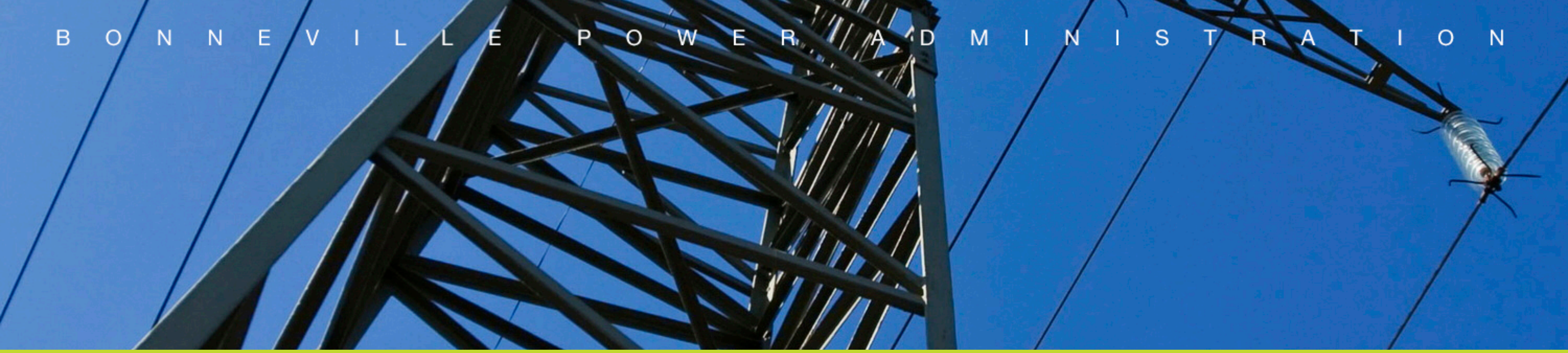



# Distributed Energy Resources at Bonneville Power

Utility Brown Bag Presentation

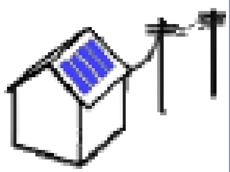
October 20, 2016

# Overview

- Define Distributed Energy Resources
- Research drivers and plans
- BPA Experience
- Review current portfolio
- How to participate

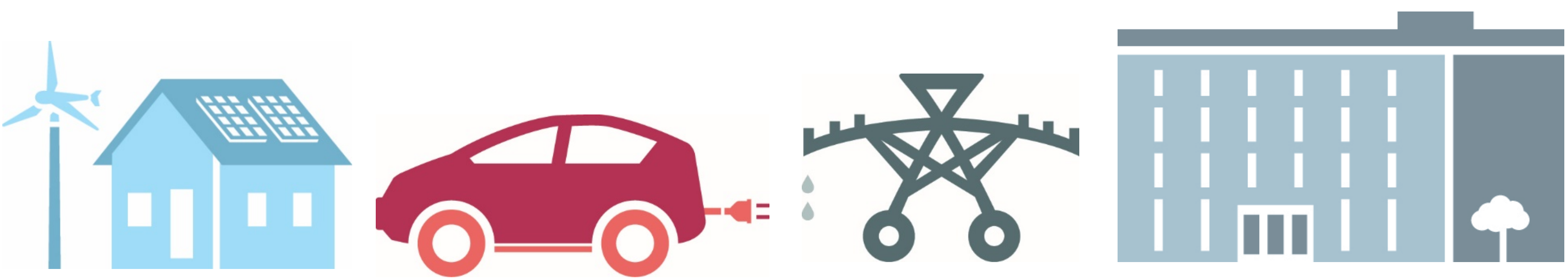
# Distributed Energy Resources: What does that mean?

# 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

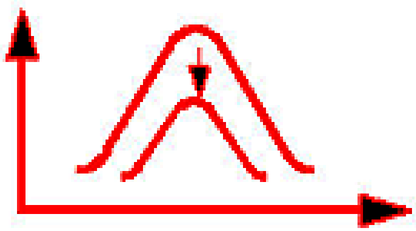
- Program types
  - Direct load control
  - Aggregator-controlled loads
- Mechanism
  - Manual: humans initiate load adjustments
  - Automated: one or two way systems initiate load adjustments
  - Transactive: two way systems negotiate pricing before initiating load adjustments

# DER Integration Points

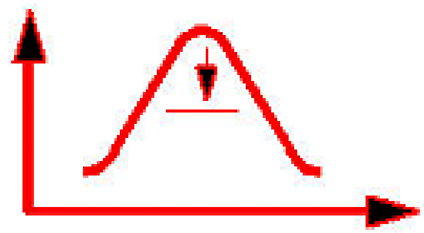
Includes DR, Distributed Energy, Storage

- Resource Planning
- Non-wires Congestion Solutions
- Energy Efficiency collaboration

