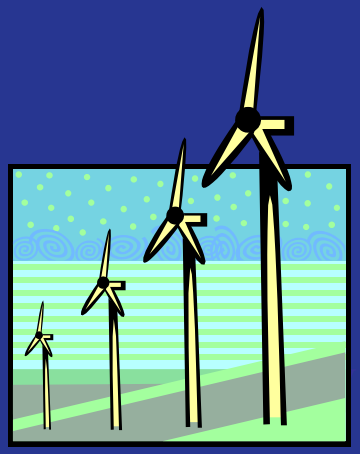
Integrating Renewable: Implications for Grid Storage Needs

Large-Scale Storage Workshop
Washington, D.C.
September 16, 2010



Sydney Berwager
Director, Strategy Integration
Bonneville Power Administration

of PPM Energy

About BPA

BPA established	1937
Service area size (square miles)	300,000
Transmission line (circuit miles)	15,397
BPA substations	284
Generation Capacity (MW)	15,900

Grand Coulee Dam

BPA is a Federal Power Marketing Administration and is part of the U.S. Department of Energy

Federal Columbia River Power System
Columbia River Basin & BPA Service Area

- **Congress created the Bonneville Power Administration (BPA) in 1937 to market and transmit the power produced by Bonneville Dam. Today, BPA markets power and transmission services from 31 Federal dams, one non-federal nuclear plant, and 75% (15,000 miles) of the high-voltage lines in the Pacific Northwest.**
