including its cost, lifespan and the quantity purchased, and combines that with data gathered from the project (and other sources) to provide an estimate of the benefit, such as avoided costs, efficiencies, et cetera. Battelle has been working with utilities to collect the information needed to get started. As data becomes available during implementation of the project, it gets plugged into the computational model where the cost/benefit analysis will come to life.

> *Consumer acceptance of Smart Grid technologies is crucial to success.*

In terms of getting ready for the Sept. 2012 "go-live" date for the project's Transactive Control System, BPA has successfully tested transmission of data files in the designated frequencies to project-level infrastructure partners Alstom Grid and 3TIER. BPA went "live" with data flows without interruption after the test.

BPA also has a lead role in communication and outreach for the Pacific Northwest Smart Grid Demonstration Project. The agency writes the quarterly newsletter, coordinates with organizations such as the National Rural Electric Company Association, and makes dozens of presentations each year to a wide variety of target audiences including utilities and utility groups, governmental agencies, Tribal organizations and the general public.

Recognizing that consumer acceptance of Smart Grid technologies is crucial to success; BPA also supports participating utilities' efforts to educate end-users of electricity. The agency presented at the Chartwell Consumer Education Summit and the Northwest Public Power Association's conferences this year on the topic, and represents the Pacific Northwest Demonstration Project with participation in the Smart Grid Consumer Collaborative.

BPA often collaborates with utilities on presentations or uses their stories as case studies. For example, BPA partnered with Milton-Freewater at the Association of Electric Services Professionals at the fall 2011 Conference to provide an overview of the project and a drill-down into the utility's investments.

A BPA Energy Efficiency manager also serves as Chairperson on the Pacific Northwest Center of Excellence for Clean Energy's Workforce Development Task Force. This important role helps ensure a skilled workforce and succession planning in the region for the future of Smart Grid.

For more information, please contact Katie Pruder at kpruder@bpa.gov.

3TIER

Forecasting renewable energy for the Pacific Northwest

3TIER provides renewable energy production forecasts hourly, daily and weekly

3TIER was selected to participate in the Pacific Northwest Smart Grid Demonstration Project, or PNW-SGDP, as a technology provider. 3TIER is tasked with providing wind energy production forecasts on an hour-, day- and week-ahead time frame for the majority of the wind assets in the Pacific Northwest on a project-specific and regional basis. 3TIER also is tasked with providing similar forecasts for solar energy production regionally. In addition, the company provides technical expertise in support of successfully integrating renewable energy into the system.

3TIER's scope of work for the PNW-SGDP project includes the following:

- Deliver:
  - Real-time wind power forecasts for the majority of wind assets in the study region;
  - Real-time aggregated wind power forecasts for the Bonneville Power Administration, or BPA, control region;
  - Real-time solar power forecasts for one solar installation in the study region; and
  - Real-time aggregated solar power forecasts for the BPA control region
- Coordinate with the project's other technology providers to:
  - Obtain the required data to produce the real-time forecasts; ensure the successful integration of renewable energy forecasts into the transactive incentive signals
- Provide technical expertise in support of meeting the project objectives

3TIER is currently providing real-time individual wind forecasts for the majority of the wind assets in the study region as well as a regional forecast for the BPA region.

Since the PNW-SGDP's inception, 3TIER has met all of the deliverables to-date as described in the scope of work and is on track for meeting upcoming milestones. Despite some challenges in obtaining observed data, 3TIER is currently providing real-time individual wind forecasts for the majority of the wind assets in the study region as well as a regional forecast for the BPA region. 3TIER is also providing a real-time solar forecast at one project in the study region.

3TIER has actively been involved in collaborating with project participants with regards to defining components of the PNW-SGDP's unique transactive control system by integrating the renewable energy forecasts into the signal.

For more information, please contact Todd Stone at tstone@3tier.com.

Peninsula Light Company

Power sharing for Fox Island, Wash.

Peninsula Light Co. used unique program to help the Island manage energy use and prevent power outages.