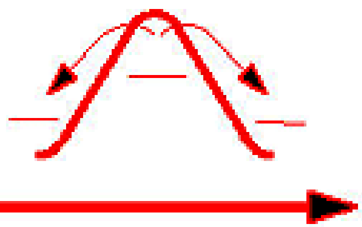
# Grid Management Uses for DER



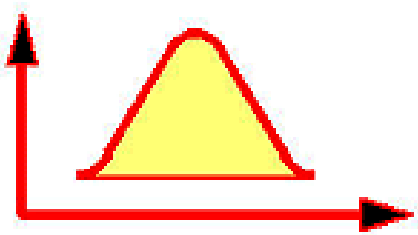
Conservation



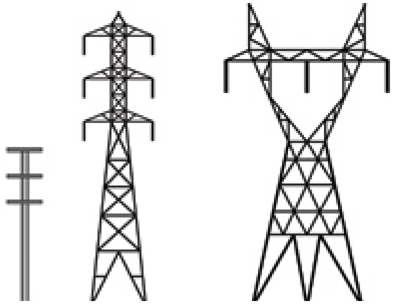
Peak Clipping

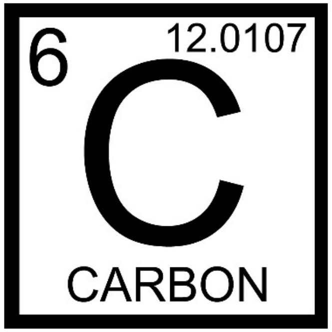


Load Shifting



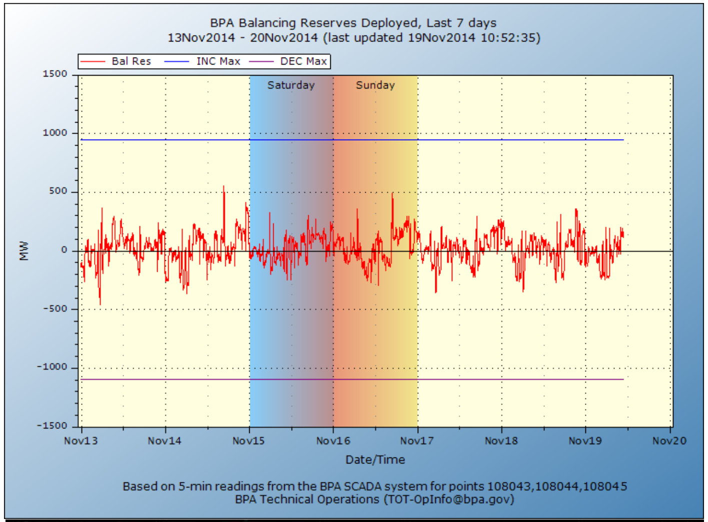
Flexible Load Shape

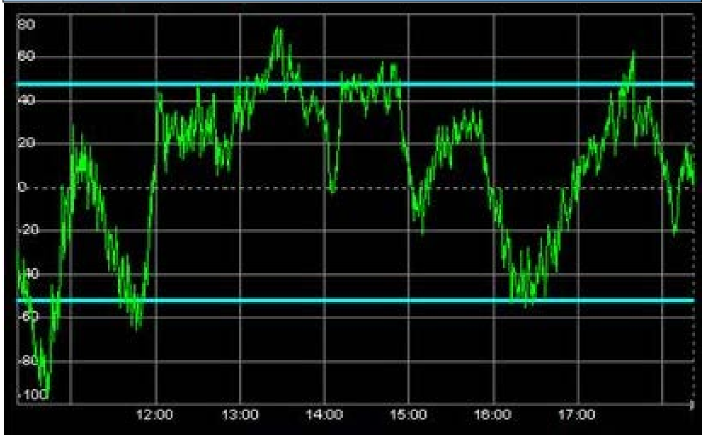




# Integrating Renewables & Storage

- 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



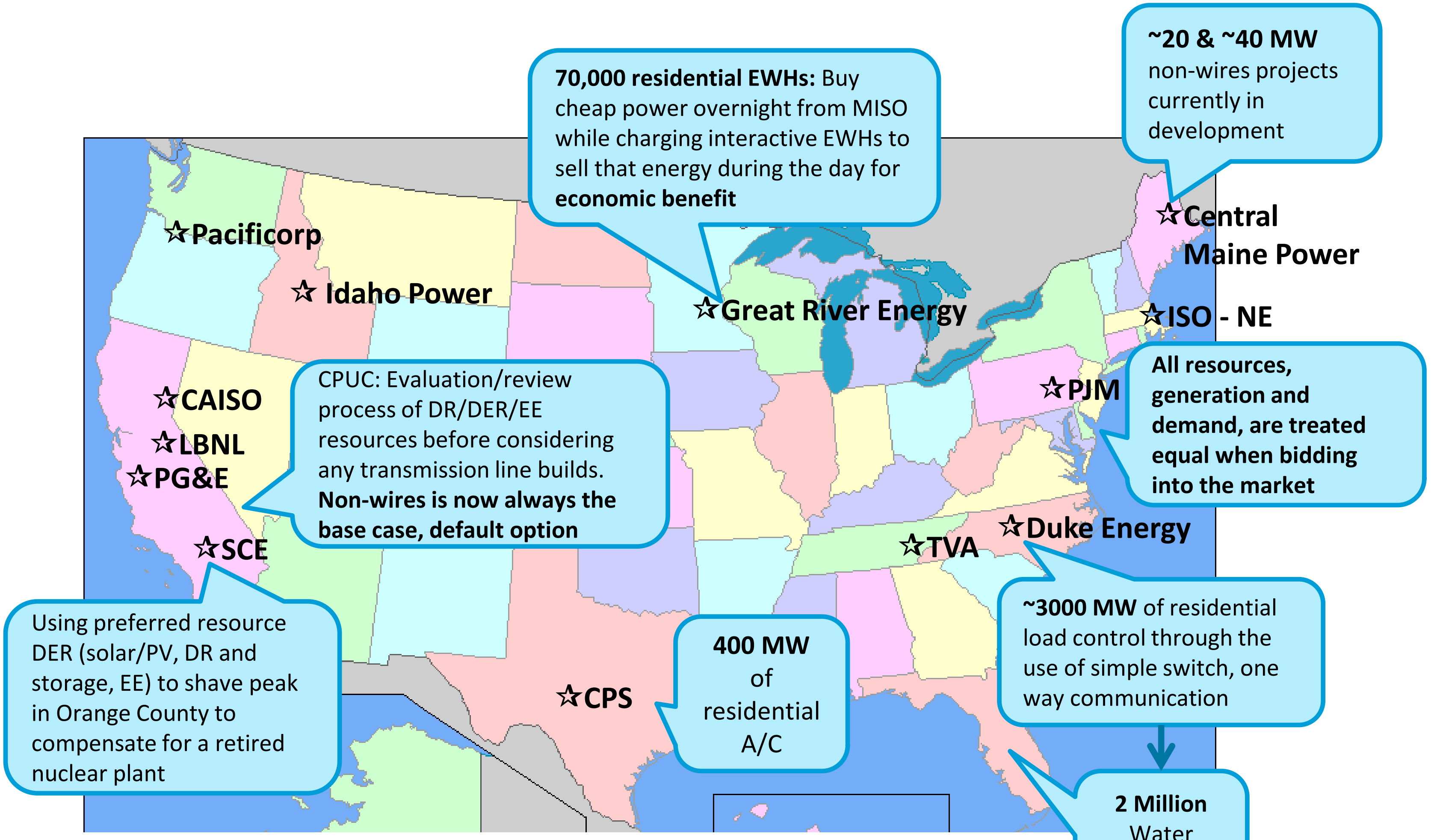
# Related to DER

- 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

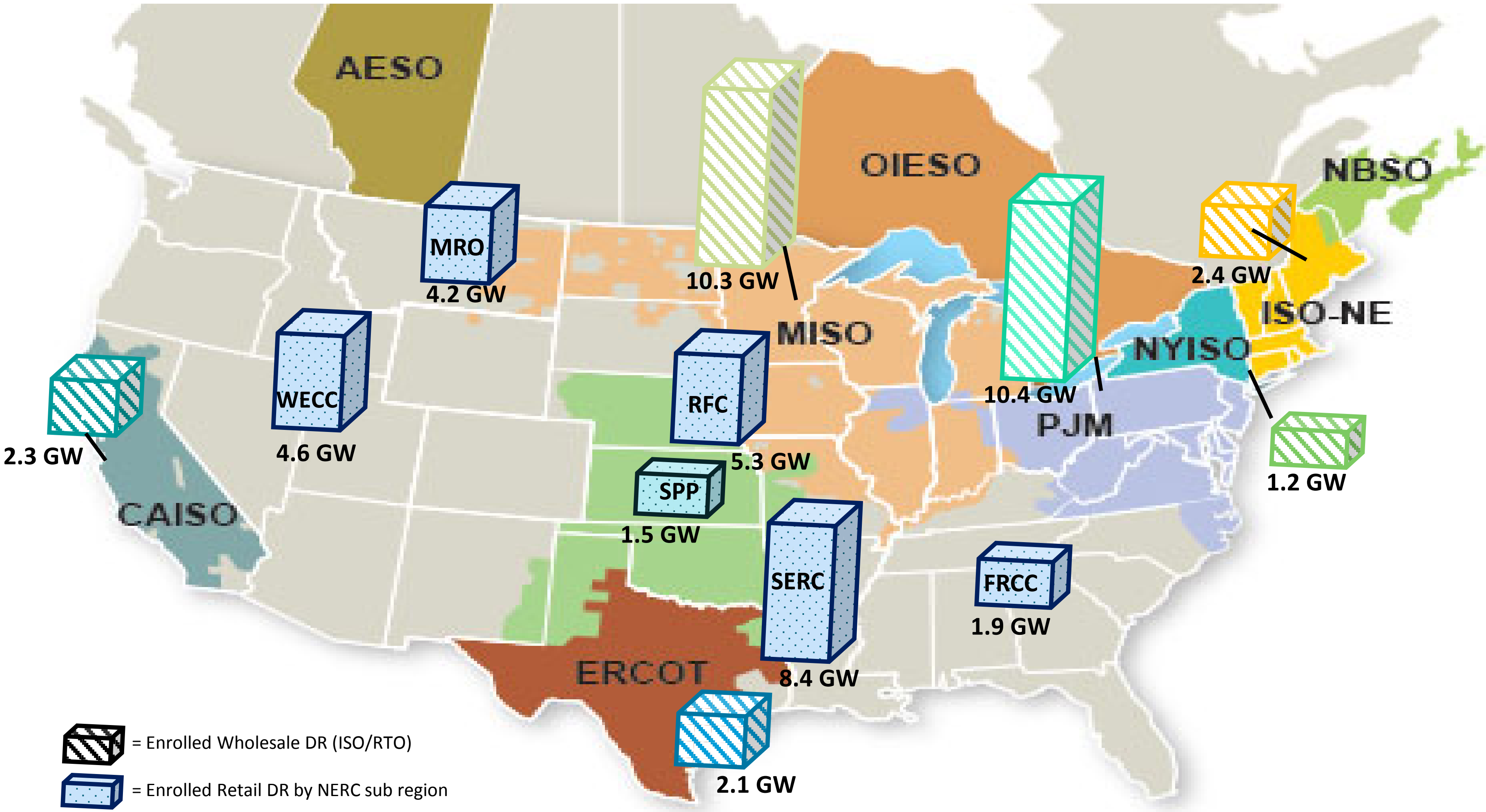
