Science.

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GridWise™ Demonstration Project Fast Facts

Program Objectives

Pacific Northwest National Laboratory teamed up with regional utilities and industry partners in the year-long Pacific Northwest GridWise™ Demonstration Project to test the notion that smart grid technologies and consumers can play an active role in managing the grid. The project, funded by the Department of Energy, involved homeowners in two separate studies to test demand-response concepts and technologies designed to maximize the electric grid's ability to provide reliable, affordable and clean energy.

The Grid Friendly™ Appliance Project demonstrated that everyday household appliances can automatically reduce energy consumption at critical moments when they are fitted with controllers that sense stress on the grid. The Olympic Peninsula Project found homeowners are willing to adjust their individual energy use based on price signals provided via information technology tools. Both studies helped reduce pressure on the grid during times of peak demand.

The study found that there are no technical hurdles standing in the way of wide-scale adoption of Grid Friendly(tm) Appliance controller and the automated technologies for demand response that were tested. With wide-scale adoption of these technologies, stress on the grid can be mitigated to prevent power outages during grid emergencies. Additionally, these technologies will help integrate renewable energy onto the grid and are projected to reduce the need to build about $70 billion (over a 20-year period) of new generation, transmission and distribution systems.

Program Background

- The GridWise Demonstration Project consisted of two separate demand-response studies—The Grid Friendly Appliance Project and Olympic Peninsula Project.
- Data was collected from March 2006–March 2007.
- Pacific Northwest National Laboratory managed the GridWise Demonstration Project
- The project was funded by the U.S. Department of Energy.
- The demonstration projects included the following partners: Bonneville Power Administration, PacifiCorp, Portland General Electric, the City of Port Angeles and Clallam County PUD #1.
- Large, in-kind contributions from industrial collaborators include appliances from Whirlpool Corp., and real-time event software and analytics developed by IBM Research.

Advantages

- Demand-response technologies can help enhance the reliability of the grid by instantly reducing demand when the balance of supply and demand is at risk. A more reliable power grid can prevent the economic impact of power failure.
- An interactive grid management system could lead to smaller electricity bills for consumers—they use less electricity and help alleviate the need for additional infrastructure to meet growing demand for electricity, especially at peak periods.
- Demand-response technologies can help accommodate the intermittent nature of renewable resources like wind power, making it possible to more effectively manage their integration into the electric grid

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The Olympic Peninsula Project

Background

- The Olympic Peninsula GridWise Demonstration looked at how consumers responded to real-time energy pricing information.
- The experiment provides insights into how customers might adjust their energy consumption based on changes in price
- The study also gave customers the choice of purchasing electricity through a variety of contract types ranging from today's fixed price contracts to real-time prices that changed as often as every five minutes.
- Automated control technology was installed to allow industrial, municipal, and residential customers to reduce their electricity consumption during times of peak demand or when prices are high and demand response was automated.
- Smart appliances, including thermostats, water heaters and clothes dryers were installed in 112 residential homes.
- Residential consumers could choose their balance between comfort and economy, and always had the option to override their initial settings.
- A virtual, real-time, two-way market with real cash incentives was established to reflect the actual costs of producing and delivering electricity and motivated consumers to reduce their electricity consumption at times of peak demand.
- Internet-based event-driven software from IBM Research created virtual thermostats and water heaters that could translate between market prices and device settings, and also enabled the devices to submit market bids and react to changing prices.
- Existing backup generators for commercial customers were used to displace additional demand for electricity and produce power locally the few occasions prices got above their preset tolerable limits.

Results

- The Olympic Peninsula Project demonstrated that an Internet-based network coordinating demand response can save consumers money on power, and reduce peak load on the grid by approximately 15 percent over the course of one year.
- A significant number of customers, including residential consumers, will sign up for and respond to a real-time price that varies on a five-minute interval when they are provided computer-based technology that automates their response and preserves their right to choose their preference for comfort or savings.
- On average, consumers saved approximately 10 percent on electricity bills from the year prior.
- A combination of demand response and distributed generation reduced peak distribution loads by 50 percent for days.
- The project demonstrated that utility-dispatched demand response can alleviate the need to build expensive new infrastructure to address constraints on the distribution or transmission system during times of peak demand.
- The project successfully managed a "virtual" distribution line, or feeder, and an imposed feeder constraint for an entire year using these innovative technologies
- The technologies and approach proved technically feasible, wide-scale adoption is more limited by regulations than technical limitations.

Implications

- The technology used in the Olympic Peninsula Project was capable of making very short-term (~5 minute) adjustments in consumption where the impact of customer comfort is negligible and cost is low.
- For homes being served by real-time market contracts, the automation also had to read and respond to temperatures and settings, as well as market trends and customer price-sensitivity, and be able to convert device settings to and from market bids and price signals.
- Calling upon reductions in demand is much less expensive for utilities and cleaner than ramping power plants up and down to follow load fluctuations. This capability has the potential to help manage the intermittent nature of wind power, helping increase its use in the future.
- If all customers were engaged in reducing peak loads at this level, peak electricity prices would be substantially reduced and construction of about $70B (over a 20 year period) of new generation, transmission and distribution systems could be avoided, with the savings passed along to ratepayers.

Grid Friendly Appliance Project

Background

- The GFA controller is a small electronic circuit board that detects when the electricity grid becomes stressed and could benefit from short-term load reduction (~1-2 minutes).
- The GFA controller was configured to react to the alternating current (AC) frequency signals at residential wall outlets.
- Decreased AC frequency signals acute stress on the power grid.
- When the GFA controller senses decreased AC frequency it automatically prompts appliances to modify operations to reduce demand for electricity and therefore help rebalance supply and demand on the electric grid.
- Demand was reduced by automatically turning off some of the appliances' functions (i.e. turning off the heating elements in specially programmed dryers and water heaters) for a few seconds or minutes).
- The GFAC was installed in 150 dryers and water heaters in homes in Yakima, Wash.; Portland, Ore.; and the Olympic Peninsula in Washington.
- The dryers in the study were commercially available Sears/Kenmore units modified to include the Grid Friendly appliance controller.

Results

- It is technically feasible to use GFA controllers to manage contingencies on the grid and prevent power outages.
- Consumers in the study reported they were not inconvenienced, and generally did not even notice the automatic reduction in their energy use (in hundreds of events).
- Most homeowners stated they would be willing to purchase an appliance configured with such grid-responsive controls.

Implications

- The GFA controller acts as a 'shock absorber' for the system by reducing power to dryers, refrigerators, water heaters and other home appliances in times of extreme stress on the power grid.
- Up to 20 percent of the nations power usage could be put on hold if GFA controllers were installed in all compatible appliances.