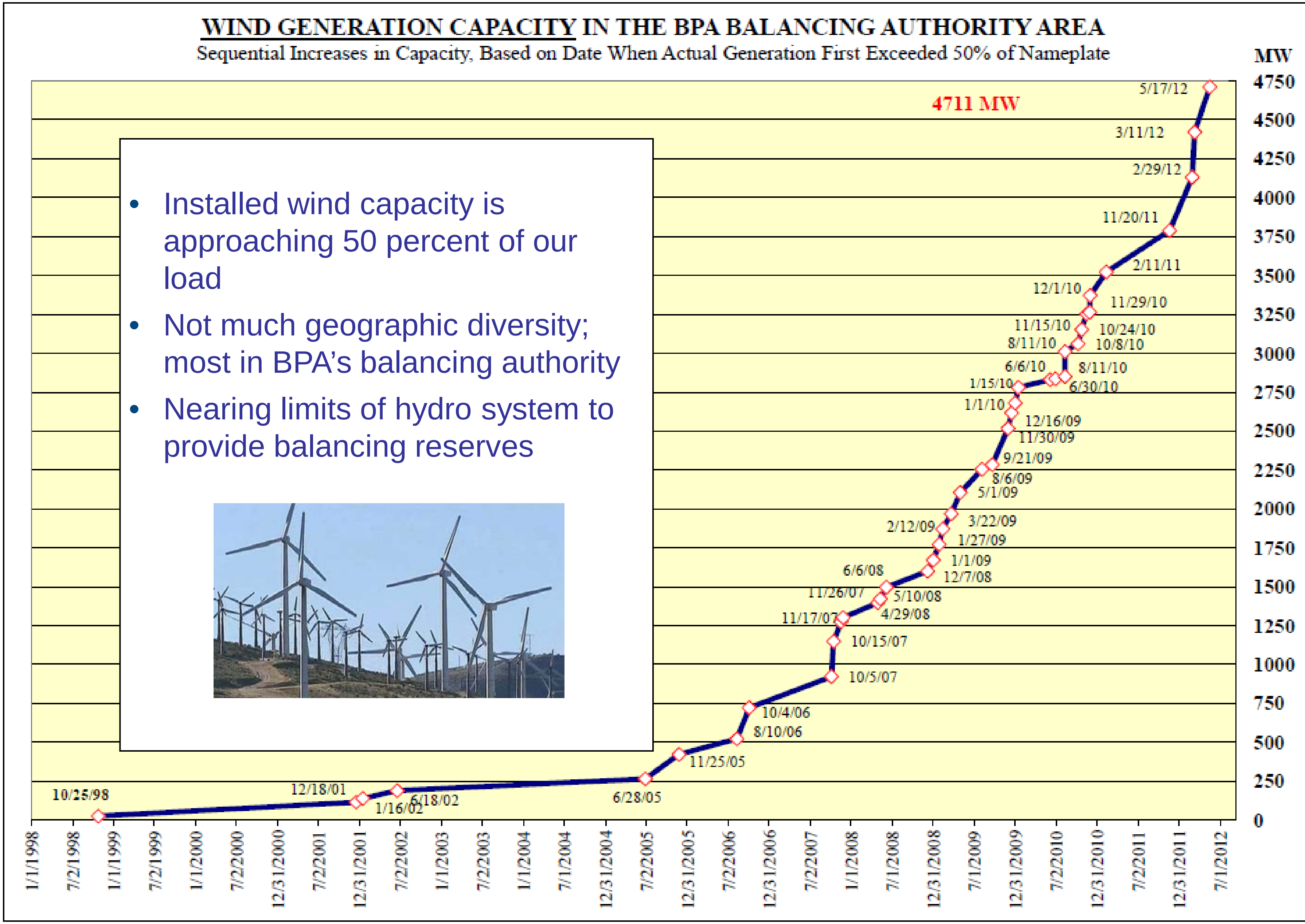
BPA – Energy Storage Pilots

Northwest Planning and Conservation Council
Energy Storage Symposium
February 13, 2013

Overview

- Drivers for energy storage
- BPA has been sponsoring multiple pilots with Energy Storage Components
  - Completed a wind integration pilot
    - City of Port Angeles – thermal & industrial processes
    - Aquifer recharge -- water
    - Ecofys - using storage and demand response to support wind integration
  - Launched several technology innovation pilots that involve storage as well
    - City University of New York
    - Primus
    - Powin
    - Data centers
- BPA is a partner in the PNW Smart Grid Demonstration that includes several utility driven storage tests
    - Benton County PUD
    - Portland General Electric