# Research Drivers and Plans for DER

# Demand Response Benchmarking




**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.

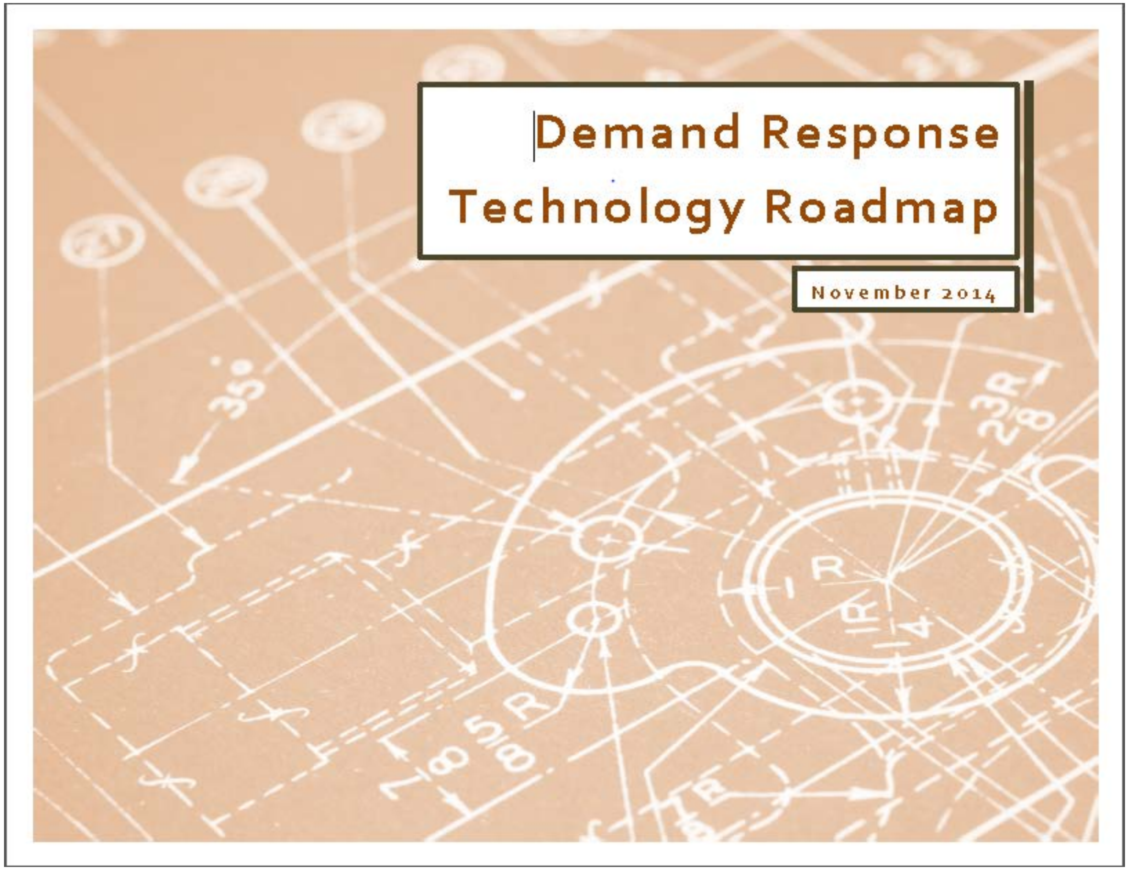
# Demand Response Market is Changing

| Then | Now |
| --- | --- |
| One-Way/Simple communications | Technology explosion |
| One asset, one revenue stream | One asset, multiple revenue streams |
| Peak shaving | Peak shaving<br>Balancing<br>Regulation<br>Economic Arbitrage<br>Load Shift<br>Oversupply |
| Demand Response | Distributed Energy Resources |
| 6th Power Plan discusses DR R&D | 7th Plan has MW Expectations |