Peninsula Light Company (PenLight) is a member-owned electric cooperative located in Gig Harbor, Wash. As a part of the Pacific Northwest Smart Grid Demonstration Project, PenLight began testing load control switches in member households. The switch interrupts power to the water heater at these homes during times of peak demand, helping PenLight reduce its peak energy charges.

The utility's residents were able to use the Power Sharing program and keep the power flowing to Fox Island.

This demand response program known as "Power Sharing" has been a marketing and communication success since its launch in October 2010. The partial failure of the submarine cable to Fox Island in July 2010 created an urgency to develop and launch the program prior to winter. By November, the program was up and running --- a year ahead of schedule and just in time for the cold winter months. The utility's residents were able to use the Power Sharing program to curtail load during time of peak demand and keep the power flowing to Fox Island.

In 2010, Peninsula Light Company developed a marketing plan targeting the Fox Island Community with a letter introducing the program, which included a FAQ sheet and application. The utility held two community meetings and participated in the annual Fox Island Community Fair. In January 2011, PenLight included an insert with its billing statement and also mailed a Power Sharing brochure to each home. Finally, the utility created a Power Sharing webpage that included program information and literature.

Last November PenLight mailed a second round of the Power Sharing brochure to its residents in an attempt to increase participation in the program and they have nearly reached their target of 500 participants.

For more information, please contact Jonathan White at jonathan@penlight.org.

IBM and Netezza

Advancing transactive energy management

IBM and Netezza have worked tirelessly to advance the core technology material to the project's transactive control system, ensuring participants can send and receive signals to one another.

IBM Research has been a core partner in the Pacific Northwest Smart Grid Demonstration Project, or PNW-SGDP, from the very beginning, focusing on system integration, interoperability architecture and cyber security.

In addition to a large, multi-disciplinary team from multiple departments across the IBM Research organization (including Industry Solutions, Business Analytics and Math Sciences, Security and Privacy, and Design Automation), IBM's Software Group and Storage and Technologies Group have both invested in the PNW-SGDP with key software components and servers.

In 2011 IBM Research worked closely with the project's other technology providers to complete Release Cycle 1, or RC1, of the project, culminating in the successful "plug fest" that took place at the Electricity Infrastructure Operations Center, or EIOC, at Battelle in April. This event represented the final integration and activation of the base system platform for the project, and demonstrated the interaction of all the key system software and hardware components across IBM, IBM's Netezza Division, ALSTOM, Quality Logic and 3TIER, as well as demonstrating communication connectivity to several of the project's utility sites.

Notable milestones accomplished in RC1 included:

- Implementation of the core programming environment for the PNW-SGDP using IBM Research's reference implementation of the ISO/IEC 18012-2 interoperability framework (referred to as Internet-scale Control Systems or iCS);
- Implementation of the Data Collection Subsystem using AMQ messaging, IBM InfoSphere Streams and the Netezza Twinfin 12 data appliance;
- Implementation of the System Management Subsystem;
- The initial implementation of the alternative proxy-based communication mechanism for the subset of Subproject Utilities not using ISO/IEC 18012 to implement their transactive nodes; and
- The initial implementation of test-versions of the Transactive Node Object Model (TNOM) software objects that were used for testing RC1.

The IBM team's focus is now turned to Release Cycle 2, or RC2, which will complete the design and initial implementation of the full transactive node system. The IBM Math Sciences team is fully engaged in the project, co-designing and then implementing the Transactive Toolkit Functions that will be used across the project.

> *IBM Research has primary responsibility for the system integration and interoperability architecture.*

IBM Research, Battelle, ALSTOM, Quality Logic and others continue to finalize the timing and transactive signal designs required by this complex, loosely-coupled system of systems. The IBM Research Industry Solutions team has implemented the designs, which continue to evolve as we all gain greater understanding of the subtle issues involved in such a unique and complex system.