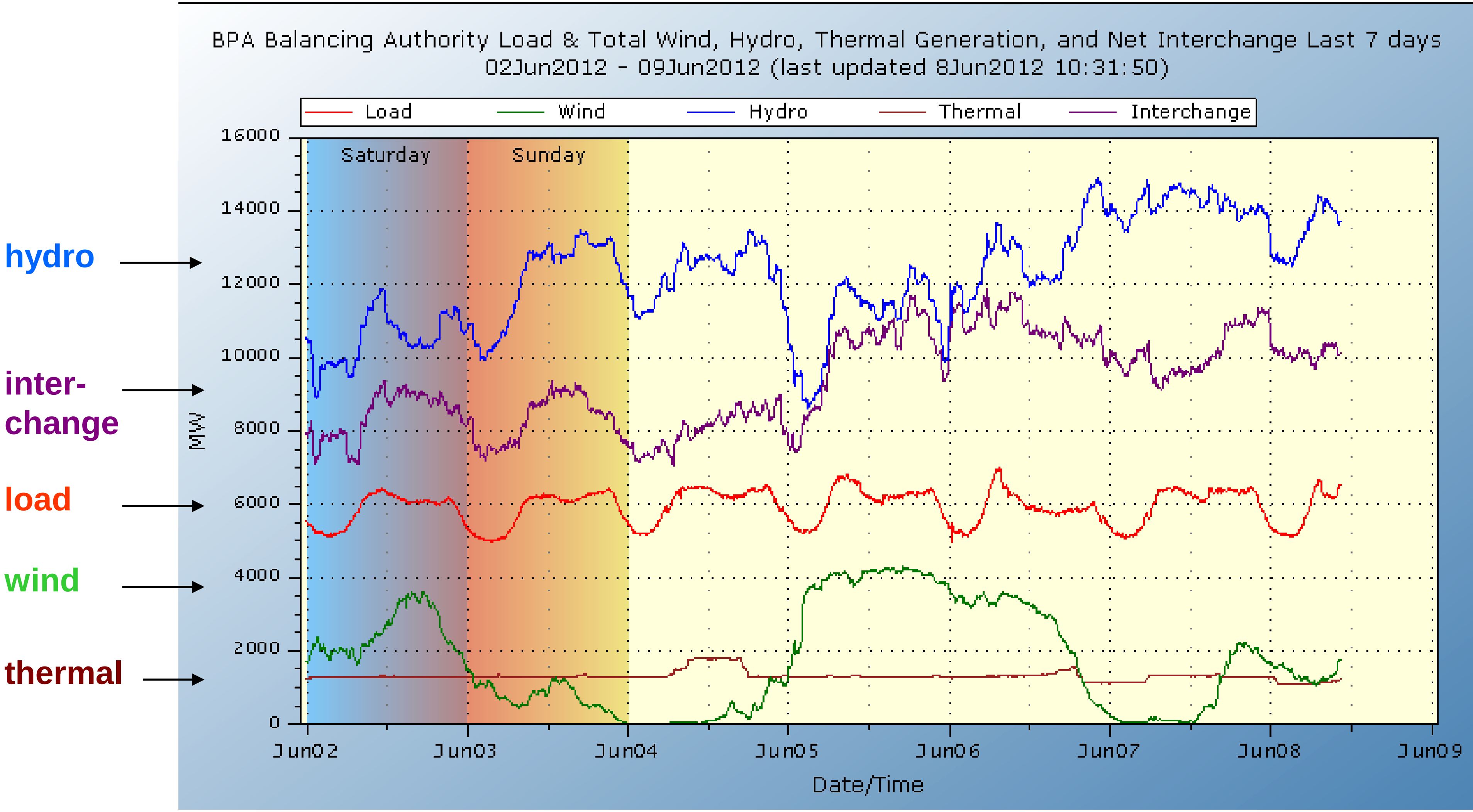
Storage – Not just batteries!



- Installed wind capacity is approaching 50 percent of our load
- Not much geographic diversity; most in BPA's balancing authority
- Nearing limits of hydro system to provide balancing reserves

WIND_InstalledCapacity_current.xls 5/18/2012

Wind increasing -- more than 4,000 MW



Regional situational analysis – issues to address

1) Operational reserve and capacity constraints

- **Wind integration:** BPA faces significant balancing reserve demands
- **River management:** BPA is at the limits of balancing reserves but must ensure sufficient margin to meet multiple use requirements, including managing over-generation events
- **Ease supply constraints** and operational demands during summer and winter peaks and large unit outages

2) Transmission expansion challenges

3) Economic impacts on utilities

- Rate design with demand charge creates incentives for our customer utilities to invest in DR

Evaluating multiple technologies for both reducing and increasing load

We just finished testing many different technologies and DR uses, including:

- Commercial and public building load control
- Residential and commercial space heating energy storage
- Water heating energy storage and load control
- Industrial process load control and energy storage
- Large farm water management system load control and storage
- Small-scale battery energy storage
- Load increase using aquifer recharge opportunities

City of Port Angeles

Thermal storage/industrial process storage

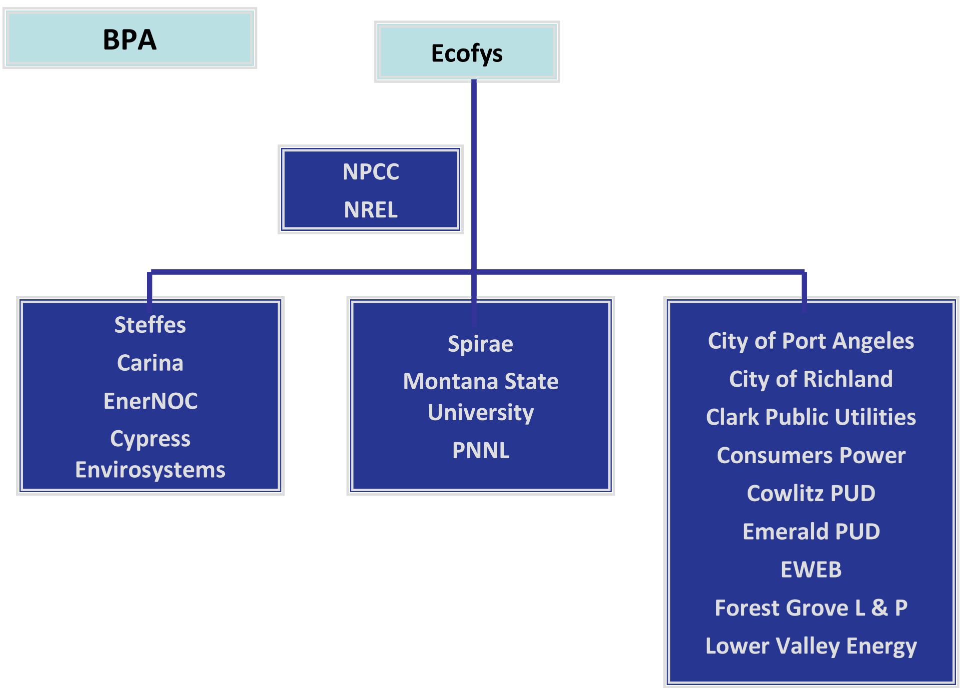
- Customer-Side
  - Residential DR Pilot (600 customer units)
    - Water heaters, smart thermostats

  Residential Wind Integration Pilot (41 customer units)
  - Water heaters, thermal storage
- Commercial & Industrial DR Pilot (8 customers)*
  - Open Automated Demand Response Communication Standards (OpenADR) communications protocol
  - Industrial Wind Integration Pilot (1 customer)

Aquifer Recharge Pilot

- BPA recently completed a pilot with United Electric Co-op test the ability of the Southwest Irrigation District to increase pumping during light load hours.
- Additional recharge during periods of lighter electricity use should reduce operational costs for deep well pumping.
- This has several benefits including helping BPA to address oversupply events.
- 1.8 megawatt proof-of-concept field test.

Ecofys Pilot - Demonstration of Use of Thermal Storage for Demand Response to Support Wind Integration



- **Project Overview:**
  - Pilot began in 2010, and substantially complete by 2012
  - **Accomplished primary objectives of supporting wind integration** with controllable assets totaling ~1.5 MW of end-use loads at 200 residential and 10 commercial sites.
  - The primary asset types tested – **cold storage warehouses and water heaters** – demonstrated controllability and response within 10 minutes - load up and load down - to a simulated system balancing need.
  - Achieved objectives without negatively impacting customers

Ecofys Pilot - Thermal Storage Electric Water Heater Results

Figure: Installed 105 gallon water heater with Steffes™ mixing valve and interactive controls