- **The dams and the electrical system are known as the Federal Columbia River Power System (FCRPS)**
- **BPA sells wholesale power to publicly owned and investor-owned utilities, as well as to some large industries BPA also sells or exchanges power with utilities in Canada and other parts of the Western United States**
- **BPA is a self-funded, not-for-profit federal agency within DOE**

BPA has substantial wind energy experience

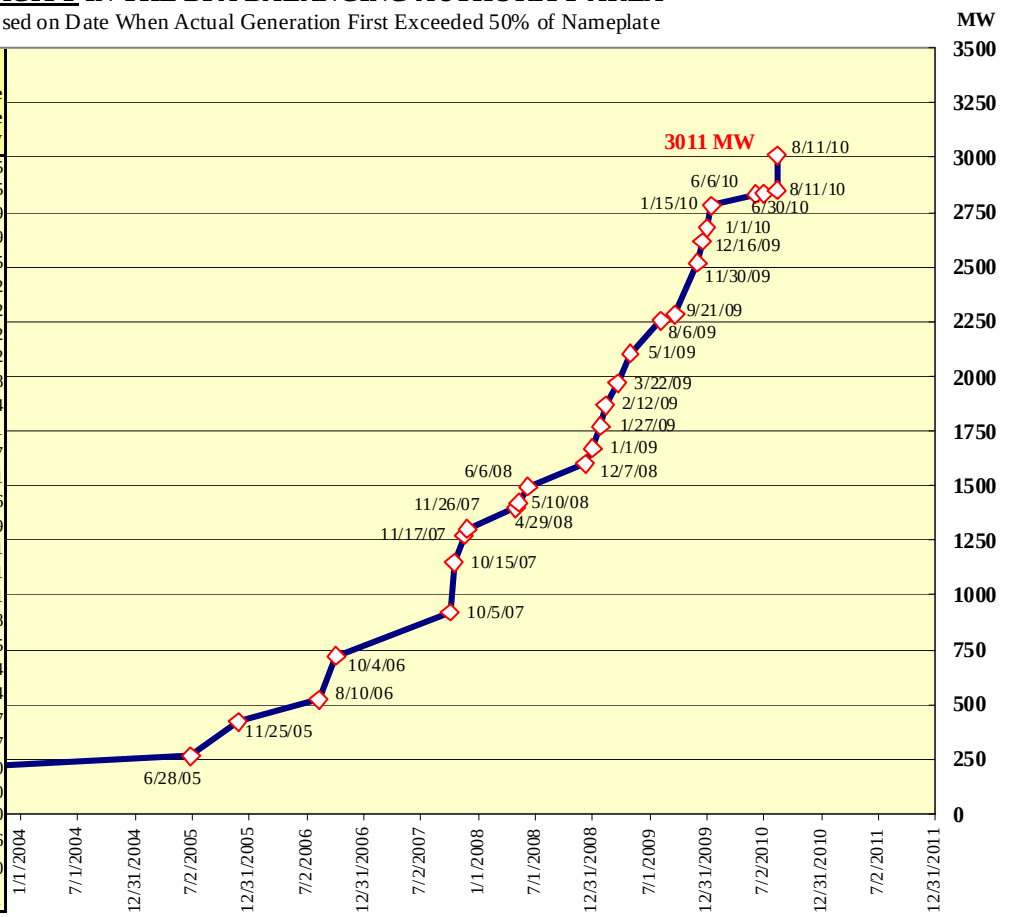
- Over 3,000 MW of wind in its 10,500 MW peak load balancing area
- 25 wind farms interconnected
- More than 1,800 wind turbines on line
- Five new substations for wind farms
- Six new taps for wind farms
- Approximately 85% of the wind serves load outside of the BPA balancing area
- In 2010, approximately 65% of wind serves loads in California balancing areas
- 7,080 MW, (60 percent) of committed requests under BPA's 2008, 2009, and 2010 Network Open Seasons are for wind generation.