IBM Research is looking forward to the completion of RC2 and the implementation of RC3, and to see the work of all the project participants come together and go live.

For more information, please contact Fabienne Guildhary at fguildhary@us.ibm.com.

QualityLogic

Establishing Standards and Interoperability for the Smart Grid

This year QualityLogic helped the Pacific Northwest Smart Grid Demonstration Project set the foundation for how participants would connect with one another.

QualityLogic is a provider of testing products and outsourced quality assurance and engineering services, specializing in the development of conformance and interoperability testing solutions for the Smart Grid industry.

As the Pacific Northwest Smart Grid Demonstration Project's testing and certification partner, QualityLogic developed the interoperability section of the PNW-SGDP proposal to the U.S. Department of Energy, or DOE. Establishing interoperability through the right technical standards is a vital requirement that helps all the pieces of the smart grid puzzle to fit together.

Technical standards can help guide investment decisions and ensure the ease of communication between electronic devices, appliances, software and signals.

> *QualityLogic is a key contributor to promoting interoperability standards and is a leader in assuring interoperability within the Project.*

The company is responsible for functional conformance and interoperability testing of the Project's transactive control system. Transactive control technology will allow the project to coordinate the responses of Smart Grid assets and allow them to monitor and manage various operational objectives and conditions. The Project also is a pilot test site for the application of the GWAC Smart Grid Interoperability Maturity Model. QualityLogic is a key contributor to developing the model and is a leader in applying it within the Project.

Together with scientists and researchers from IBM and Battelle, QualityLogic developed conformance and interoperability test suites and programs to confirm end-to-end transactive signal interoperability for the Project's first Release Cycle, or RC1. Partner utilities needed a convenient way to test their implementations so, during RC1, QualityLogic developed an easy-to-use, web-based test program. QualityLogic also developed the transactive node application to support the testing of RC1's goals of connectivity for transactive signals, system management and data collection.

The Project successfully met the requirements for RC1 in testing conducted by QualityLogic in June 2011. Subsequently, the company performed conformance testing on most test sites throughout the region and conducted interoperability tests on the full system. QualityLogic continues to develop the required conformance and interoperability testing programs for the Project to meet additional requirements specified in Release Cycle Two, or RC2, and beyond.

Through direct involvement and participation in Smart Grid standards development activities, QualityLogic has assisted the development, evaluation, and promotion of standards to be used by utilities in the Project. QualityLogic executives and technical staff are deeply involved in the DOE's work on smart grid interoperability through the efforts of the GridWise Architecture Council, or GWAC, the Smart Grid Interoperability Panel Test and Certification Committee supported by the National Institute of Standards and Technology, and through a number of smart grid technology alliances and standards development organizations.

QualityLogic co-chairs the Project's Standards Working Group, or SWG, which was created to assess and recommend Smart Grid standards to achieve the interoperability goals and objectives that are part of the PNW Regional Project Narrative and the Interoperability and Cyber Security Plan submitted to the DOE. The SWG conducted research on standards for transactive control signals, inputs and outputs to the RC2 Toolkit, and presented recommendations to the Project Team in September 2011. Based on a survey of Subprojects, the SWG established the key standards to consider in developing the RC2 Toolkit, which is a set of functions for the computation of the transactive signals and management of the transactive nodes. QualityLogic led the SWG in writing a formal paper on the standards lessons learned by the Project. The paper was presented at Grid-Interop 2011.

QualityLogic is proud of its achievements and contributions to date and will continue its leadership in the Project's conformance and interoperability testing, as well as standards-related activities in the RC2 phase and beyond.

For more information, please contact Laura Posson at lposson@qualitylogic.com.

