Summary of Comments
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Introduction

Smart grid technology – two-way communication and intelligence at all levels – poised to deliver:

- demand response
- other distributed resources like DG and storage

integrated into the every day operation of the grid

- reducing costs for new infrastructure
- mitigating peak wholesale prices
- increasing reliability

Also be <u>leveraged to transform the grid into a national asset for a sustainable energy future</u>.

The Project. Over the past two years, Pacific Northwest National Laboratory has been conducting the Pacific Northwest GridWise™ Demonstration project on the Olympic Peninsula in the state of Washington and elsewhere in the region, with support from the U.S. Department of Energy and in partnership with the Bonneville Power Administration, PacifiCorp, Portland General Electric, IBM, Invensys Controls, Clallam County PUD #1, the City of Port Angeles and Whirlpool Corporation.

Although this is a small-scale pilot project, it aggressively demonstrates how smart grid technology can integrate a wide variety of smart grid resources – deployed among residential, commercial and institutional consumers – with the moment-by-moment operation of the power grid. At the same time, technology makes it possible to leverage these resources to bring multiple benefits to all levels of the grid, from wholesale markets to transmission, distribution and ancillary services.

The project has shown that even residential customers will choose to shift from a fixed-price contract to a time-differentiated contract, and adjust their usage accordingly to lower their power bills. When given a choice between a time-of-use/critical peak price and a 5-minute real-time price, a substantial fraction pursued the greater savings opportunities presented by the real-time contract. The home energy management automation technology provided by the project allows customers to fully automate their response to price signals, adjusting their consumption to capitalize on savings opportunities, while providing the flexibility to change or override selected preferences for relative comfort versus economy at any time.

The system consists of a smart meter, an gateway between the broadband service and home computer, a smart thermostat, and a water heater load control module from Invensys, all communicating wirelessly within the home. The customers use their home computer and Internet connection to program the responsiveness of their thermostats and water heaters.

At the core of the project is a local, substation-level retail market. The price signals superimpose the costs of wholesale electricity, transmission congestion, and a local retail market that closes every five minutes to strictly manage a distribution constraint (albeit an artificial one). The market functionality we developed was implemented within an IBM-supplied middleware system that uses Internet-based communications. We use the same market signaling mechanism to aggregate the response of a commercial building, a backup generator, a microturbine, and a municipal water pumping system.

Preliminary Results. We have observed some remarkable capabilities of this two-way communication-based demand management network. We have shown it can cap net demand at an arbitrary level, 16% less than the normal peak demand, for days on end. This represents real capital cost savings when a $10M substation can be deferred or downsized.

We have found that we can easily synchronize thermostatically controlled loads to follow the grid's need for regulation services. Demand resources easily respond over the short term because the excursions from normal setpoints are so small that there is minimal if any discomfort. Market closing costs to buy this kind of response were very low as a result. The implication is that demand can provide an ancillary service very analogous to regulation, and is likely to do so at costs far lower than what power plants charge to ramp up and down.

We also use a network of Grid Friendly™ appliances, consisting of new Whirlpool-produced clothes dryers and retrofitted water heaters, that autonomously detect under-frequency events in the Western Interconnection and shed load for up to a few minutes – and no one noticed that they did so in hundreds of such events. This response is an ancillary service that can displace spinning reserves and increase reliability, and offers the advantage of reacting within a half second to sudden regional power deficits. The controller also delays and randomizes when the appliance is restored to normal operation to avoid shocking the grid, which also eases cold load pickup after an outage. Mass produced residential appliances alone generally make up about 20% of demand, so they can provide a vast and inexpensive "safety net" for the power grid.

While it might be self evident that no one would notice a water heater turning off for a minute or two, Whirlpool's dryer responds by turning off only the 4.5 kW heating element, the major component of the load, The controls remain active and the drum continues to tumble, making the curtailment completely unobtrusive. On its own volition, Whirlpool also added a demand response function to the dryer. The dryers display a high price warning and prompt the user to to push the start button twice to proceed with operation.

Looking to the Future. It is increasingly apparent that the utility industry and policy makers are beginning to focus on energy efficiency and renewables in light of the growing public concern about climate change. Congress actively is considering national energy policies that include options such as a cap-and-trade system for carbon emissions, national renewable portfolio standards (RPS), energy efficiency portfolio standards analogous to, or incorporated in, RPS, and tax credits for measured energy savings and peak load reductions at customer premises.

We can have a power grid that is cleaner, more efficient, less expensive, and more robust if we extend the capabilities of two-way demand management networks to measure and verify savings in terms of demand, energy, and carbon.   It will be especially important to develop methods to account for values from assets like distributed renewables/photovoltaics and plug-in hybrid electric vehicles. The digital backbone for the grid, and the grid itself, can become an expanded national asset for supporting a sustainable future. Smart grid systems can provide not only the traditionally-promised values of peak load reduction and enhanced reliability, but also can serve as the basis for controlling, measuring and motivating our future sustainable energy system.