Wind power is growing fast

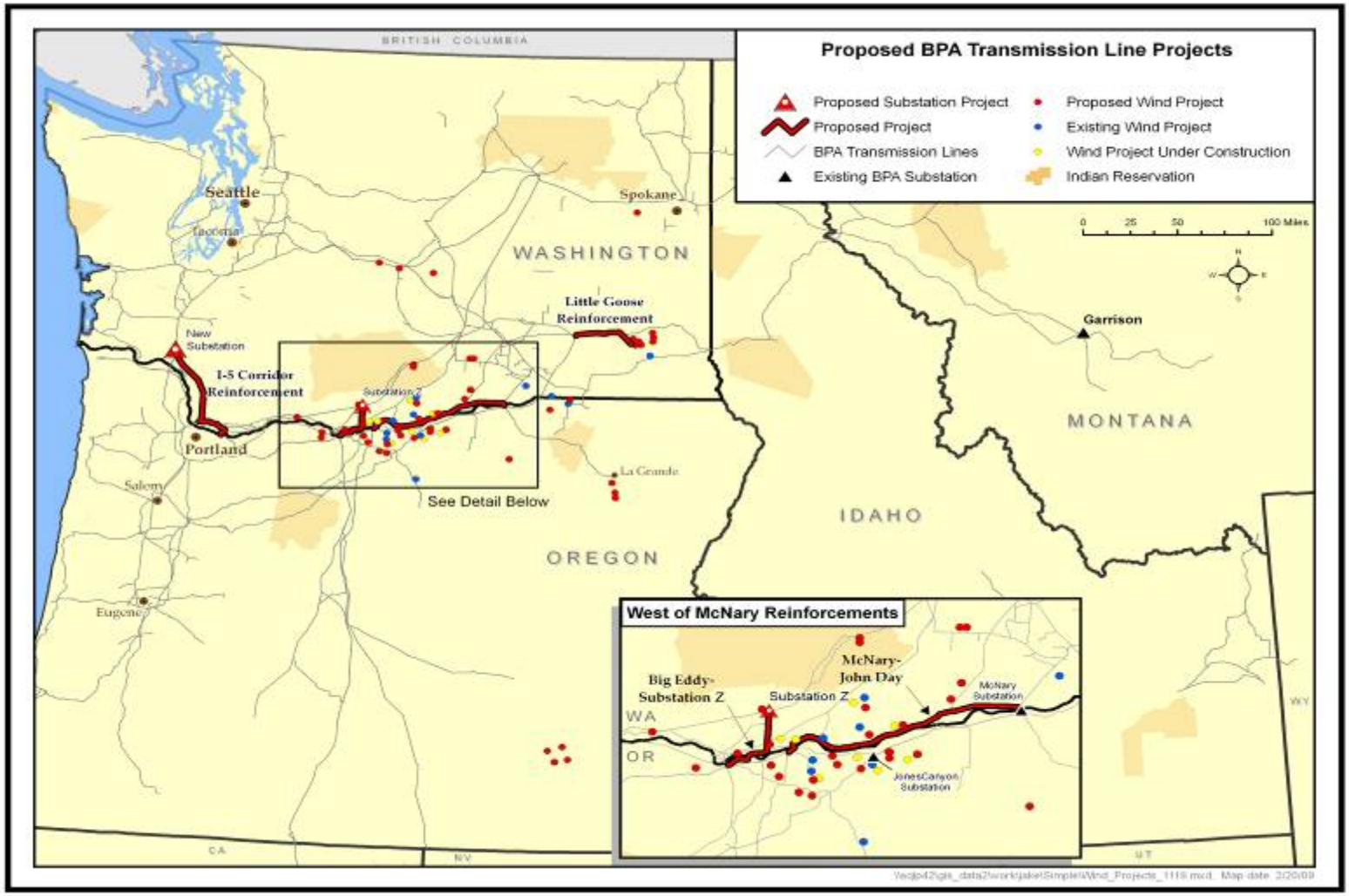
WIND GENERATION CAPACITY IN THE BPA BALANCING AUTHORITY AREA

Sequential Increases in Capacity, Based on Date When Actual Generation First Exceeded 50% of Nameplate

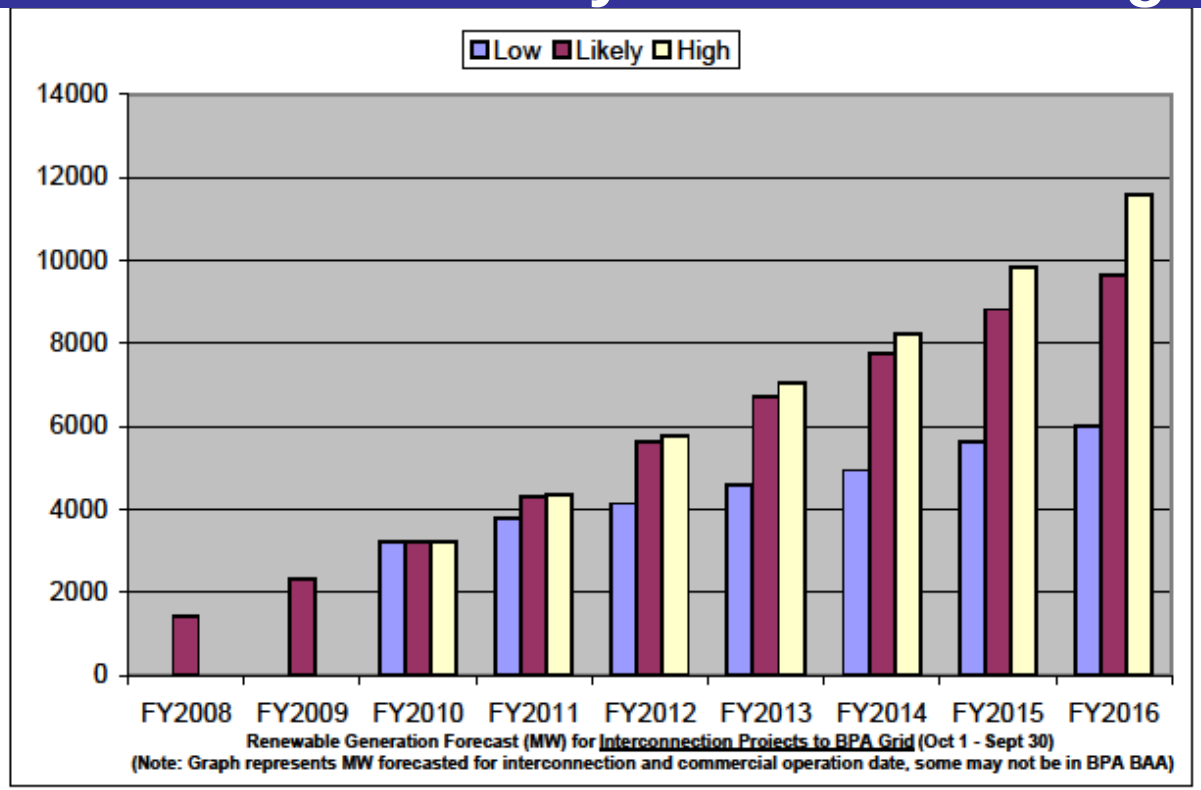
Plant	Nameplate Capacity MW	Date When Actual Gen First Exceeded 1/2 of Current Nameplate Capacity	Cumulative Nameplate Capacity MW
Vansycle	25	10/25/1998	25
Stateline	90	12/18/2001	115
Klondike I	24	1/16/2002	139
Condon	50	6/18/2002	189
Klondike II	76	6/28/2005	265
Hopkins Ridge	157	11/25/2005	422
Leaning Juniper	100	8/10/2006	522
Big Horn	200	10/4/2006	722
White Creek	200	10/5/2007	922
Klondike III	226	10/15/2007	1148
Biglow Canyon	126	11/17/2007	1274
Nine Canyon @ 28%	27	11/26/2007	1301
Goodnoe Hills	96	4/29/2008	1397
Nine Canyon @ 52%	24	5/10/2008	1421
Klondike 3a	75	6/6/2008	1496
Arlington	103	12/7/2008	1599
Willow Creek	72	1/1/2009	1671
Pebble Springs	100	1/27/2009	1771
Hay Canyon	100	2/12/2009	1871
Wheatfield	97	3/22/2009	1968
Tuolumne	137	5/1/2009	2105
Biglow Canyon Phase 2	149	8/6/2009	2254
Windy Flats Dooley (phase 1)	30	9/21/2009	2284
Windy Flats Dooley (phase 2)	233	11/30/2009	2517
Harvest	100	12/16/2009	2617
Combine Hills	63	1/1/2010	2680
Star Point	100	1/15/2010	2780
Linden Farm	50	6/6/2010	2830
Coastal Energy	6	6/30/2010	2836
Biglow Canyon Phase 2 (add'l)	14	8/11/2010	2850
Biglow Canyon Phase 3	161	8/11/2010	3011