Ellensburg

Renewable Energy to mitigate changes in generation

The City of Ellensburg is demonstrating the benefits of centralized versus dispersed small renewables for both customers and utilities

The Pacific Northwest Smart Grid Demonstration Project bolstered the City of Ellensburg's plans of expanding its renewable energy footprint. With 58KW of poly-crystalline solar panels already installed, Ellensburg leveraged project funding to expand its renewable energy park. Ellensburg started with 54KW of thin-film nano-technology solar panels, then added a 10 kW, 80 ft.-tall Bergy wind turbine, and a 2.4 kW, 40 ft.-tall Skystream wind turbine. Three additional units currently being installed include a 1.2 kW, 30 ft.-tall Windspire turbine; a 2.5 kW, 47 ft.-tall Energy Ball turbine; and a1.5 kW, 37 ft.-tall WindTronics turbine.

By early summer of 2012, Ellensburg plans to open its Renewables Park with the installation of a 4 kW, 100 ft.-tall UrbanGreen Energy turbine; a 5.5 kW, 100 ft.-tall WePower Falcon turbine, and a 10 kW, 80 ft.-tall Tanguarie Alternative Power turbine. Several ancillary systems, such as a large meteorological tower, will be installed to collect weather data. A new supervisory control and data acquisition, or SCADA, system will collect all the data from the various generating resources and feed it back to the Regional control center. And anybody can see how much renewable energy is being produced at any time by visiting http://view2.fatspaniel.net/Ellensburg/project/EndUserView.html.

Ellensburg's sub-project will demonstrate the utility and customer benefits of centralized vs. dispersed small renewables.

The City's sub-project will demonstrate the benefits of centralized versus distributed renewable energy to the utility to customers. Ellensburg expects to see many benefits from using the various renewable energy sources in conjunction with the project's transactive control system, including: better quality control, improved crew safety during utility outages, better load predictability, and greater customer satisfaction with renewables. There are direct benefits to customers, too: a cheaper cost of participating (as low as $250), the ability of all customers to participate (including renters), and no direct ongoing maintenance costs to customers participating in the project.

In addition, Ellensburg will be developing comparative data of the relative efficiencies of the various types of renewables, supporting research and K-12 curricula development by professors and graduate students at Central Washington University, and, hopefully, demonstrating the ability of centralized small renewables, such as Ellensburg's Renewables Energy Park, to cost effectively help mitigate regional over-generation (high-wind, high-water events) by using the project's transactive control to automatically take the park off and on-line as necessary.

For more information, please contact Beth Leader at leaderb@ci.ellensburg.wa.us.

Portland General Electric

Salem Smart Power Project Underway

Portland General Electric is building one of the most reliable electricity systems in the nation

About 500 Portland General Electric, or PGE, residential and business customers in Southeast Salem will soon get their electricity from one of the most reliable, advanced electricity systems in the nation thanks to PGE's role in the five-year Pacific Northwest Smart Grid Demonstration Project.

PGE's "Salem Smart Power Project," will test several technologies including remote-operated power line switches, energy storage, demand response, dispatchable standby generation, and solar generation. All of these technologies will work in concert to create a "micro-grid" — an area able to generate and sustain its own power for optimal reliability.

If there is a weather-related power outage in the area, PGE will be able to keep the power on for residential and business customers within the test area using advanced technology and distributed resources.

As part of the project, PGE plans to build an energy storage facility which will house the project's battery storage equipment and will also serve as a smart grid educational center open to the public for tours and demonstrations. PGE is hiring local contractors to design and build the facility next to one of its Salem substations. PGE hopes to have the project up and running and welcome visitors to the facility in the summer of 2012.

The state of Oregon is participating in the project at several of its facilities — the Oregon State Data Center, Oregon Military Department and the Andersen Readiness Center — with several back-up generators located in the area for the pilot's dispatchable standby generation.

Business and residential customers in the area will voluntarily participate in the project through PGE's Energy Partner demand response program. Customers will be compensated for reducing energy use during peak times or when a test event is occurring.

Participating businesses will be called upon to automatically reduce energy use by doing things like dimming lighting or cycling their air conditioners.

Twenty Salem residential customers have signed up to participate for an innovative water heater demand response program that allows PGE to remotely cycle their electric water heaters on and off for short periods, never more than four hours a day.