# 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

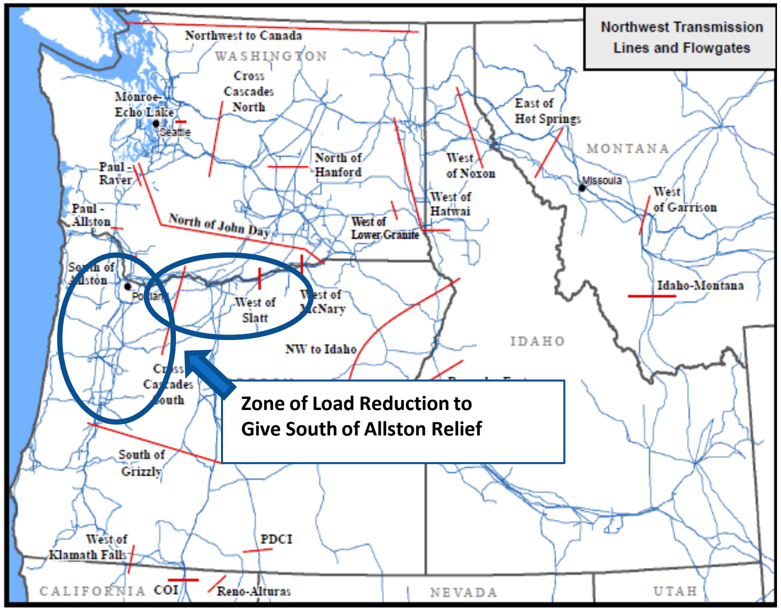

Demand Response
Technology Roadmap
November 2014

# Drivers for DER at BPA

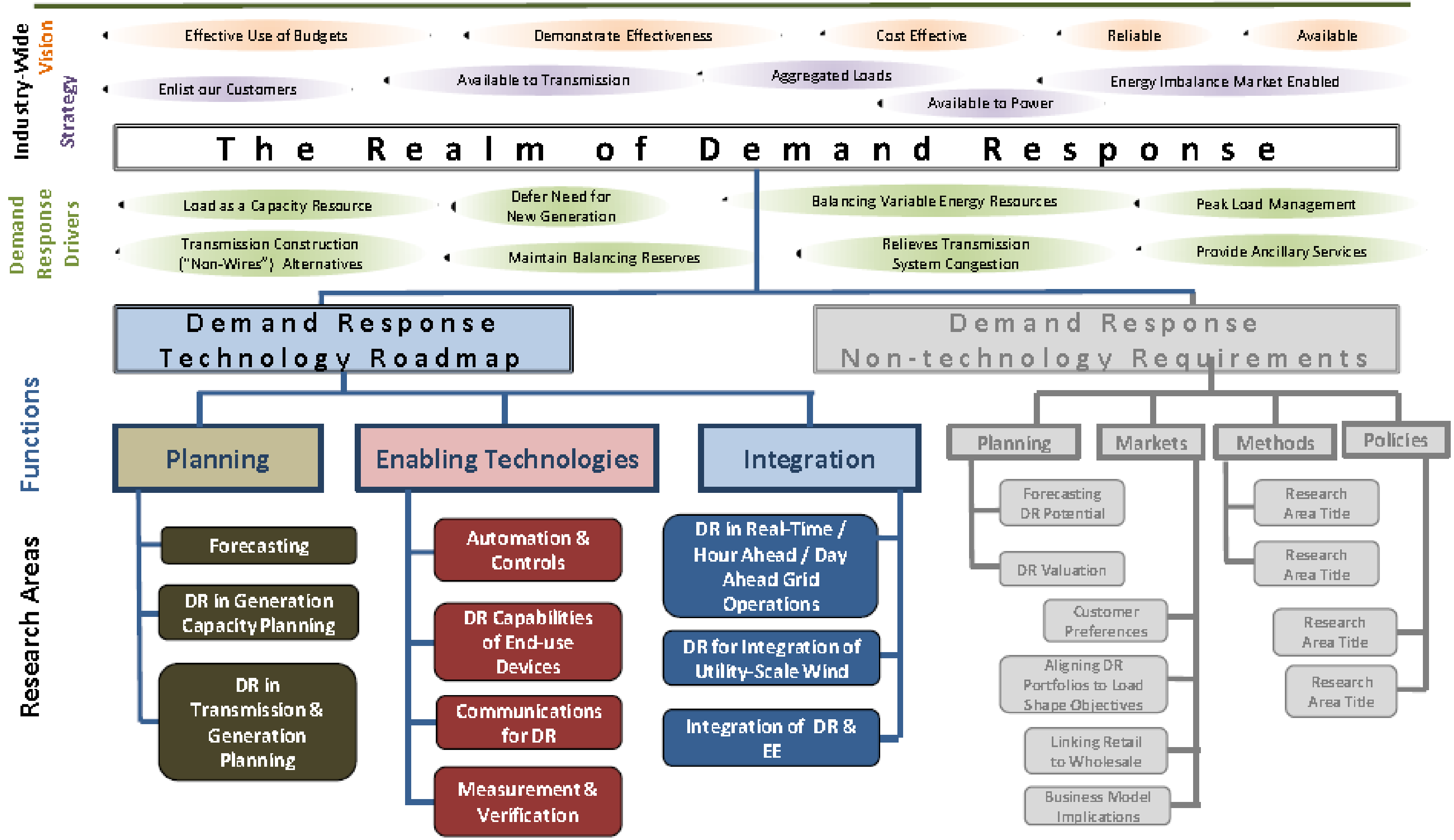

**The hydro system has been stretched to its physical margin," Mainzer said. "Our task is to bring new and cost-effective, flexible capacity from outside of the hydro system."**

Elliot Mainzer Keynote speech, National Conference (Oct 2013)

- Supply Constraints
- Transmission Opportunities & Cost of Wires Projects
- Integrating Renewables
- Utility interest
- 7th Power Plan



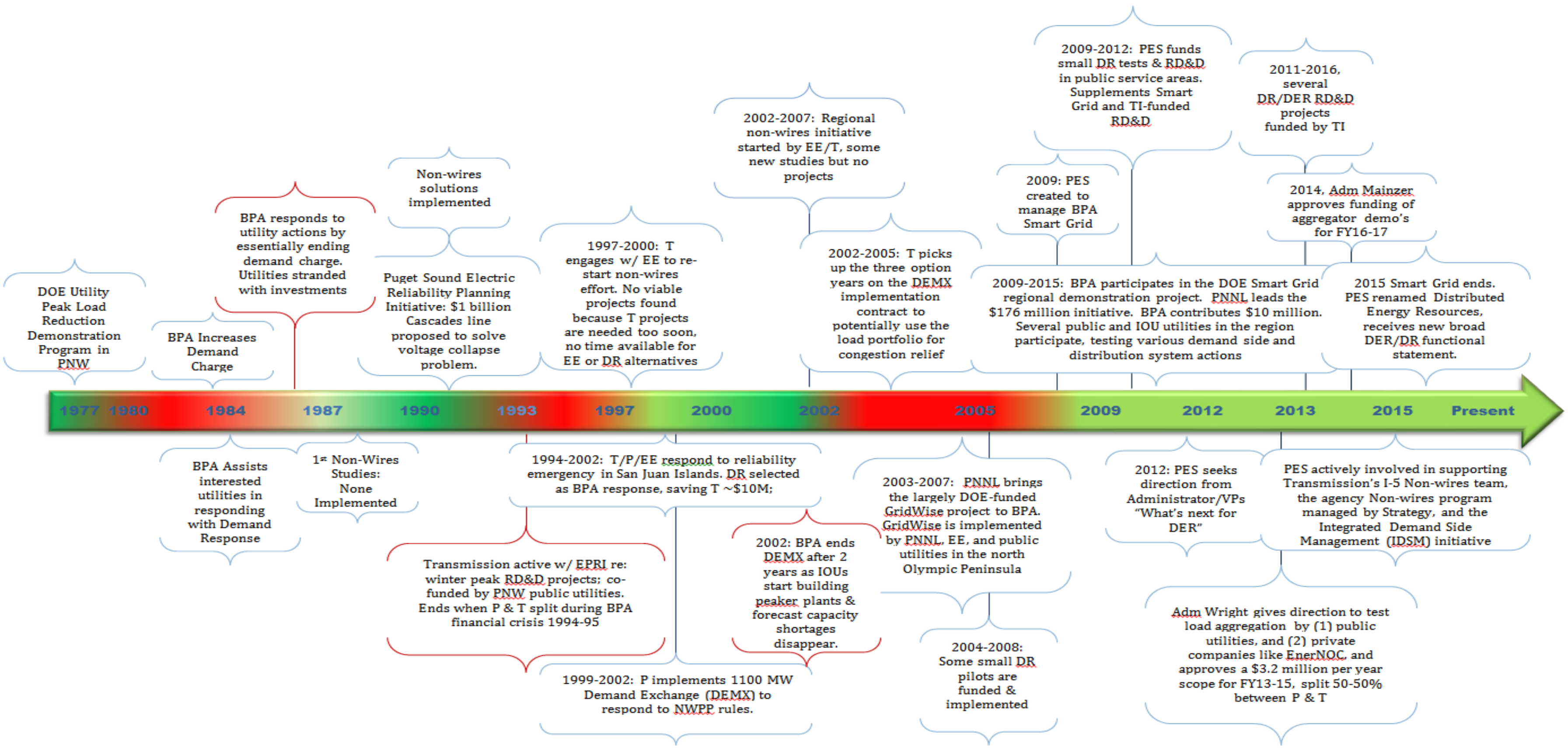
# Strategy, Vision, and Structure of the Demand Response Technology Roadmap