Wind farms are clustered along the Columbia River near existing BPA transmission and new transmission projects



Wind Generation Capacity Connected to BPA's Transmission System is Growing



NOTES: S. Enyeart/C. Randall - As of: 5/20/2010

1. Projections beyond FY11 may be impacted or delayed due to a need for Transmission system expansion.
2. Projected totals based on previous experience and present growth factors including Production Tax Credits and RPS Demand.
3. Total Renewable Projects / GI Study Requests **23,511** Megawatts
4. Wind generation shown is interconnected to BPA-T; amount within BPA Balancing Authority Area is not estimated.
5. Graph FY assumption based on estimate of commercial operation of wind projects.

Much of the Wind Resource Serving Load Outside BPA Balancing Authority (BA)

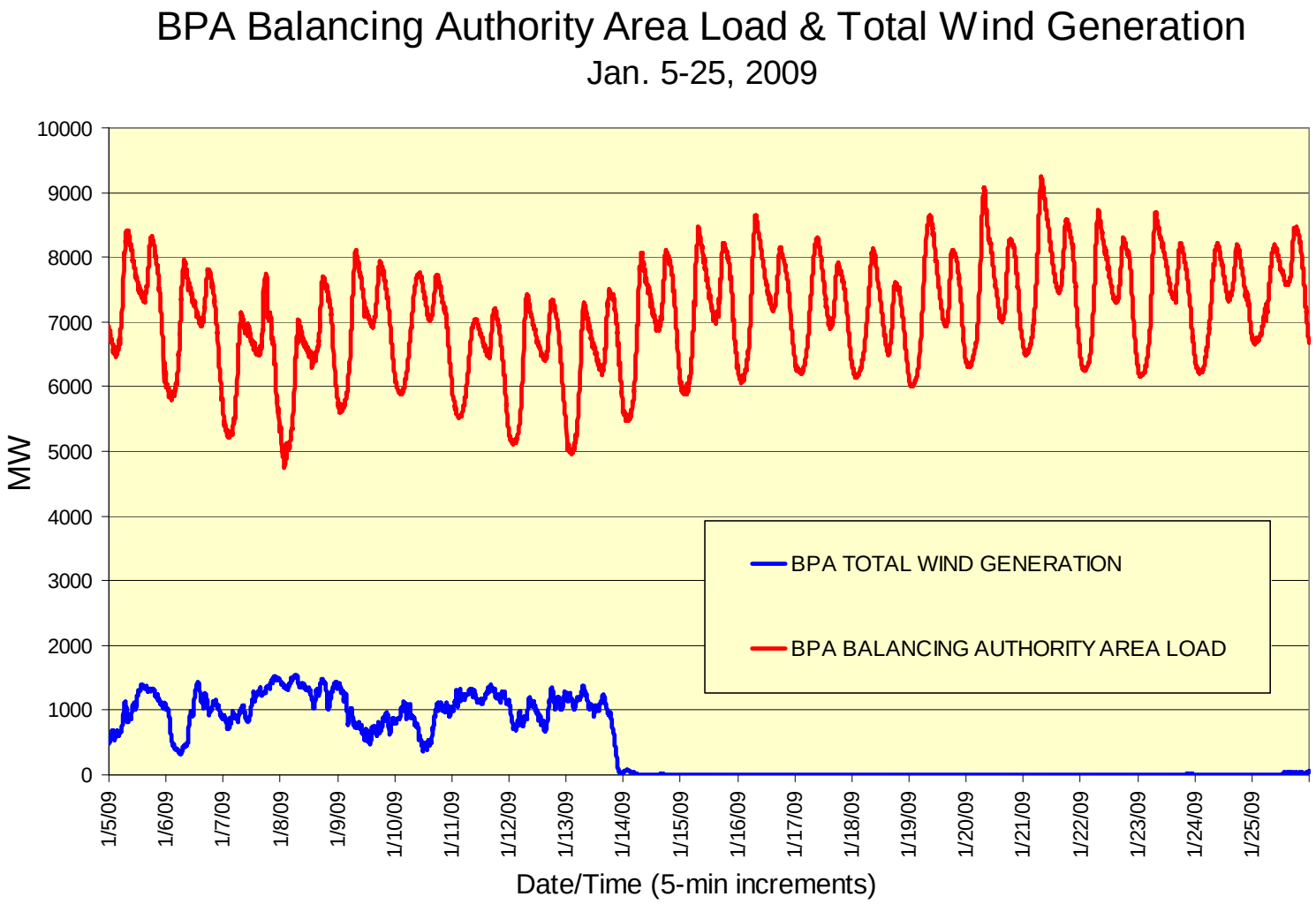
Year	Wind Generation Inside BPA Balancing Authority	Location of Load Being Served			
		BPA BA	Other NW BA	California (33% RPS)	Unknown Customer
2010	3,600	475	775	2,350	N/A
2012	5,950	800	2,075	3,075	N/A
2020 Scenario	9,800	1,200	1,700	2,100	4,800