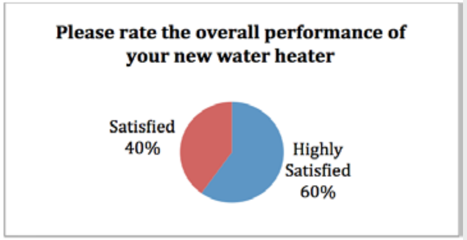


Figure: Results of customer satisfaction survey

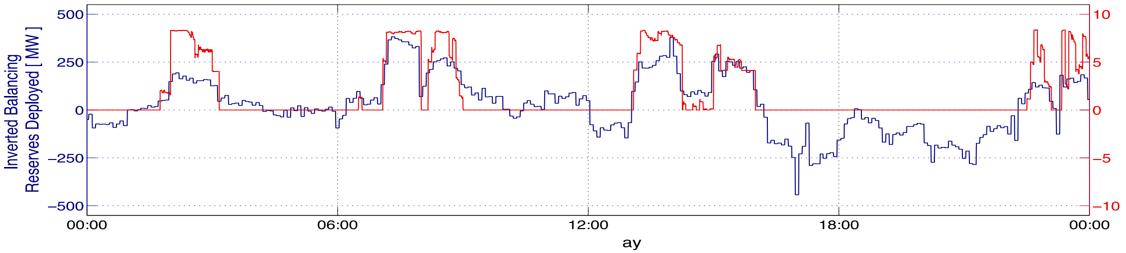


Figure: Balancing reserves deployed (inverted) and aggregate response from two Steffes™ thermal storage water heaters over a one day period

Project tested water heater controllers (200) that enable higher control (up/down):

- Steffes
- Carina

Loads showed ability to move in response to a BPA Balancing Reserves Deployed data

Results:

- Steffes controlled units adept at load up and down response
- Spirae modeling showed capability to effectively charge (pre-charge) during LHL.
- Costs for Gen 1 controllers are still high – five hours of installation. Next gen forthcoming; approach is promising as costs decrease.

Ecofys Pilot - Cold Storage Warehouse Results

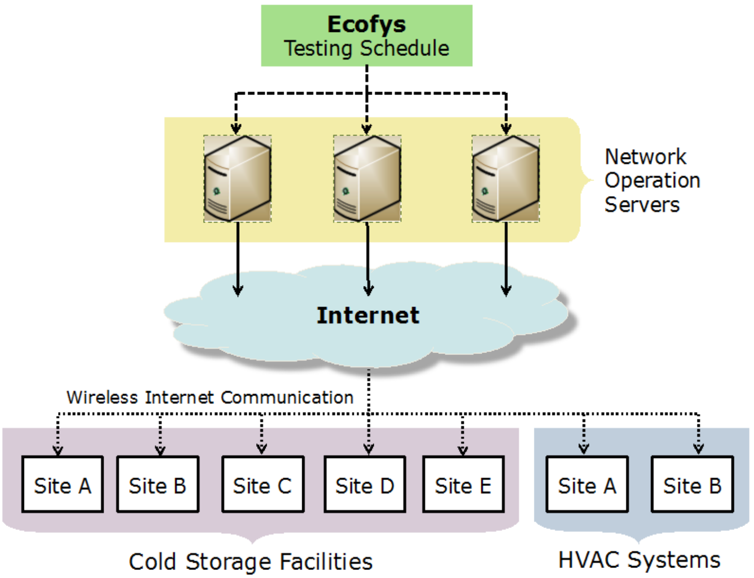


Figure: Testing configuration for the cold storage facilities and commercial HVAC systems

Site	Controlled Equipment	Average Demand	Target Increase	Target Decrease
A	Compressors	400 – 700 kW	200 kW	200 kW
B	Compressors, Evaporators	400 – 700 kW	100 kW	200 kW
C	Compressors, Evaporators	100 - 450 kW	50 kW	200 kW
D	Compressors, Evaporators	700 – 1100 kW	100 kW	200 kW
E	Compressors, Evaporators	700 – 900 kW	200 kW	200 kW
Total	-	**2300 - 3850 kW**	**650 kW**	**1000 kW**

Table: Characteristics of the cold storage demand response pilot sites

Tests with five cold storage sites at four utilities:

- EWEB
- Forest Grove Light and Power
- Consumers Power
- City of Richland

EnerNOC enabled sites managed tests. Conducted 51 load events.

Result: Response in 10 minutes. Average curtailment (INC) just under 200kW/site, and increases (DECs) at 100kW.

Participation over 90% for INCS. DECs more variable, and some reduced participation (70%) primarily because of demand charge risk.

Opportunity: Estimated 100+ DR favorable cold storage sites in the PNW

- Mature control systems
- Favorable economics (e.g. . cheaper to enable per kw)
- Multiple use – INC/DEC, load shift

Ecofys Pilot - ETS Furnaces / Controllable Thermostat Testing

Lower Valley in Jackson has installed 7 **ETS Furnaces**

- 5 residential, 2 commercial
  - ~ 300 kW of DR potential
- Being controlled & monitored by Steffes
- Results pending the Winter 12/13 tests

Steffes Furnaces

Cypress Thermostats

Controllable thermostats:

- Installed at two schools in Vancouver - 44 at one location, 51 at the other.
- Tested 3 degree adjustment for 30 minutes
- Result: Very effective for efficiency/monitoring via interface of condition in each room; however, as configured not for Fast DR response.