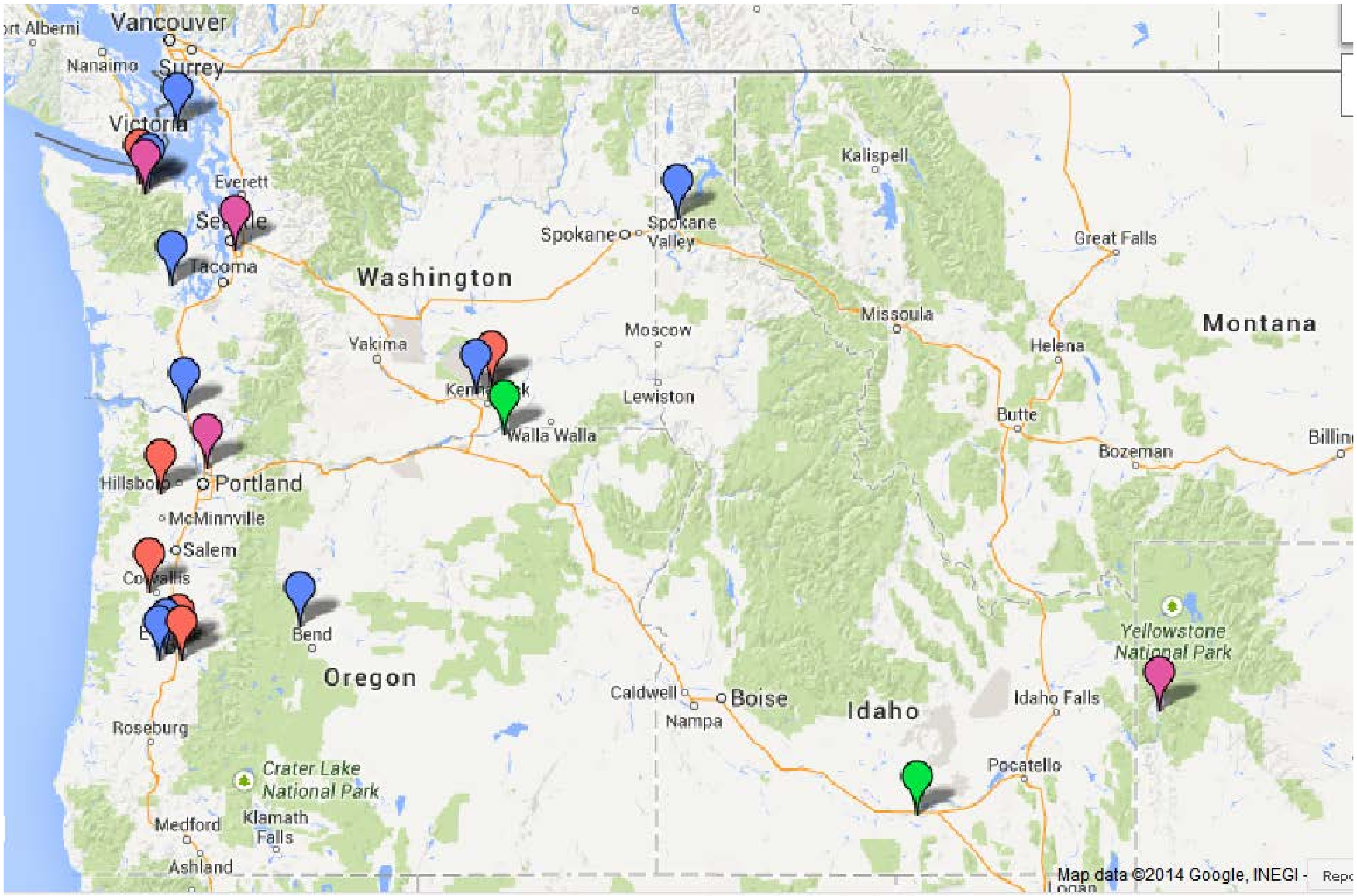
# BPA’s Experience with DER

# 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)

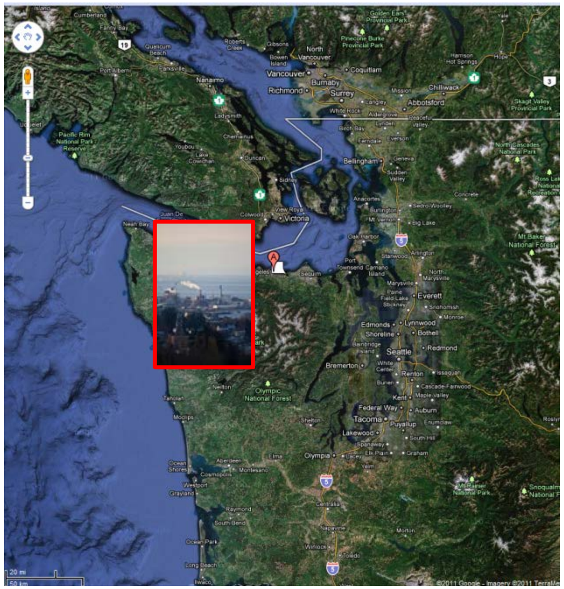



Residential Commercial Agricultural Industrial

# In 2014 BPA Moved to Larger and More Complex Advanced Demonstrations of DR

| Entity | Status | MW | Timing | Product Demonstrated |
|---|---|---|---|---|
| City of Port Angeles | Complete | 30 | 2013 - 2014 | ✓ Imbalance Capacity |
| Energy Northwest | Complete | 35 | 2014 – Jan 2016 | ✓ Imbalance Capacity |
| EnerNOC | Testing in progress. | 5 - 25 | 2015 - 2017 | ✓ Winter Peak Shave<br>✓ Summer Congestion Relief |
| Total | | 80 | | |

# City of Port Angeles and Nippon Paper Demonstration




# Process Storage for Load Shifting

## City of Port Angeles / Nippon Paper Demonstration

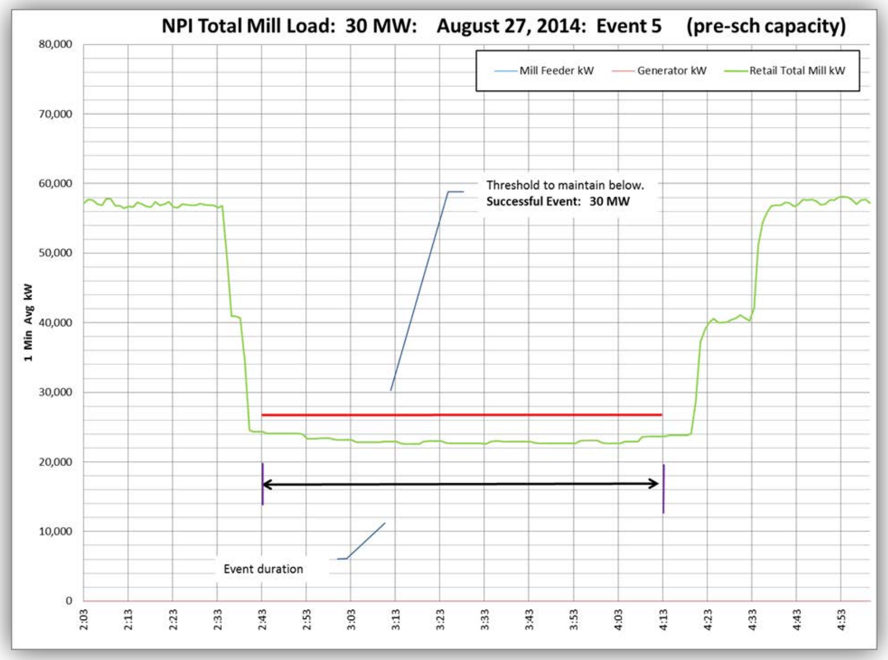
### Performance

- 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

- Went live February 2015, ended January 2016.
- Original nomination was 25MW.
- ENW enrolled 35MW, the contractual cap.
- Phased testing: Pre-scheduled to Event triggered tests (Fall 2015).

## Asset Roster

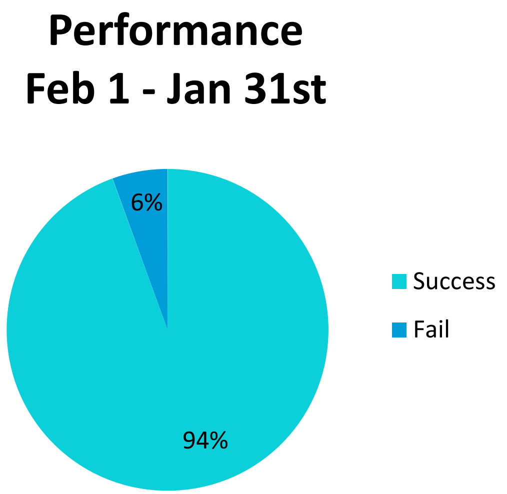
- **Cowlitz PUD:** NORPAC (up to 28 MW).
- **Pend Oreille PUD:** Ponderay Newsprint (up to 19 MW).
- **City of Richland:** 800 kW Demand Voltage Reduction.
- **Powin Battery:** 20kW.

