Distributed Energy Resources at Bonneville Power

Utility Brown Bag Presentation

October 20, 2016
Overview

• Define Distributed Energy Resources
• Research drivers and plans
• BPA Experience
• Review current portfolio
• How to participate
Distributed Energy Resources: What does that mean?
Distributed Energy Resources

- **Demand Response**: changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time or to incentive payments.

- **Distributed Generation**: small generation systems located at a customer site.

- **Energy Storage**: technologies that allow electricity generated at one time to be used at another time.
End Loads are Power Users

- Commercial and Industrial Loads
- Agricultural
- Utility-scale loads
- Batteries
- Residential loads
Communicating with End Loads

• Program types
  – Direct load control
  – Aggregator-controlled loads

• Mechanism
  – Manual: humans initiate load adjustments
  – Automated: one or two way systems initiate load adjustments
  – Transactive: two way systems negotiate pricing before initiating load adjustments
DER Integration Points

Includes DR, Distributed Energy, Storage

- Resource Planning
- Non-wires Congestion Solutions
- Energy Efficiency collaboration
Grid Management Uses for DER

- Conservation
- Peak Clipping
- Load Shifting
- Flexible Load Shape
Integrating Renewables & Storage

• BPA balances the difference between scheduled and actual variable renewable energy primarily with hydropower generated at Federal dams

• Flexible capacity available from the federal dams is limited

• BPA has started acquiring supplemental capacity for generation imbalance
Related to DER

• Smart Grid and the Internet of Things
  – Automated, two-way communications are hallmark
  – Can enable DER in innovative new ways

• Transactive Energy
  – Automated pricing negotiation for services
  – Could someday improve participation and satisfaction
Research Drivers and Plans for DER
Demand Response Benchmarking

70,000 residential EWHs: Buy cheap power overnight from MISO while charging interactive EWHs to sell that energy during the day for economic benefit.

~20 & ~40 MW non-wires projects currently in development.

CPUC: Evaluation/review process of DR/DER/EE resources before considering any transmission line builds. Non-wires is now always the base case, default option.

Using preferred resource DER (solar/PV, DR and storage, EE) to shave peak in Orange County to compensate for a retired nuclear plant.

400 MW of residential A/C.

~3000 MW of residential load control through the use of simple switch, one way communication.

2 Million Water Heaters Program.

Public Benchmarking Report will be issued in April 2016.
55,000 MW of DR Across the U.S. (6% of peak)

Source: FERC Assessment of Demand Response and Advanced Metering, Staff Report. December 2014. Excludes distributed generation and storage, nor does it show 6,000 MW of DR in Canada. Enrollment amounts over 1 GW shown on map only.
Demand Response Market is Changing

<table>
<thead>
<tr>
<th>Then</th>
<th>Now</th>
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</thead>
<tbody>
<tr>
<td>One-Way/Simple communications</td>
<td>Technology explosion</td>
</tr>
<tr>
<td>One asset, one revenue stream</td>
<td>One asset, multiple revenue streams</td>
</tr>
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<td>Peak shaving</td>
<td>Peak shaving</td>
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<td>Balancing</td>
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<td>Economic Arbitrage</td>
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<td>Load Shift</td>
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<td>Oversupply</td>
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<td>Demand Response</td>
<td>Distributed Energy Resources</td>
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<tr>
<td>6th Power Plan discusses DR R&amp;D</td>
<td>7th Plan has MW Expectations</td>
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</table>
Lessons from National Efforts

• **Multi-year contracts** needed (3-5 years at least initially; TVA did a 10 year contract).

• **A market needs to be “seeded”.** PJM wrote rules looser to build its market and attract entrants, and just now is tightening standards.

• **Residential should not be underestimated** as a viable source. 70% of BPA’s Load is Residential.

• **Simple devices** are often more cost effective than complicated technologies.

• Trend is to integrate demand-side as a **standard part of resource planning** (e.g. Pacificorp and PG&E).

• Demand Response is used widely for **economic benefit**, not just reliability.
Planning The Future of DR

Demand Response Technology Roadmap

November 2014
Drivers for DER at BPA

The hydro system has been stretched to its physical margin,” Mainzer said. “Our task is to bring new and cost-effective, flexible capacity from outside of the hydro system.”

Elliot Mainzer Keynote speech, National Conference (Oct 2013)

• Supply Constraints
• Transmission Opportunities & Cost of Wires Projects
• Integrating Renewables
• Utility interest
• 7th Power Plan
Strategy, Vision, and Structure of the Demand Response Technology Roadmap

The Realm of Demand Response

- Effective Use of Budgets
- Demonstrate Effectiveness
- Cost Effective
- Reliable
- Available

- Enlist our Customers
- Available to Transmission
- Aggregated Loads
- Available to Power
- Energy Imbalance Market Enabled

Demand Response Drivers

- Load as a Capacity Resource
- Deferr Need for New Generation
- Transmission Construction ("Non-Wired") Alternatives
- Maintain Balancing Reserves
- Balancing Variable Energy Resources
- Relieves Transmission System Congestion
- Peak Load Management
- Provide Ancillary Services

