This is the 12th article in a series highlighting the case studies of DSM Task XV, Network Driven DSM. This Task demonstrated that DSM can be successfully used to support electricity networks in two main ways 1) by relieving constraints on distribution and/or transmission networks at lower costs than building ‘poles and wires’ solutions, and 2) by providing services for electricity network system operators, achieving peak load reductions with various response times for network operational support.

INTRODUCTION

In the United States, the Bonneville Power Administration (BPA) owns and operates 75% of the Pacific Northwest’s electricity transmission system that includes more than 15,000 miles of high-voltage transmission lines and 285 substations. At peak usage, the system transports about 30,000 MW of electricity to customers in Oregon, Washington, Idaho and Montana, as well as to parts of Wyoming, Nevada, Utah and California.

In 2001, BPA started considering measures other than building new transmission lines to address load growth, constraints and congestion on the transmission system. BPA, along with others in the region, commenced exploring “non-wires solutions” as a way to defer large construction projects (see Figure 1).

Figure 1. BPA Non-wires Solutions Activities

BPA defines non-wires solutions as a broad array of alternatives, including demand response, distributed generation, energy efficiency measures, generation siting and pricing strategies that individually or in combination delay or eliminate the need for upgrades to the transmission system.
BPA and its consultants developed a screening process and checklist to evaluate a transmission problem area to determine whether it is a candidate for a non-wires solution.

The Olympic Peninsula received particular attention since it is an environmentally sensitive area with increasing demand for electricity and limited transmission capacity. Forecasts showed that the capacity of the transmission lines on the Peninsula might become inadequate by December 2007, if there was a forced outage of one line during peak periods of cold weather. A significant transmission construction project, including a new 20-mile 230-kV line, was planned for construction on the Peninsula.

BPA carried out several pilot projects to determine whether it was possible to use non-wire solutions to defer the transmission construction project. A peak load reduction of 50 MW was required to achieve a five year deferral. All projects had to pass the total resource cost test before they could be implemented.

**NON-WIRES SOLUTIONS PILOT PROJECTS**

The following non-wires solutions pilot projects were carried out on the Olympic Peninsula:

- direct load control;
- demand response;
- voluntary load curtailments;
- networked distributed generation;
- energy efficiency.

**Direct Load Control**

The overall target for direct load control on the Olympic Peninsula was 20 MW.

The objectives of the pilot phase of the direct load control project were to demonstrate the reliability and technical feasibility and measure the peak load reduction impacts of direct load control.

To participate in the pilot phase, residential customers had to have an electric water heater and heat pump, forced air furnace or baseboard space heating.

The pilot phase aimed to obtain 5 MW (2500 sites x 2kW) of curtailable loads in the residential sector from one distribution utility or a combination of utilities.

Direct load control was accomplished through the use of a one-way radio pager network linked to a direct load control unit located in the dwelling (see Figure 2). The control unit communicated with appliances through power line carrier signals. Controlled end-uses included water heaters, pool pumps and space heating.
Demand Response

The target for demand response on the Olympic Peninsula was 16 MW.

The objectives of the pilot phase of the demand response project were:

• to demonstrate the reliability and technical feasibility and measure the peak load reduction impacts of demand response;

• to use incentives to test the value proposition of demand response for customers; and

• to test the use of Grid-Friendly™ appliance concepts, hardware and responses to automatically reduce load in response to stress on the grid.

To participate in the pilot phase of the demand response project, residential customers had to have an electric water heater, heat pump or forced air furnace, a minimum of three people in the dwelling, and a fibre or cable high speed internet connection.

The pilot phase aimed to install 250 two-way internet gateways in the residential sector (see Figure 3). The gateways enabled automatic control of space heating, air conditioning, water heating and pool pumps in participating dwellings. The gateways also measured the load from individual end-uses in the dwelling.
Demand response was accomplished through the use of two-way broadband to communicate with the internet gateways. Customers could use the internet to set price levels at which automatic load switching occurred and also to override the automatic settings. This enabled customers to lower energy use and reduce electricity costs.

In addition, 250 Grid-Friendly™ appliances (200 clothes dryers and 50 water heaters) were installed in 200 participating dwellings. Controllers installed in each Grid-Friendly™ appliance sensed frequency disturbances in the electricity network and controlled the appliances to act as spinning reserve – no communications technology was required beyond the network itself.

The Grid-Friendly™ appliance controller developed at Pacific Northwest National Laboratory is a simple computer chip that senses network conditions by monitoring the frequency of the system and provides automatic demand response in times of disruption. The controller can be installed in appliances that regularly cycle on and off during normal use, so that consumers do not notice when the Grid-Friendly™ device is in operation.

Grid-Friendly™ appliances allow customers to become an integral part of electricity network operations. Grid-Friendly™ controllers can be programmed to autonomously react in fractions of a second when a disturbance is detected. Demand can be rebalanced to match available supply almost instantaneously (within a half-second). This is an improvement over the approximately 30 seconds it currently takes for power plants kept on standby to come up to speed. Grid-Friendly™ controllers can also be programmed to delay restart instead of all coming on at once after a power outage.
Voluntary Load Curtailments

BPA operated a Demand Exchange (DEMX) program that provided commercial and industrial customers with the ability to curtail their load during system emergencies and volatile market conditions.

Under the DEMX program, BPA worked with customers to define their load curtailment capability and determine the benefits of participation. DEMX aggregated customers' curtailment potential and represented the aggregated load in the wholesale energy market as a reliability option. DEMX built an internet-based auction site where participants were alerted to hourly, one day-, and two day-ahead price signals associated with peak load events, and were able to post their willingness to participate at a set price.

In March 2004, BPA ran a successful test using DEMX to reduce congestion on transmission lines on the Olympic Peninsula. A local utility, two paper manufacturing companies and the US Navy voluntarily reduced their transmission loads during a simulated period of severe weather and critical peak demand.

The test occurred over four days. During the test, BPA posted an hourly price per megawatt, giving test participants the chance to accept, reject or counter the offer. Participants then bid to reduce their demand by using backup generation or by shifting load to other hours. BPA was able to purchase an average of 22 MW of peak demand reduction during each hour of the simulated event. This is about one year’s load growth on the Olympic Peninsula.

Networked Distributed Generation

The target for distributed generation on the Olympic Peninsula was 4 MW. This was achieved with 12 units in 10 locations.

In the pilot phase of the distributed generation project, backup generators were used at one commercial and one industrial site:

- Sequim Marine Sciences Lab - 0.5 MW backup generators for load shed and transactive control demand response integrated with the generators;
- Port Angeles municipal water supply system - 0.9 MW backup generators in parallel with 0.9 MW demand response from pumps.

Energy Efficiency

The target for energy efficiency on the Olympic Peninsula was 15 MW.

As a general policy, BPA ensures development of all cost-effective energy efficiency in the electrical loads BPA serves across the Pacific Northwest. BPA treats energy efficiency as a resource and defines goals in terms of megawatts of energy efficiency acquired. The bulk of the energy efficiency acquired by BPA is pursued and achieved at the local level in association with local distribution utilities.

BPA applied these general principles to acquiring peak load reductions on the Olympic Peninsula through energy efficiency programs across the residential, commercial and industrial sectors developed in association with local distribution utilities.

This article was contributed by David Crossley, Managing Director of Energy Futures Australia Pty. Ltd and Senior Advisor at The Regulatory Assistance Project. For more information on this case study and others, visit Task XV, Network Driven DSM at: http://www.iedasm.org/ViewTask.aspx?ID=17&Task=15&Sort=1.