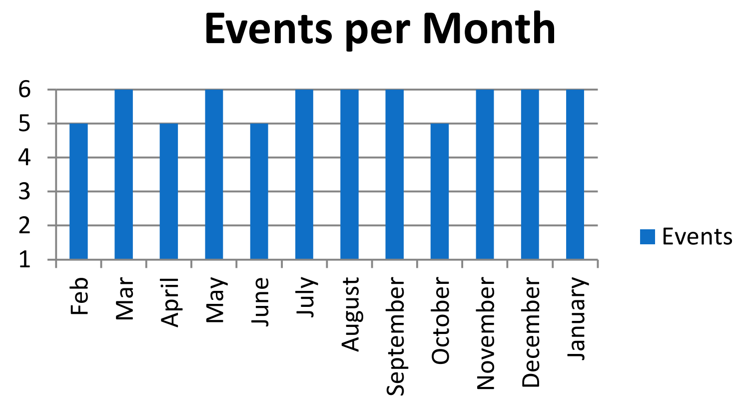

PLMA
Demand Response Leadership Since 1999

Program Pacesetter Award, 2016

# Energy Northwest Model Proved Successful

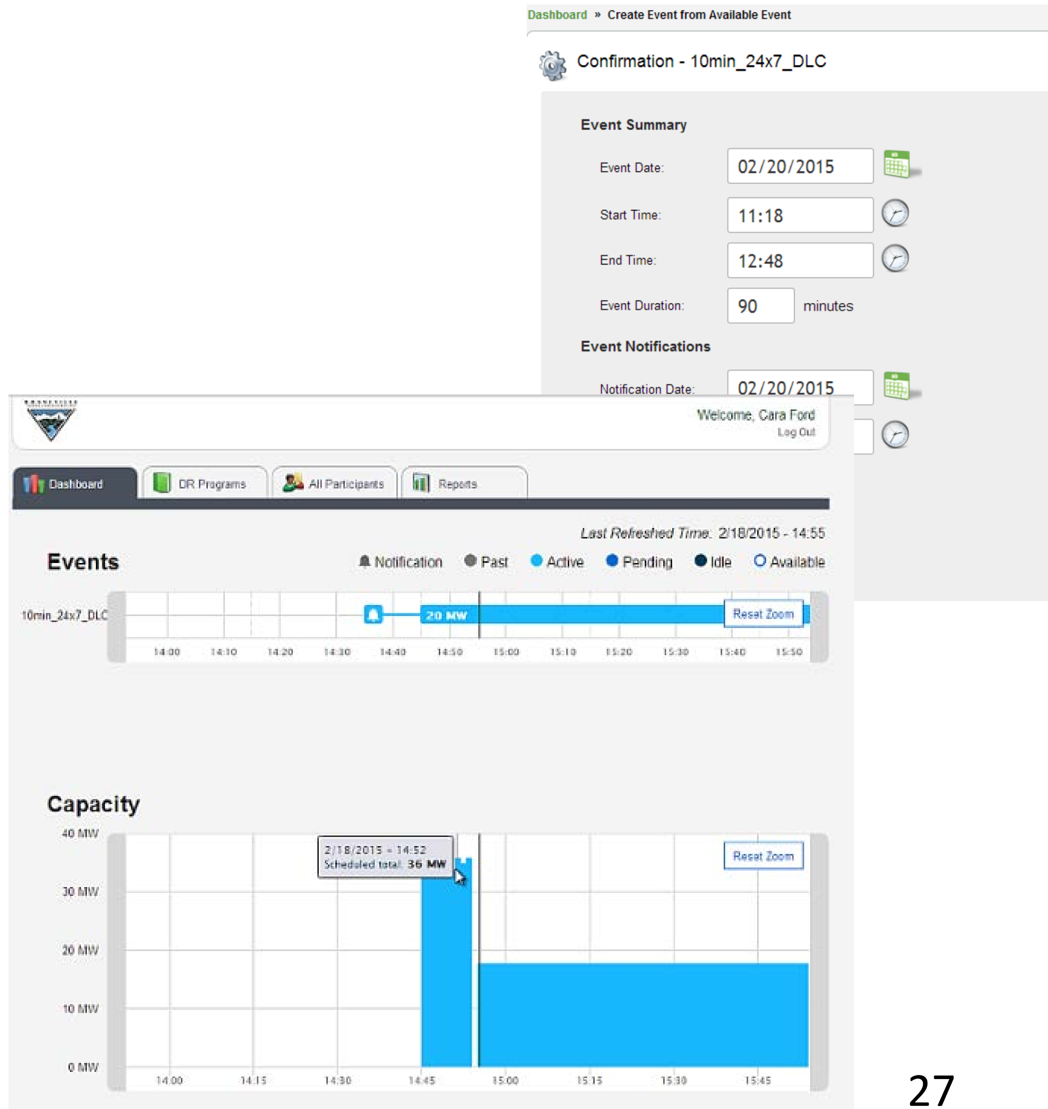
- **Performance - 94% with 64 successful events and 4 failures.**
- **Assets included NORPAC, City of Richland DVR, and a battery all responding on 10 minute notice for up to 90 minutes.**
- **Performance impressive given operating parameters of "Fast DR".**



# 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.




AutoGrid

# 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

Energy Smart Industrial
BPA ENERGY EFFICIENCY

| | Municipal Water | Cold Storage | Food Processing - Chilled | Food Processing - Frozen |
|---|---|---|---|---|
| **EE Implementation** | **Track and Tune** (Year 2) | **ROC** (Year 1)<br>Large Capital Project | **ROC** (Year 2) | **ROC** (Year 2) |
| **DR Opportunities** | 1. Water Storage (Pumping Systems) | 1. Freezers<br>2. Fork Lift batteries | 1. Small Freezer<br>2. Fork Lift Batteries<br>3. Production scheduling | 1. Freezers |
| **Initiate Event** | Manual initiation from SCADA | Automated (End node and refrigeration control system) | Manual | Manual |

# Wastewater Management

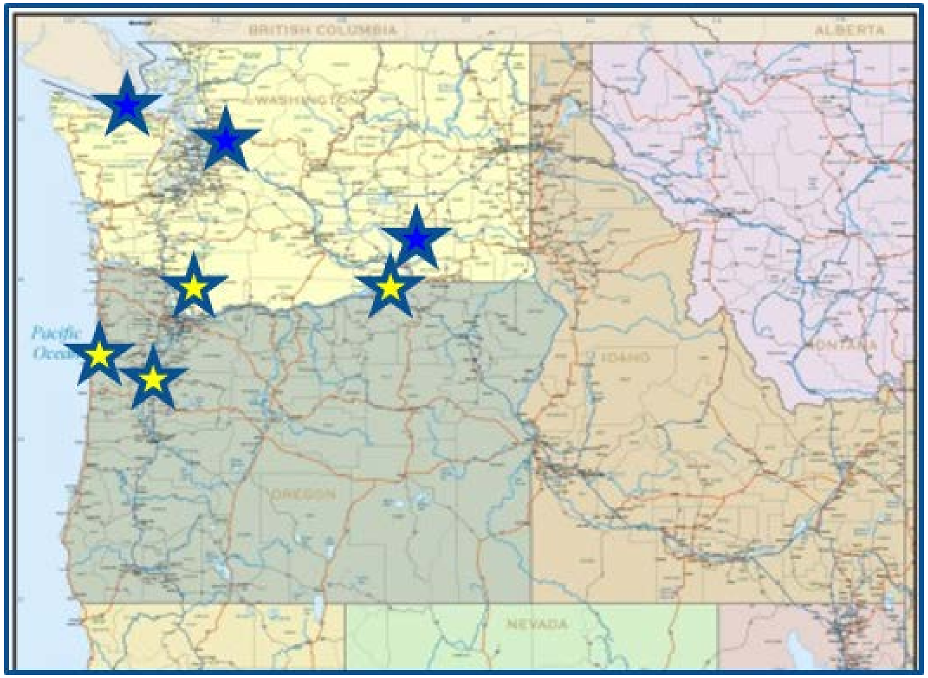
- Act as a dispatchable large utility-scale DR resource (>1MW) to increase and decrease load as needed.
- Measure and verify to provide a performance-based approach in developing reliable resources that can be used year-round for ancillary services.
- Tested EE/DR combination