According to Mark Osborn, PGE's smart grid manager, the utility is creating a high-reliability zone in one Salem neighborhood to pilot several smart grid technologies designed to improve the electric system's operation and reliability giving PGE invaluable experience in developing complex applications on the system.

All of these smart grid technologies tested by PGE will be optimized through a two-way communications system with Battelle, the PNW-SGDP lead. Working to support regional needs, Battelle will send transactive incentive signals to PGE simulating information about what power is available on the system and at what price. PGE will be able to use these signals to optimize its project resources like storing energy in batteries when market power prices are low or putting energy back on the grid when prices are high.

Being part of this important project will help PGE learn how to use new technologies to better serve its customers in the service area and across the region.

For more information, please contact Elaina Medina at Elaina.Medina@pgn.com.

Flathead Electric Cooperative

Flathead unrolls "Peak Time" for smart grid

This year Flathead and the citizens of three communities made major strides to install equipment to help the utility make better use of its electricity.

Flathead Electric Cooperative, the second largest electric utility in Montana, is demonstrating the roll-out of different levels of demand response implementation through its "Peak Time" project in the Libby, Marion and Kila areas.

In 2011, Flathead completed communications work on the Libby, Kootenai and Haskill substations, completed the AMI system upgrade in Libby and of all installations in the Haskill substation area, which kept a five-person journeyman meter crew busy for several months. The installed Aclara TWACS AMI system will enable real-time outage management, provide hourly data, and reliable 30-day billing reads, in addition to several additional technologies such as demand response services for water heaters and in-home energy displays, or IHDs. So far in the project, Flathead has installed 90 sets of GE grid friendly appliances with installations ongoing; handed out 86 in-home displays with real-time peak event notification capability, and 83 in the Demand Response Unit, or DRU, with installations ongoing. Testing in the appliance and DRU groups has been successful so far. Members in Flathead's appliance group are able to receive and respond to a pricing signal, and the DRU's are receiving the test signal and responding as planned. Flathead also plans to provide wireless technology to volunteers in the In-Home Display group to allow the member to access real time information about their own energy use directly from their AMI meter.

Flathead's communication staff developed several member outreach and volunteer recruitment tools including radio and newspaper ads and press releases, member packets, flyers, brochures and customer presentations. As of November 2011, Flathead has 262 of a 300 member goal signed up to participate in the Libby area project, and 14 of the 150 goal in the Marion/ Kila area, where recruitment is just beginning.

Flathead now has one of the more modern residential grids in Montana.

The first wave of GE grid friendly appliances installed have been positively received and members seem to be, for the most part, happy with their product and the ease of using the technology. While the majority of responses to the Peak Time project and meter change-outs were positive; some members voiced concerns including the use of "smart meters" and critical reporting in the news from other regions in the nation. Flathead has recognized the need to continually communicate with its members about the voluntary participation in the project, and has employed staff and media resources to educate members and address those concerns.

On the budgetary side, Flathead has lived up to the commitments in its original grant application in the area of job creation and preservation. Leveraging the ARRA funding provided, Flathead has been able to create one new full-time position for the project, the Demand Response Coordinator in the Libby office. Various sub-contractors have also benefited from the project, including three businesses in the Libby area that have been contracted to install appliances and other components of the program. Total employment impacts are difficult to measure, but an additional 20-30 employees and contractors have worked on the project at one point or another, anywhere from one week to several months at a time. Lastly, this project enabled Flathead to build one of the more modern residential grids in Montana and, with the addition of the Kootenai substation, offers an opportunity for growth.

Overall, the Peak Time Program has been well-received in the community and has worked well with other energy saving programs. Despite some setbacks in equipment technology and the general misperceptions surrounding "smart meters", Flathead's Peak Time project is on point.

For more information, please contact Teri Rayome-Kelly at t.rayome-kelly@flathead.coop.

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Cover Photo: Scott Butner

PROJECT PARTNERS