Ecofys Pilot - Tested Aggregator and OpenADR platforms to dispatch loads

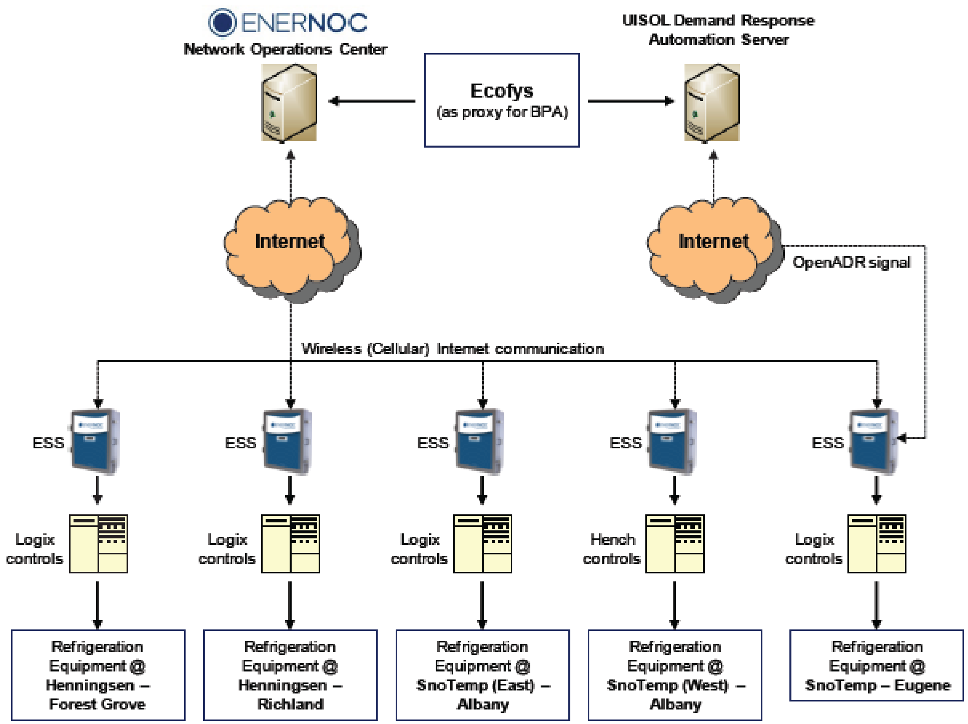


Figure 9: Technology and Communication Infrastructure

ALSTOM | Grid

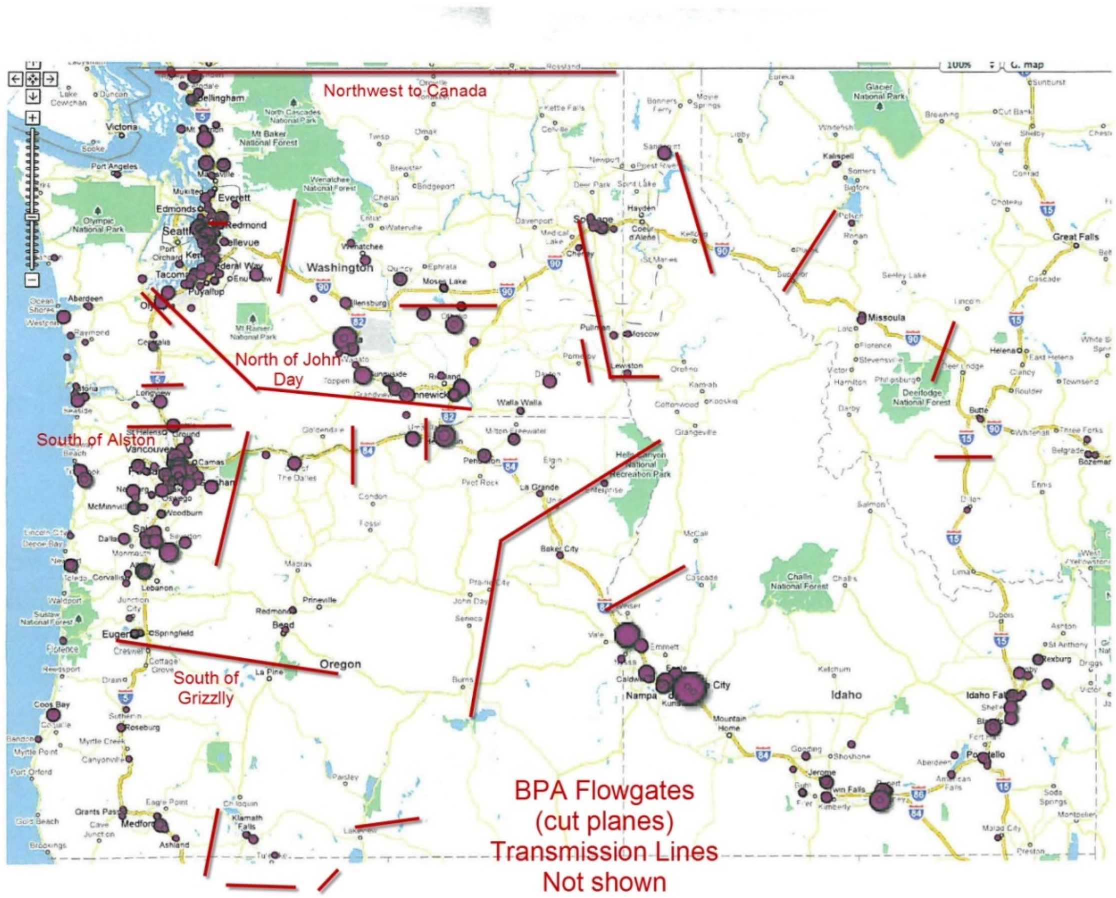
The Project tested the EnerNOC and Alstom Grid OpenADR compliant platforms to trigger events at 2 locations:

- Platform uses OpenADR, a standard protocol for DR
- Dispatch platform particularly important for Fast DR
- <u>Result</u>: Effectively dispatched communicating with Warehouse control equipment (10 min product)

CUNY and NW Food Processors Pilot

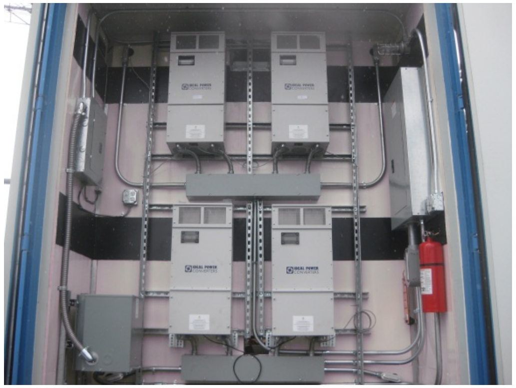
Model the Use of Battery Storage to Address Transmission Constraints / Peak Loads

- BPA TI Funded pilot (with cost share) to model utilization and benefits of energy storage at various points of the electric grid
  - Find optimal combination of location, size, technology for battery installation
  - Focus on addressing a transmission constraint / peak load > Combine load reduction (DR) at facility with need of transmission
- Potential Field Demonstration (after modeling)



Powin Energy Storage Project Synopsis

- The project involves field testing and evaluating a modular, dispatchable 120kW/500kWh battery storage unit
- Test will last over a two-year period
- Partners include Powin Energy, PNNL, Energy Northwest, and the City of Richland, Washington



Primus Energy Storage Expected Benefits

Energy storage can address four key challenges on BPA's Transmission R&D Roadmap

Challenge	Storage addresses by
Power system stability control	provision of balancing services, spinning reserves, frequency response and voltage/VAR support
Congestion management	placement at key points in the grid to facilitate power flows
Integration of renewable energy resources	provision of balancing services and raising the minimum load condition
Changing load characteristics	During charging mode, storage is fast responding load based on frequency response and voltage/VAR control strategies

Data Centers

- Provide peak shifting and balancing reserves, as well as other advanced transmission-level services that will allow BPA to defer infrastructure investment, improve congestion management, voltage control, and inter-regional balancing.

- Over a 2-year period, the project will implement a project that will represent approximately 1 MW of DR potential.

- Best option for storage is “thermal mass,” or pre-cooling the buildings

Pacific Northwest Demonstration Project

What:

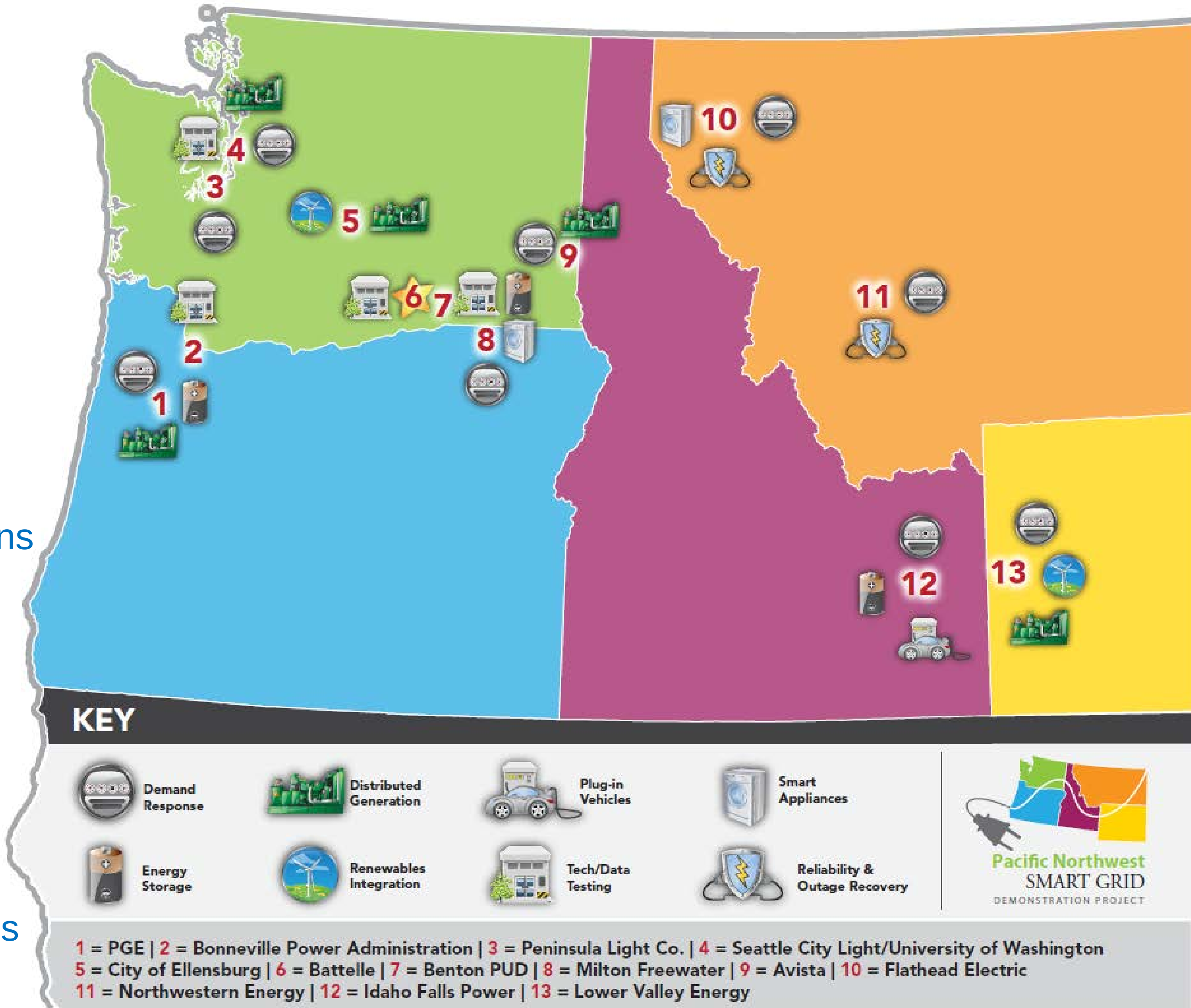
- $178M, ($89M from partners, $89M DOE-funded)
- 5-year demonstration
- 60,000 metered customers in 5 states

Why:

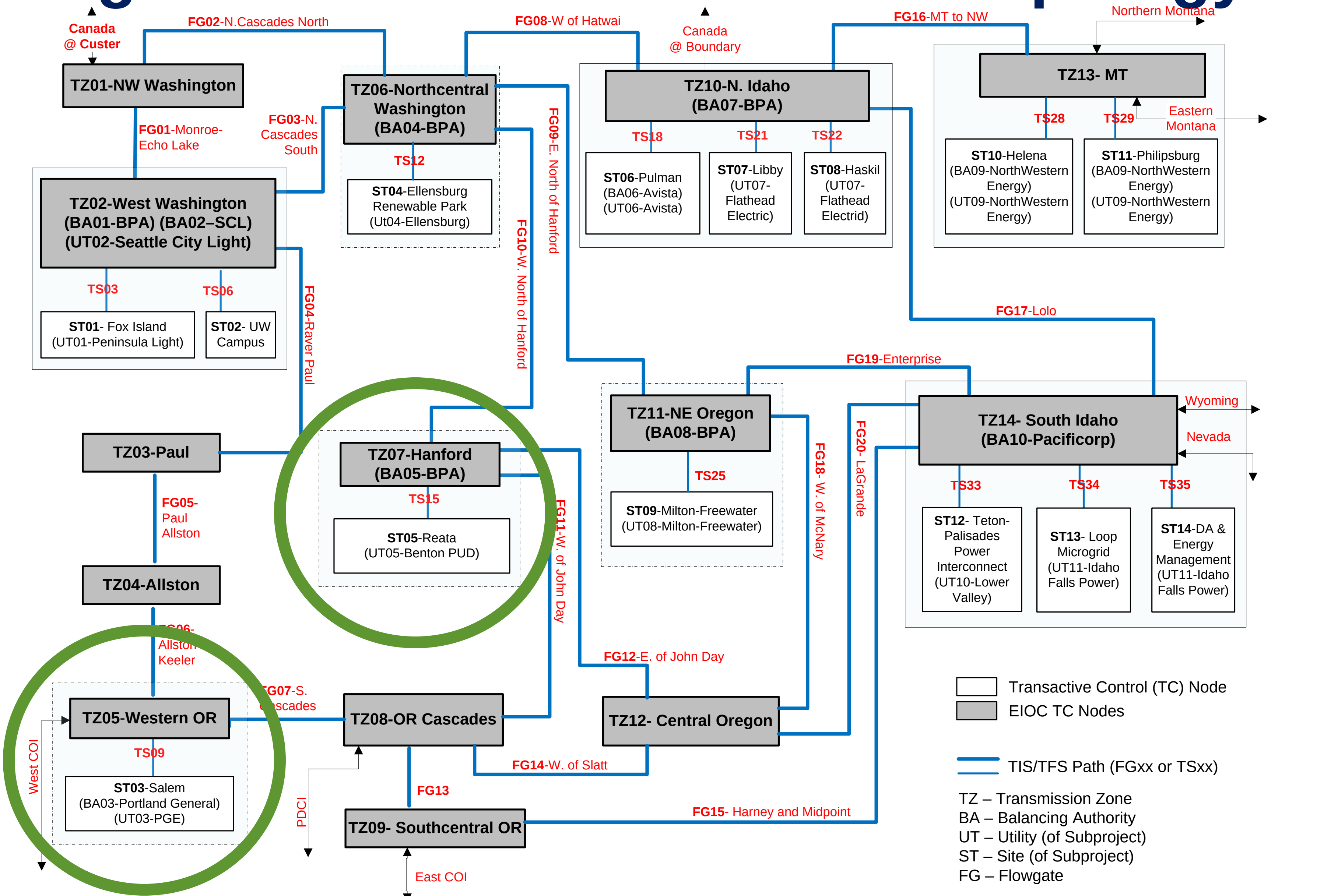
- Quantify costs and benefits
- Develop communications protocol
- Develop standards
- Facilitate integration of wind and other renewables

Who:

Led by Battelle Lab, BPA, 11 utilities, 2 universities and 5 vendors



Regional Nodes and Network Topology



Benton County Public Utility District

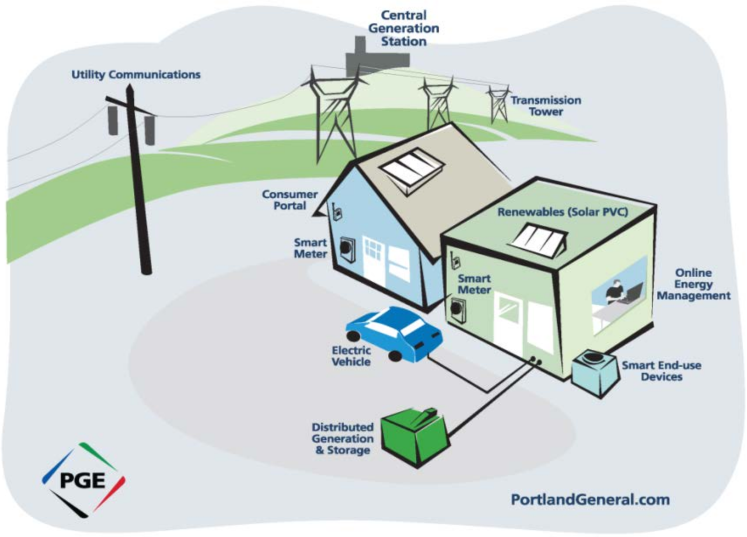
- Benton PUD is testing how small-scale distributed energy storage and generation devices could be dispatched to help integrate wind and reduce peak electrical demand.
- Working with “sister utilities” in the Tri-Cities, Franklin PUD and the City of Richland (not part of the Smart Grid Demo), have tied together their 10 kilowatt batteries.
- The three storage devices take energy from the grid during off-peak hours, then store and provide up to four hours of energy, releasing it back to the grid during times of peak demand.

BENTON P·U·D

Portland General Electric

- Implement a 1,300 kWh, 5 MW feeder-battery-energy-storage system.
- Intentional islanding of a feeder segment with distributed resources.
- Self healing of a feeder after a transmission or major distribution outage.
- Improve power reliability for customers in a high reliability zone.
- Reduce peak demand using battery/inverter storage system & DSG.
- Develop Battery Controls to accept wind energy in off-peak hours

Portland General Electric



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