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Wind Integration from Demand Response: Load that Moves Both Ways

PLMA Fall 2010 Conference, Nov. 9-10

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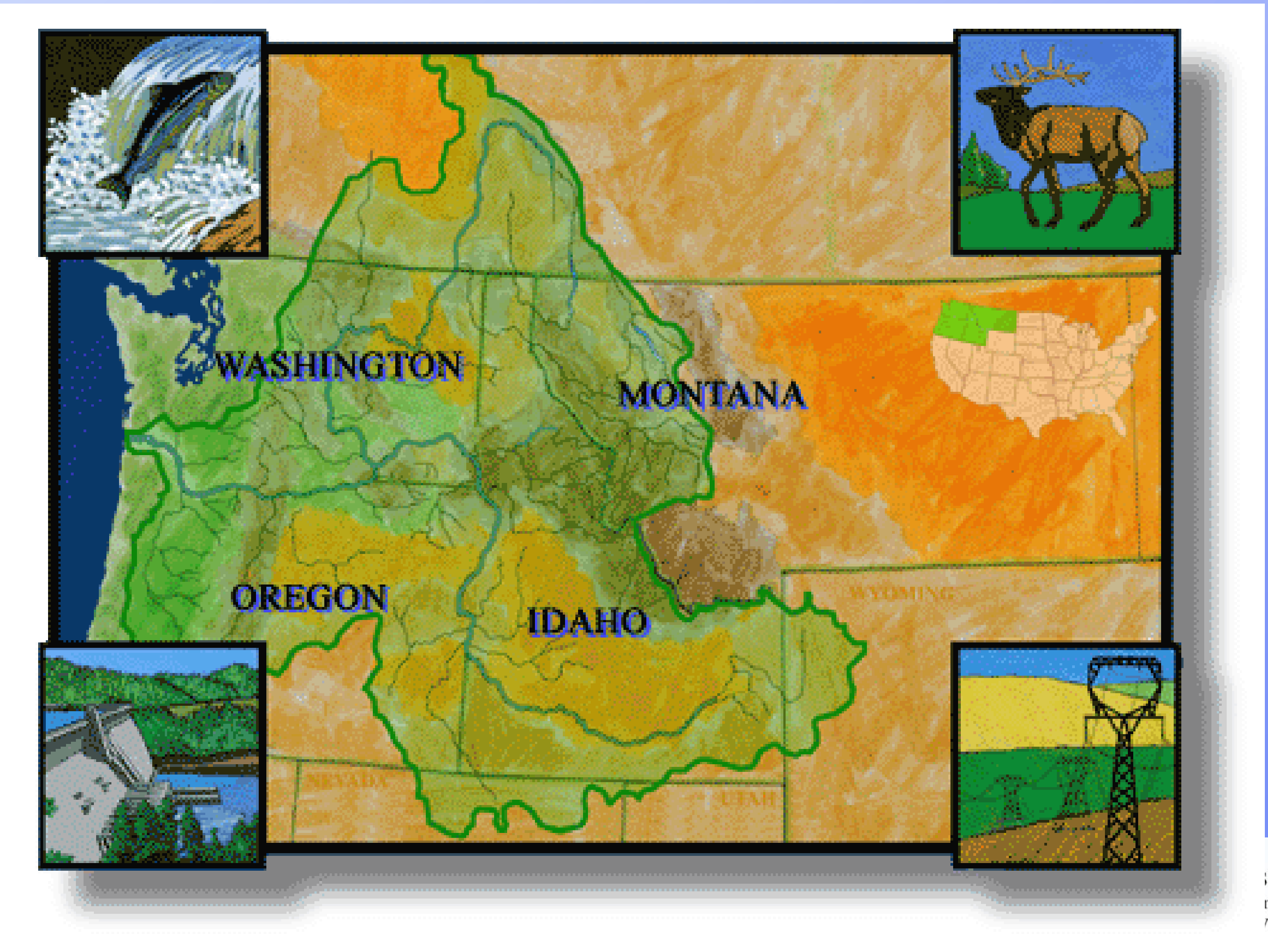
The Pacific Northwest



System Operators' Job in the Operating Hour

- Given forecast load and scheduled generation,
- Match actual load, actual generation
  - Loads are uncertain and volatile
  - Generators, transmission are not perfectly reliable
  - Wind and solar are variable, increasing share of system

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System Operators' Tools in the Operating Hour

- Resource reserves for balancing, e.g.
  - Simple cycle gas turbine or hydroelectric generator running at 80% of capacity
  - Capable of increasing to 100% and decreasing to 60% quickly
  - Balancing reserves = 20% up and down