Demand Response Technology Roadmap

Planning
- Forecasting
- DR in Generation Capacity Planning
- DR in Transmission & Generation Planning

Enabling Technologies
- Automation & Controls
- DR Capabilities of End-use Devices
- Communications for DR
- Measurement & Verification

Integration
- DR in Real-Time / Hour Ahead / Day Ahead Grid Operations
- DR for Integration of Utility-Scale Wind
- DR for Integration of DR & EE
- Integration of DR & EE

Demand Response Non-Technology Requirements

Planning
- Forecasting DR Potential
- DR Valuation

Markets
- Customer Preferences
- Aligning DR Portfolios to Load Shape Objectives
- Linking Retail to Wholesale

Methods
- Research Area Title
- Research Area Title
- Research Area Title

Policies
- Research Area Title
- Research Area Title
- Research Area Title
BPA’s Experience with DER
The History of Demand Response at BPA

- BPA has historically had the advantage of a low-cost, flexible and high capacity hydro system, but has used DR on and off as needs have changed.
Extensive Piloting and Testing in the Region (2009-2016)
In 2014 BPA Moved to Larger and More Complex Advanced Demonstrations of DR

<table>
<thead>
<tr>
<th>Entity</th>
<th>Status</th>
<th>MW</th>
<th>Timing</th>
<th>Product Demonstrated</th>
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<tbody>
<tr>
<td>City of Port Angeles</td>
<td>Complete</td>
<td>30</td>
<td>2013 - 2014</td>
<td>✓ Imbalance Capacity</td>
</tr>
<tr>
<td>Energy Northwest</td>
<td>Complete</td>
<td>35</td>
<td>2014 – Jan 2016</td>
<td>✓ Imbalance Capacity</td>
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<tr>
<td>EnerNOC</td>
<td>Testing in progress.</td>
<td>5 - 25</td>
<td>2015 - 2017</td>
<td>✓ Winter Peak Shave ✓ Summer Congestion Relief</td>
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<tr>
<td>Total</td>
<td></td>
<td>80</td>
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</table>
City of Port Angeles and Nippon Paper Demonstration

Hydraulic Starter Motor for Refiner & 12000 HP Motor
Process Storage for Load Shifting
City of Port Angeles / Nippon Paper Demonstration

Performance
• 60% success on real-time events
• 92% success rate when prescheduled

Learnings
• Unpredictable downtimes; timely communications on outages is key
• High reliance on two refiner lines
• The plant performed well when existing load allowed them to do so

Portfolio Diversity is essential
Energy Northwest and BPA Demonstration: Public Aggregation for Public Power

Background
- Original nomination was 25MW.
- ENW enrolled 35MW, the contractual cap.
- Phased testing: Pre-scheduled to Event triggered tests (Fall 2015).

Asset Roster
- Cowlitz PUD: NORPAC (up to 28 MW).
- Pend Oreille PUD: Ponderay Newsprint (up to 19 MW).
- City of Richland: 800 kW Demand Voltage Reduction.
- Powin Battery: 20kW.

Program Pacesetter Award, 2016
Energy Northwest Model Proved Successful

- Performance - 94% with 64 successful events and 4 failures.
- Assets included NORPAC, City of Richland DVR, and a battery all responding on 10 minute notice for up to 90 minutes.
- Performance impressive given operating parameters of “Fast DR”.

![Performance Chart](image)

![Events per Month Chart](image)
Demand Response Management System (DRMS)

- Utilizes OpenADR dispatch signals.
- Operator Dashboard view shows all available programs and load shed in near real time for active events.
- More than 100 events dispatched.
- Integrated with EnerNoc and EN Systems.
Battery Storage for Solar Smoothing

- **Powin Energy**: The project involves field testing and evaluating a modular, dispatchable 120kW/500kWh battery storage unit at four different sites around the Pacific Northwest – testing at the BPA lab right now.

- **Primus Energy**: Demonstrate how an electric energy storage device placed close to an end-user to provide service similar to demand response, but without need for behavioral change or impact on end users.
Aquifer Recharge Scheduling for Load Shifting

- 1.8 MW of controllable irrigation pumps
- Shifting aquifer recharge from HLH to LLH
- Coordination with water districts, irrigators, utility
- Successful month-ahead scheduling, 2013
- Tested day-ahead scheduling, through FY16
## EE-DR Interaction

<table>
<thead>
<tr>
<th>EE Implementation</th>
<th>Municipal Water</th>
<th>Cold Storage</th>
<th>Food Processing - Chilled</th>
<th>Food Processing - Frozen</th>
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<td>Track and Tune (Year 2)</td>
<td>ROC (Year 1) Large Capital Project</td>
<td>ROC (Year 2)</td>
<td>ROC (Year 2)</td>
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### DR Opportunities

<table>
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<th>Water Storage (Pumping Systems)</th>
<th>Freezers</th>
<th>Small Freezer</th>
<th>Freezers</th>
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<td>1.</td>
<td>Pumping Systems</td>
<td>Fork Lift batteries</td>
<td>Fork Lift Batteries</td>
<td>Production scheduling</td>
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### Initiate Event

|---|---|---|---|---|
Wastewater Management

• Act as a dispatchable large utility-scale DR resource (>1MW) to increase and decrease load as needed.

