The Olympic Peninsula Project

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Pacific NW GridWise™ Testbed Projects
Unleashing the power of distributed resources

Summary of Projects

- **Olympic Peninsula Demand Response Demonstration:**
  - Integrating in-the-field demand response and backup generators in a virtual operating environment
  - Experimenting to relieve transmission and distribution congestion during peak periods.

- **Grid Friendly Appliance Controller Demonstration:**
  - Equipping 150 homes in Washington and Oregon with Grid Friendly appliance controllers on water heaters and clothes dryers.
  - Testing ability to automatically reduce energy consumption to stress on the grid.

Project Objectives

- Illustrate how the transformed power grid will operate.
- Demonstrate how transmission and distribution investment can be deferred.
- Define the role demand response can play on the grid.

Completed Projects

- Olympic Peninsula GridWise Demonstration #1

Who Benefits from GridWise?

- Bonneville Power Administration
  - Reduce constraints on transmission grid
  - Provide ancillary services that increase power system reliability and minimize outage size and duration.
  - Optimize cost-effectiveness by minimizing power purchases and maximizing power sales to regional wholesale market

Local utilities:

- Pacific NW National Lab
- Invensys
- Preston Michie Associates
- Dr. Lynne Kiesling, IFREE

Pacific NW GridWise Testbed Participants

- U.S. Dept of Energy
- Bonneville Power Administration
- Pacificorp
- Portland General Electric
- IBM
- Whirlpool/Sears
- Mason County PUD #3
- Clallam County PUD #1
Environment

- Integrate multiple commercial and residential assets
  - Distributed Generation (DG)
    - Aggregated DG across several commercial sites
    - Individual dispatchable DG
  - Demand Response (DR)
    - Residential and Commercial Demand Response assets
    - Direct load control
    - Residential customer signals to encourage usage change
Shadow Real-Time Market

- Handled outside the normal utility energy bill; cost of energy from the market is paid for by Residential Customers with DoE-seeded funds in a managed account.

- Both DR and DG assets bid into market
  - Base clearing price is calculated from the Mid-Columbia wholesale market price, adjusted based on real-time market demand and constraints.
Price-based Distribution Dispatch

Unresponsive loads (control/fixed/TOU res, and large unmanaged commercial loads)

Large commercial customers with asynchronous DG or managed loads

First synchronous DG unit

Second synchronous DG unit

Residential RTP customers

Price ($/MWh)

$P_{\text{clear}}$

Quantity (kW)

$Q_{\text{clear}}$

Feeder
How real-time price flattens load
Feeder capacity impact
High load with good response
Feeder capacity management: Load flattening under high-load conditions
We defined assumptions about the real-time market model that we wished to test.

Defer capital investment; improve response to unplanned outages.

Real-time market and buy/sell bids as the primary optimization mechanism.

Real-time Pricing accounts with customers.

Defined virtual devices that combined the physical device functions with addl business process information flow & functions.

Used an implementation of ISO/IEC 18012-2 to establish heterogeneous interoperability and enable semantic model above.

IP and non-IP bridged by a gateway – little or no application function in the gateway.

Heterogeneous mix of wired and wireless technologies.
ISO/IEC 18012 in terms of OSI model

Application (7)
- Presentation (6)
- Session (5)
- Transport (4)
- Network (3)
- Data Link (2)
- Physical (1)

Presentation (6)
Network (3)
Data Link (2)
Physical (1)

System A connection
(CEBus, KNX, Zigbee, Echelon …)

System B connection
(CEBus, KNX, Zigbee, Echelon …)

Manufacturer-provided interworking Function

ISO/IEC 18012 Interoperability specification domain

RGIB

Interop Residential Gateway

ISO/IEC 15045 Residential Gateway Specification domain

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Dritan Kaleshi - Networks & Protocols Group
The Virtual Thermostat Object

Utility Business Domain

Retail Energy Market

Customer Management

Billing System

Utility Operations Domain

Base Supply Price/Capacity

Distribution Feeder Status/Capacity

Distributed Generation Control

Customer Premises

Home Energy Mgt Object

Distributed Generation Control

Virtual Thermostat

T-Stat

Distributed Generation

Virtual Water Heater

T-Stat

Distributed Generation

Virtual Electric Meter

T-Stat

Distributed Generation

WH

Meter

Distributed Generation
RTP Control for Thermostatic Devices

Small $k$: low comfort, high demand response

Large $k$: high comfort, low demand response
Results

- An Internet-based network coordinating DR can save consumers money on power, and reduce peak load on the grid by approximately 15% over the course of 1 year.

- A significant number of customers will sign up for and respond to a real-time price that varies on a 5-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.

- A combination of demand response and distributed generation reduced peak distribution loads by 50 percent for days.

- Utility-dispatched DR can alleviate the need to build expensive new infrastructure to address constraints on the T&D system during times of peak demand.

- Successfully managed a “virtual” distribution line, or feeder, and an imposed feeder constraint for an entire year

- The technologies and approach proved technically feasible, wide-scale adoption is more limited by regulations than technical limitations.
Expands upon the 2006 DOE-funded Pacific Northwest Gridwise Demo project

Spans Idaho, Montana, Oregon, Washington, and Wyoming, 12 utilities, $178M over 5 years

Objectives:

- Validate smart grid technologies and business models
- Provide two-way communication between distributed generation, storage, and demand assets and the existing grid infrastructure
- Quantify smart grid costs and benefits
- Advance standards for interoperability and cybersecurity approaches

Team will implement a unique distributed communication, control, and incentive system

IBM Research team leading overall system architecture and interoperability/integration and contributing to cybersecurity, analytics (for DER), and secure messaging
Thank you