EWEB

# 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

# 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

| Event # | Event Date | Start Time | End Time | Duration in minutes | Cumulative Hours of Seasonal Testing | Targeted Participants | Load Shed in MW | Nominated MW | Performance | Performance | Dispatch |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 12/7/2015 | 9:00 | 10:00 | 60 | 1.0 | 16 | 16.7 | 9 | 186% | Success | DR Team Pre-Schedule |
| 2 | 12/8/2015 | 18:00 | 19:00 | 60 | 2.0 | 16 | 16.3 | 9 | 181% | Success | DR Team Pre-Schedule |
| 3 | 12/16/2015 | 17:00 | 20:00 | 180 | 5.0 | 16 | 20.0 | 9 | 222% | Success | DR Team Pre-Schedule |
| 4 | 12/17/2015 | 7:00 | 10:00 | 180 | 8.0 | 16 | 12.8 | 9 | 142% | Success | DR Team Pre-Schedule |
| 5 | 12/28/2015 | 17:00 | 20:00 | 180 | 11.0 | 16 | 22.3 | 9 | 248% | Success | DR Team Pre-Schedule |
| 6 | 12/28/2015 | 7:00 | 10:00 | 180 | 14.0 | 16 | 16.4 | 9 | 182% | Success | DR Team Pre-Schedule |
| 7 | 12/29/2015 | 17:00 | 20:00 | 180 | 17.0 | 16 | 20.4 | 9 | 227% | Success | DR Team Pre-Schedule |
| 8 | 12/29/2015 | 7:04 | 10:00 | 176 | 19.9 | 16 | 22.2 | 9 | 247% | Success | DR Team Pre-Schedule |
| 9 | 12/30/2015 | 17:00 | 20:00 | 180 | 22.9 | 16 | 21.0 | 9 | 233% | Success | DR Team Pre-Schedule |
| 10 | 12/30/2015 | 7:00 | 10:00 | 180 | 25.9 | 16 | 27.0 | 9 | 300% | Success | DR Team Pre-Schedule |
| 11 | 1/29/2016 | 18:00 | 19:30 | 90 | 27.4 | 16 | 19.5 | 9 | 217% | Success | Operational Dispatch |
| 12 | 4/18/2016 | 17:00 | 20:00 | 180 | 30.4 | 23 | 11.7 | 13 | 90% | Success | Operational Dispatch |
| 13 | 4/19/2016 | 17:00 | 20:00 | 180 | 33.4 | 23 | 14.7 | 13 | 113% | Success | Operational Dispatch |
| 14 | 4/20/2016 | 18:00 | 20:00 | 120 | 35.4 | 23 | 19.5 | 13 | 150% | Success | Operational Dispatch |
| 15 | 4/20/2016 | 7:00 | 10:00 | 180 | 38.4 | 23 | 2.4 | 13 | 18% | *Failure* | Operational Dispatch |
| 16 | 4/27/2016 | 17:00 | 20:00 | 180 | 41.4 | 23 | 17.4 | 13 | 134% | Success | Operational Dispatch |
| 17 | 4/27/2016 | 7:30 | 10:00 | 150 | 43.9 | 23 | 17.8 | 13 | 137% | Success | Operational Dispatch |
| 18 | 4/28/2016 | 17:00 | 20:00 | 180 | 46.9 | 23 | 16.0 | 13 | 123% | Success | Operational Dispatch |
| 19 | 4/28/2016 | 7:00 | 10:00 | 180 | 49.9 | 23 | 14.1 | 13 | 108% | Success | Operational Dispatch |
| 20 | 4/29/2016 | 17:45 | 20:00 | 135 | 52.2 | 23 | 15.3 | 13 | 118% | Success | Operational Dispatch |
| 21 | 4/29/2016 | 7:00 | 10:00 | 180 | 55.2 | 23 | 14.6 | 13 | 112% | Success | Operational Dispatch |

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

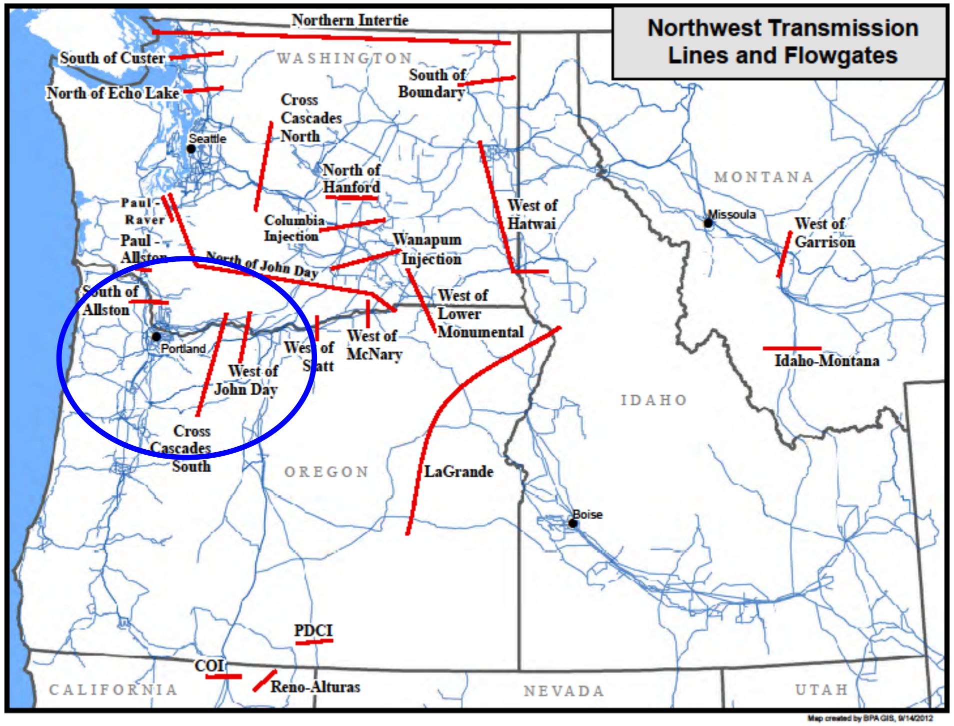
**Winter 2016/2017 Goals:** Season will focus on having **real-time power operations** using DR for **multiple uses** to meet operational triggers determined by real-time operations such as:

- ✓ 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.



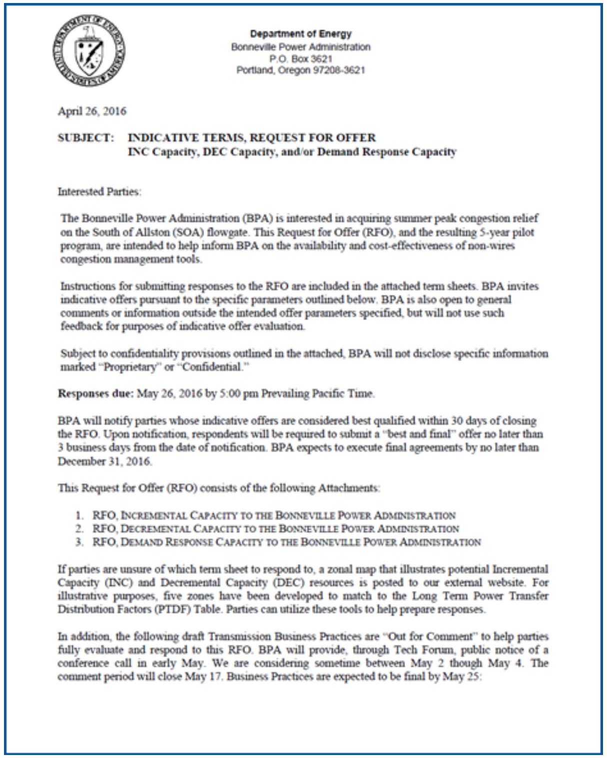

Red lines represent flowgates

## 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**



**Department of Energy**
Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

April 26, 2016

**SUBJECT: INDICATIVE TERMS, REQUEST FOR OFFER**
**INC Capacity, DEC Capacity, and/or Demand Response Capacity**

Interested Parties:

The Bonneville Power Administration (BPA) is interested in acquiring summer peak congestion relief on the South of Allston (SOA) flowgate. This Request for Offer (RFO), and the resulting 5-year pilot program, are intended to help inform BPA on the availability and cost-effectiveness of non-wires congestion management tools.

