

Electric Distribution R&D Peer Review 2006 Project Summary

YOUR ORGANIZATION:	PNNL
PROJECT TITLE:	Pacific Northwest GridWise™ Testbed Demonstration
PRESENTERS:	DJ Hammerstrom
FY 2005 FUNDING:	\$1.5M
FY 2006 FUNDING:	\$0.6M
START/COMPLETION DATES:	3/2005 – 3/2007

Overall Project Purpose and Objectives: The Pacific Northwest GridWise™ Testbed Demonstration has two major field demonstration components—a smart appliance demonstration and an electrical energy price response demonstration.

The smart appliance field demonstration component observes underfrequency protection responses that have been built into 150 Sears Kenmore dryers manufactured by Whirlpool Corporation and 50 retrofitted residential water heaters at three locations in Oregon and Washington. When the grid frequency drops below a threshold, the heating elements in the dryers and water heaters are directed to autonomously curtail their loads. The electrical loads then return to operation at a prescribed time, once the grid frequency returns to its normal range. Our goal is to demonstrate the reliable performance of a distributed frequency curtailment response and to confirm that such response will be readily tolerated by appliance owners. If the penetration of such frequency-responsive appliances were to become extensive throughout power grids, operating margins could be decreased and grid reliability could be improved.

The energy price response project component demonstrates the coordination of various generation and load resources to manage transmission and distribution constraints on a feeder. At the residential level, 110 residences are distributed among four project energy contract types—control, fixed, time-of-use, and real-time price groups. Invensys Controls GoodWatts™ load control automation equipment is installed in each of the homes and helps each homeowner automate the response of his home to best benefit from his contract type. Quarterly, the homeowners are compensated for their responsiveness to the tier and price signals they receive. A fair, side-by-side comparison of the residential contract types should be possible at the conclusion of the demonstration. The most complex contract type is the real-time price contract, in which residents, commercial distributed generation (DG), and large loads are configured to bid their energy resources and needs into a 5-minute, two-way clearing energy market. IBM Corporation assisted with the design of market communications through its WebSphere™ software. Our goal is to demonstrate that transmission and distribution constraints can be managed through automated responses to pricing signals controlling available residential, commercial, and industrial loads and distributed generation. These tools could be applied at any location where constraints exist to improve availability and reliability of the electrical supply while deferring or eliminating the need for building additional transmission or distribution infrastructure.

FY 2005 and FY 2006 Results and Accomplishments: The project has conducted weekly phone meetings to discuss progress and resolve issues. Nearly all project contributors have chosen to attend these meetings. A project ribbon-cutting event was held January 11, 2006 in Seattle and included speaker Rep. Patty Murray. Project staff have been interviewed for radio and news approximately seven times concerning this project and have given slide presentations at over five technical conferences.

So far, the project has recruited 50 residential participants in Gresham, Oregon, served by Portland General Electric; 50 residential participants in Yakima, Washington, served by PacifiCorp; and 110 residential participants in Sequim and Port Angeles, Washington, served by Clallam County PUD and the City of Port Angeles, respectively. These residents have already received incentive compensation for 3 months of participation.

The project negotiated a subcontract with Invensys Controls to supply and install its residential GoodWatts™ metering and automated control equipment, some of which was then modified to recognize and respond to underfrequency events. The host utilities swapped existing meters for the GoodWatts revenue meters.

Whirlpool Corporation modified 150 of its Sears Kenmore HE2 dryer to receive and respond to underfrequency event signals. The modified dryer also displays a “PR” price alert signal when prices are high. Furthermore, when high price is indicated, the dryer will not respond to the first depression of the start button, allowing the appliance operator to acknowledge the price alert. Whirlpool supplied and installed these dryers which the project purchased

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at a deeply discounted price.

PNNL and IBM Corporation developed software for PNNL servers to facilitate the operation of the project's energy price market. A Web interface, where homeowners sign in to view their progress, was designed and implemented. PNNL designed and IBM implemented the market price algorithm that autonomously incorporates the inputs from the Mid-Columbia transmission price, the aggregate project load (as if collocated on a single feeder), a simulated feeder's transmission limitation, bids from DG units (reflecting realistic operating costs), and bids from individual loads (based on the loads' "satisfaction" with their present settings).

The project controls one small microturbine DG unit, and the controls for two additional DG units that are nearly completed in Sequim. The control of additional DG units and a large municipal load are presently under negotiation.

Project equipment is over 90% installed. All residential price contracts were functional as of May 1, 2006. Underfrequency event data is being continuously collected.

FY 2007 Plans and Expectations: As a result of equipment installation delays, the project was not able to collect data during the winter of 2006. Negotiations have begun continuation of the project through March 2007 to observe a full heating season. Data collection will continue through this duration.

Plans have begun for a Grid Friendly™ summit meeting in late summer 2006 to be organized by PNNL for the discussion of the Grid Friendly technologies and their commercialization.

We expect to publish project results during FY 2007. Project reporting to the U.S. DOE will be completed and submitted in early summer 2007.

Project equipment is scheduled to be removed during April 2007.

We will survey homeowners at the conclusion of the experiment to assess their acceptance of the technologies. Whirlpool Corporation has offered to lead the preparation and collection of the survey, as a result of their interest in assessing the acceptance of the technologies for their customers.

Public/Private Partnerships: **Pacific Northwest National Laboratory** manages the project for the U.S. Department of Energy and is the architect of the Grid Friendly underfrequency response and the project's real-time pricing algorithms. **IBM Corporation** has provided in-kind labor support and the use of its WebSphere™ software, which facilitates the electronic communication between the project hardware and software components.

Whirlpool Corporation has collaborated with the project to design and supply modified dryers that are responsive to the project's underfrequency signals and has provided the dryers to the project at a substantial discount. **Invensys Controls** won a competitive request for proposal (RFP) to supply its GoodWatts control and monitoring equipment to the project, including modifications that permit their equipment to participate in the real-time pricing experiment and to respond to the project's underfrequency response.

Bonneville Power Administration, Portland General Electric, and PacifiCorp each provided additional project money, access to demonstration sites in their service territories, and in-kind labor. **Clallam County PUD** and city of **Port Angeles** provided the project access to residents within their service territories and provided in-kind labor for the swap of the revenue meters required by the project.

Consultants **Lynn Kiesling** and **Preston Michie & Associates** provide valuable insights for the design and implementation of the economic pricing experiment.

Montana Tech, also a recipient of U. S. DOE GridWise funding, has agreed to collaborate by providing the project a summer student who will assist with collection and interpretation of our underfrequency event data.