Understanding wind energy

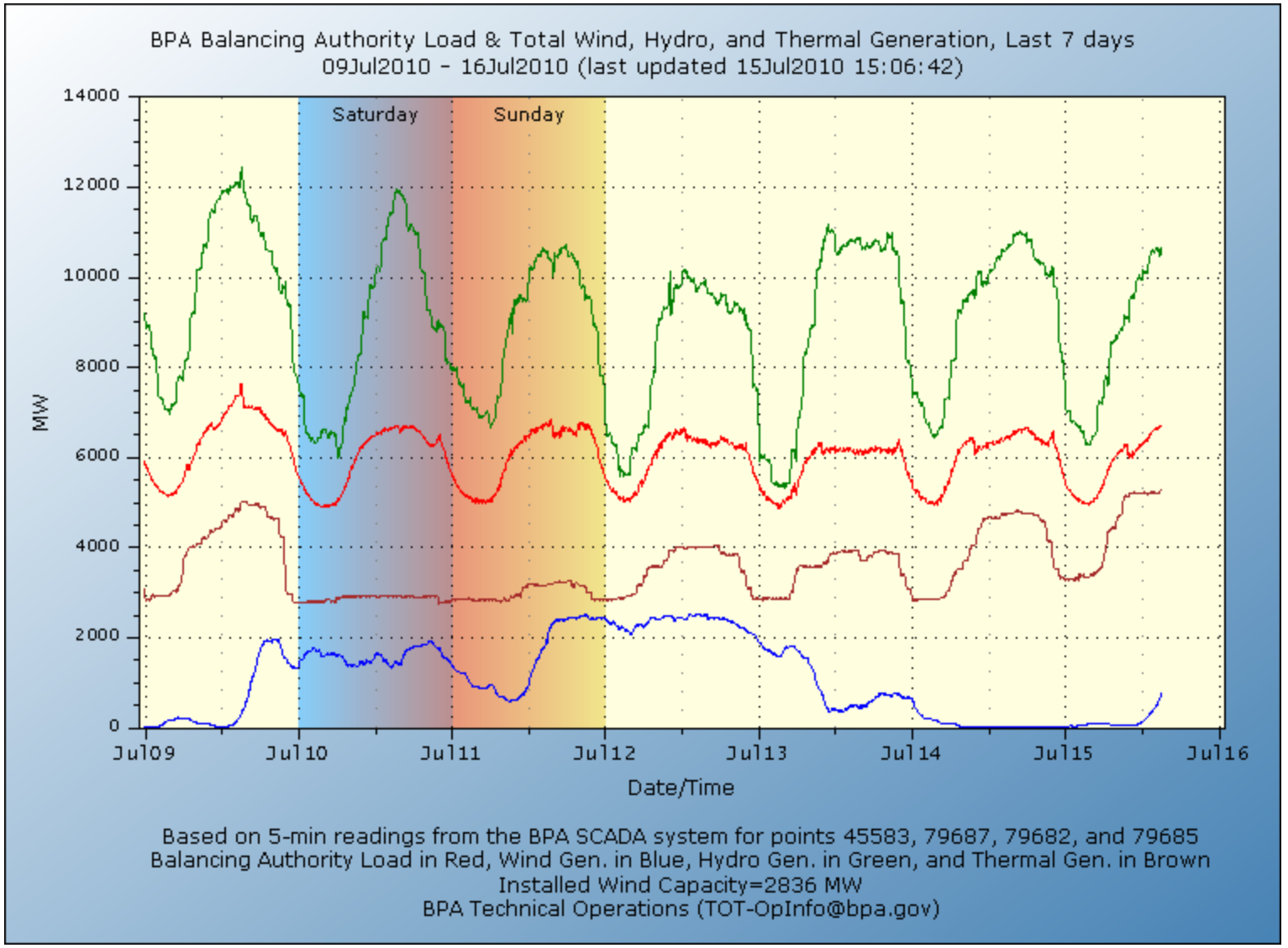
Wind is primarily an *energy*, rather than a *capacity* resource

- **High value, similar to hydro electricity's value. Both reduce carbon emissions and offer low, stable fuel price.**
- **Variability and supply uncertainty also similar to hydro, but differs in three ways:**
  - **Hydro can be stored, wind can not**
  - **Time scale of the variability**
    - **Hydro's variability is measured in years, months and weeks**
    - **Wind's variability is measure in days, hours and minutes**
  - **Level of variability**
    - **Hydro runoff has varied from 88.7 to 190.8 million acre-feet in a year**
    - **Wind can vary from zero to nameplate capacity in a few hours**
- **Wind power increases need for balancing reserves**
- **Wind power requires changing system operations and trying innovative approaches**