• Measure and verify to provide a performance-based approach in developing reliable resources that can be used year-round for ancillary services.

• Tested EE/DR combination
Current Project Portfolio: Testing and Demonstrating Programs and Technologies
Commercial DR Aggregation

- Most common DR implementation model
- Peak shave (winter)
- Fully enrolled at 13 MW
- 22 sites with 7 utilities
- Strong performance on 39 hours of testing
EnerNOC: Reliability Pattern Established, Upcoming Winter will Focus on Multiple BPA Uses

Winter Season 2015/2016 Results. Events were initially called based on fixed schedules and later by real-time power operations. As operational conditions did not trigger events in Feb-early April, team called rigorous events at end of the April testing season.

- 56 hours of testing
- 21 events
- 95% success rate

<table>
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<tr>
<th>Event #</th>
<th>Event Date</th>
<th>Start Time</th>
<th>End Time</th>
<th>Duration in minutes</th>
<th>Cumulative Hours of Seasonal Testing</th>
<th>Targeted Participants</th>
<th>Load Shed in MW</th>
<th>Nominated MW</th>
<th>Performance</th>
<th>Performance Dispatch</th>
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<td>14.6</td>
<td>13</td>
<td>112%</td>
<td>Success Operational Dispatch</td>
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</table>

Note: Events are contractually successful at 90%+ performance.

Winter 2016/2017 Goals: Season will focus on having real-time power operations using DR for multiple uses to meet operational triggers determined by real-time operations such as:

- Unplanned outages, e.g. CGS, Grand Coulee unit
- Near-term capacity constraints
- Price triggers based on market energy prices
Transmission Congestion Demo

Context
- BPA operates ~75% of the high voltage transmission in the PNW
- BPA serves 490 transmission customers
- Transmission flowgates are areas where transmission lines group, and can become congested
- Transmission line construction costs and time requirements have increased.

Problem
The N-S flowgate South of the Allston substation is facing congestion issues.
In 2016, BPA Tests the Market with a South of Allston Non Wires Demo

- All Sources RFOs including Demand Response (April 2016)

- 5 year demonstration with initial 2 year acquisition

- Up to 250 MW. Maximum deployment 40 hours, July-Sept.

- Significant demand-side interest including DR, DVR and battery storage
Home Management Battery: EE & DR

- 5kW/home DR capacity, over 90% reliable and available
- Prediction from individual homes, day/hour/minute
- Guaranteed comfort and improved energy savings
- Optimal scheduling of home appliances based on user preferences and DR requests
- Cyber secure DR delivered by CIP-compliant systems
Utility-Scale Batteries

Questions to Address

• What flexibility services can be provided to the grid?
• Can useful services be affordable?
• How does location affect impact?
• How can batteries support hydro, considering the growth of wind, solar, and distributed generation?
• Can batteries be used for firming wind or solar power?
• Which strategies can minimize renewable curtailment and greenhouse gas emissions, maintaining reliability and reducing costs?

Three, Primary Challenges

• How to realize the full revenue opportunities consistent with the value energy storage can provide?
• How to reduce cost of interconnection and ongoing operations?
• How to increase certainty regarding processes and timelines?

Final Report available late 2018
MW Scale Battery Integration

- Protocol for requesting use of distribution-level ES and DR resources to support BPA’s transmission operations
- Software to enable communications between BPA and the distribution utilities it serves
- Transmission level “energy positioning” algorithms to most effectively use ES and DR resources
- Simulated real-world testing and refinement of the system using SnoPUD’s deployed assets
Summary

- Reduce transfer costs by calling an event during Pac’s Peak. Up to 5 chances/mo.
- BPA calling day-ahead events based on MWF. Fall River notifies irrigators, reports nominations to BPA
- <5 MW of aggregated load

Objectives:

- Determine predictability of Transmission peak outside of the BPA Balancing Authority.
- Test utility partners as aggregators.
- Document program costs and benefits
- Understand DR issues in agriculture and irrigation.
- Document variables affect participation.

Report due in early 2017
Demand Voltage Reduction

- Reduce distribution voltage in response to DR events
- Voltage factors differ by load types
- Tested with KEC (2014) and City of Richland (2015)
- Investigating use to address real BPA needs with several utility partners
Residential Water Heating

CEA-2045
• OEM DR equipment
• Communications

CO2 HPWH
• Responsiveness
• Recovery
• Customer Satisfaction
Preparing for Operational Use

- Residential DR
- BYOD
- DVR

- Batteries
- Energy NW
- EnerNoc

- Irrigation DR
- DRMS

Document Use Case and Commercialization Plan

Transition To Operations
Lessons We’ve Learned

• Some loads look cost-effective, available, predictable, and reliable!
• DER can address multiple regional needs
• Portfolio Diversity is critical
• Robust systems & data management required
• Operations requires it to be easy, available, reliable
• Utility collaboration is a key success factor
• Residential should not be underestimated
For more information or to participate:

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