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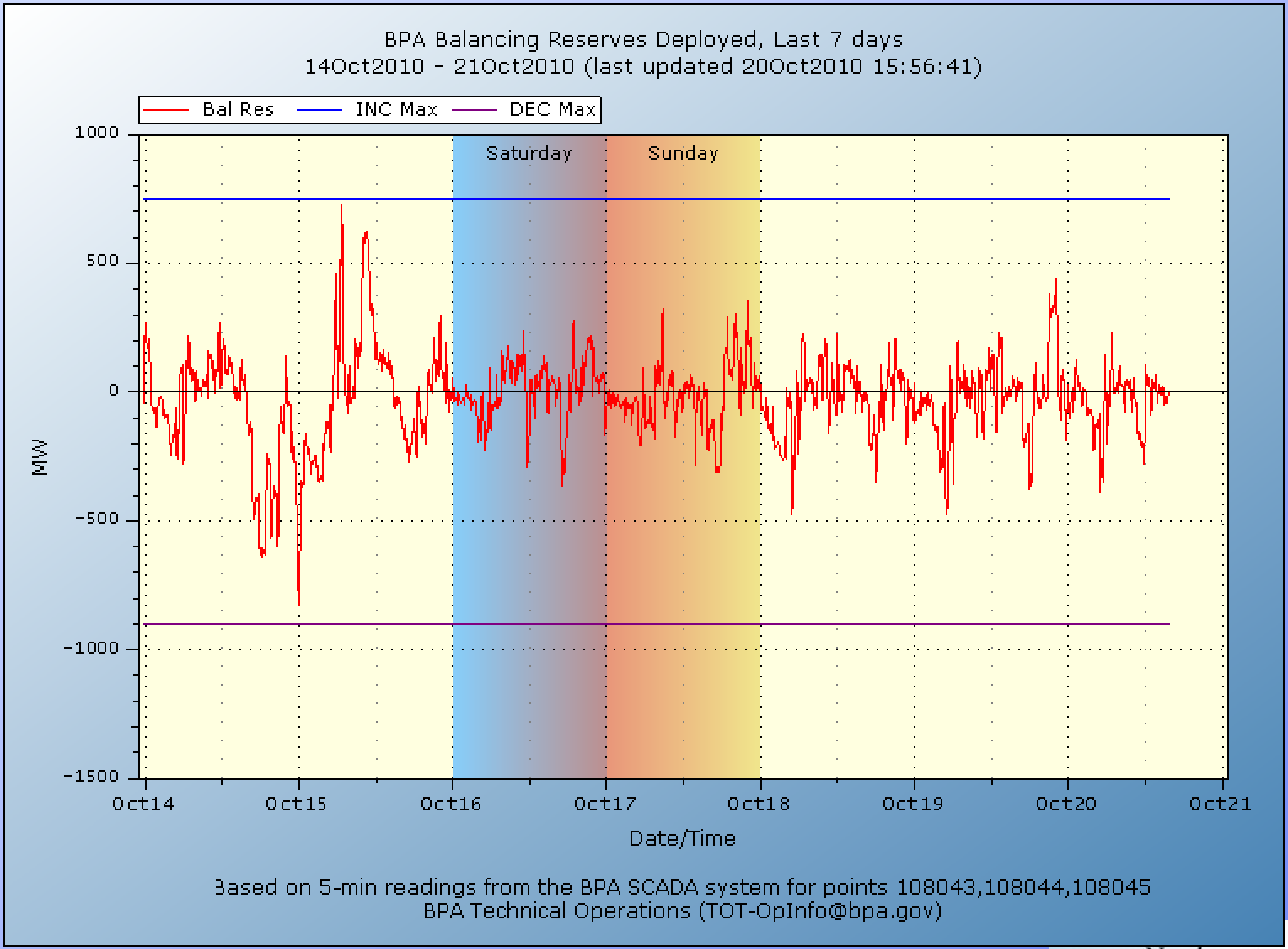
Balancing Services Deployed – BPA



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"Conventional" DR

- Reductions in load at or near peak
- Dozens of hours/year
- Mostly avoids capacity cost

DR for Balancing Reserves

- Includes both increases and decreases in load
- Needed virtually every hour of year
- Avoids capital and operating costs
- Requires quick response, flexibility

So What Kind of DR Might Work?

- Water heating, w/ expanded energy storage, smart grid tech
- Cold storage warehouses
- Pumping into reservoirs
- Some electrochemical processes
- Ice storage for HVAC

Thermal Storage Water Heater - Decrease Load

- Delay recovery when hot water is used
- Stored water is stratified, so temp at tap remains stable
- 6-8 kWh typically stored in 50 gallon tank at 120^{o}F

Thermal Storage Water Heater – Increase Load

- Increase storage temp
  - 170^{o}F stores 6 kWh more than 120^{o}F (50 gallon tank)
  - “Tempering valve” ensures hot water leaving tank = 120^{o}F
  - Energy recovered when hot water used
    - heater off until tank temp = 120^{o}F

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Thermal Storage Water Heater - Additional Services

- Reduce peaks/fill troughs
  - Avoid capacity costs and/or
  - Serve heavy-load hours at light-load hour prices
  - Standby losses on extra storage = 0.4%/hr (for perspective, pumped storage one-cycle loss = 20-25%)

Pilots Testing Concept in Pacific Northwest - 1

- Water heaters
  - 100 conventional w/controls and communication
    - Control strategy creates “room” for energy
  - ~100 thermal storage w/ controls and communication
    - Allowing temps < 170^{o}F creates storage capacity

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PNW Pilots - 2

- Space heaters
  - Thermal storage, controls, communication
- Cold storage warehouses
  - Thermal storage (frozen food), controls, communication

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PNW Pilots – 3

- > Six utilities in Bonneville Power Administration pilot projects
- Recruitment and installations underway, results in fall 2012
- Potentially more in PNW Smart Grid Demonstration Project (BPA, Pacific Northwest National Lab, 11 regional utilities)

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From here?

- Early days – pilots to prove concept
- Costs in quantity over time?
- Optimal mix of services from resource?
- > 3 million electric water heaters in PNW => thousands of potential MW

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Questions?

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Comparative Cost & Efficiency

Technology	Cost/kW	Efficiency
Extended Thermal Storage Water Heaters	$100-200*	98% (5-hour storage)@
CAES (above ground)	$700-800#	75%@
ZnBr Flow Cell	$425-1300#	70-75%@
Pb Acid Battery	$420-660#	
NaS Battery	$450-550#	89%@
Flywheel	$3360-3920#	
Pumped Storage	$1750-2500@	75-82%@

*Steffes Corporation
#EPRI
@NWPCC

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