Instructions for submitting responses to the RFO are included in the attached term sheets. BPA invites indicative offers pursuant to the specific parameters outlined below. BPA is also open to general comments or information outside the intended offer parameters specified, but will not use such feedback for purposes of indicative offer evaluation.

Subject to confidentiality provisions outlined in the attached, BPA will not disclose specific information marked "Proprietary" or "Confidential."

**Responses due:** May 26, 2016 by 5:00 pm Prevailing Pacific Time.

BPA will notify parties whose indicative offers are considered best qualified within 30 days of closing the RFO. Upon notification, respondents will be required to submit a "best and final" offer no later than 3 business days from the date of notification. BPA expects to execute final agreements by no later than December 31, 2016.

This Request for Offer (RFO) consists of the following Attachments:

1. RFO, Incremental Capacity to the Bonneville Power Administration
2. RFO, Decremental Capacity to the Bonneville Power Administration
3. RFO, Demand Response Capacity to the Bonneville Power Administration

If parties are unsure of which term sheet to respond to, a zonal map that illustrates potential Incremental Capacity (INC) and Decremental Capacity (DEC) resources is posted to our external website. For illustrative purposes, five zones have been developed to match to the Long Term Power Transfer Distribution Factors (PTDF) Table. Parties can utilize these tools to help prepare responses.

In addition, the following draft Transmission Business Practices are "Out for Comment" to help parties fully evaluate and respond to this RFO. BPA will provide, through Tech Forum, public notice of a conference call in early May. We are considering sometime between May 2 though May 4. The comment period will close May 17. Business Practices are expected to be final by May 25:

# 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

BONNEVILLE POWER ADMINISTRATION

U.S. DEPARTMENT OF ENERGY

NREL NATIONAL RENEWABLE ENERGY LABORATORY

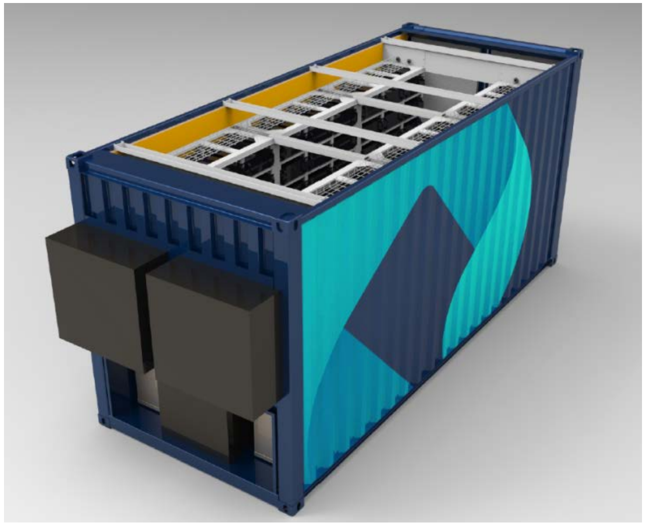
BOSCH

Colorado State University

# 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?

PowinEnergy NREL NATIONAL RENEWABLE ENERGY LABORATORY

Final Report available late 2018

# MW Scale Battery Integration

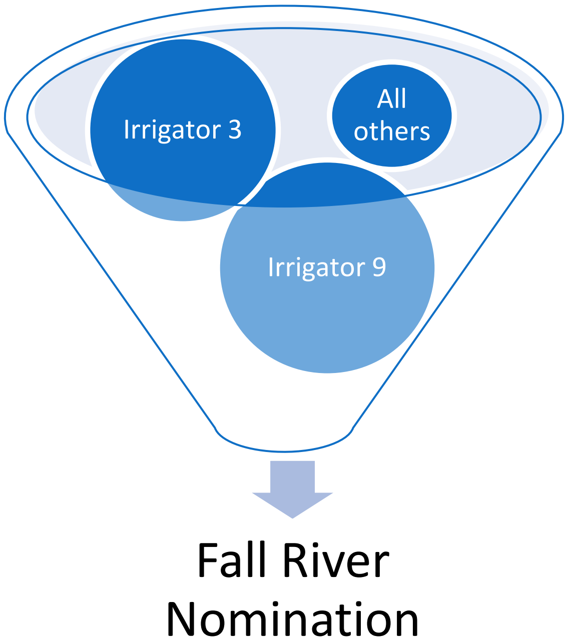
- Protocol for requesting use of distribution-level ES and DR resources to support BPA's transmission operations
- Software to enable communications between BPA and the distribution utilities it serves
- Transmission level "energy positioning" algorithms to most effectively use ES and DR resources
-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

SNOHOMISH COUNTY PUD PUBLIC UTILITY DISTRICT NO. 1

# Irrigation Demand Response Fall River Rural Electric Coop

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



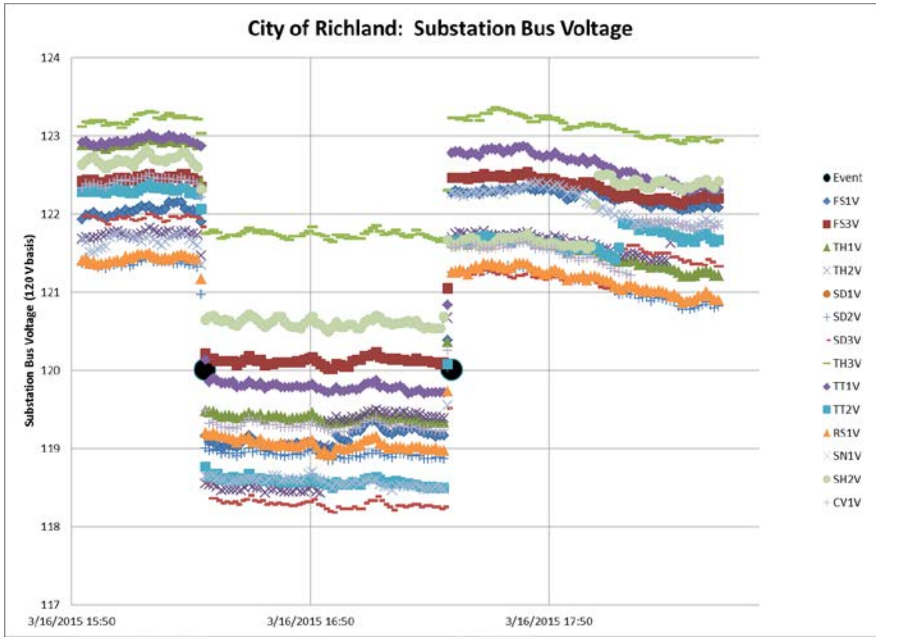

Objectives:

- 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

Identify

- Residential DR
- BYOD
- DVR

Test & Evaluate

- Batteries
- Energy NW
- EnerNoc

Document Use Case and Commercialization Plan

- Irrigation DR
- DRMS

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:

**Lee Hall**

**Distributed Energy Resources Manager**

503-230-5189 LJHall@bpa.gov