BPA Balancing Authority Area Load & Total Wind Generation



BPA Balancing Authority Total Wind Generation and Wind Basepoint



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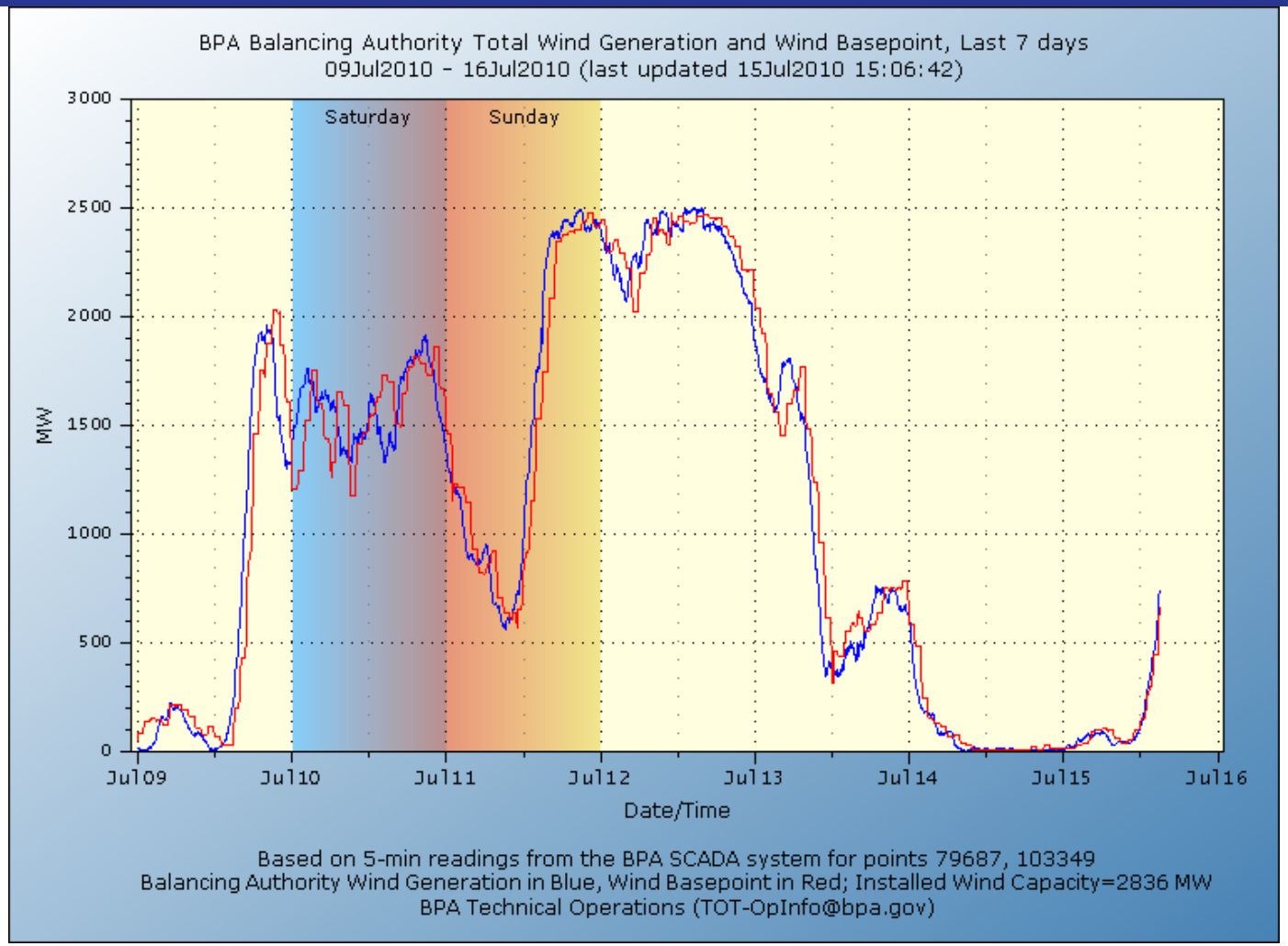
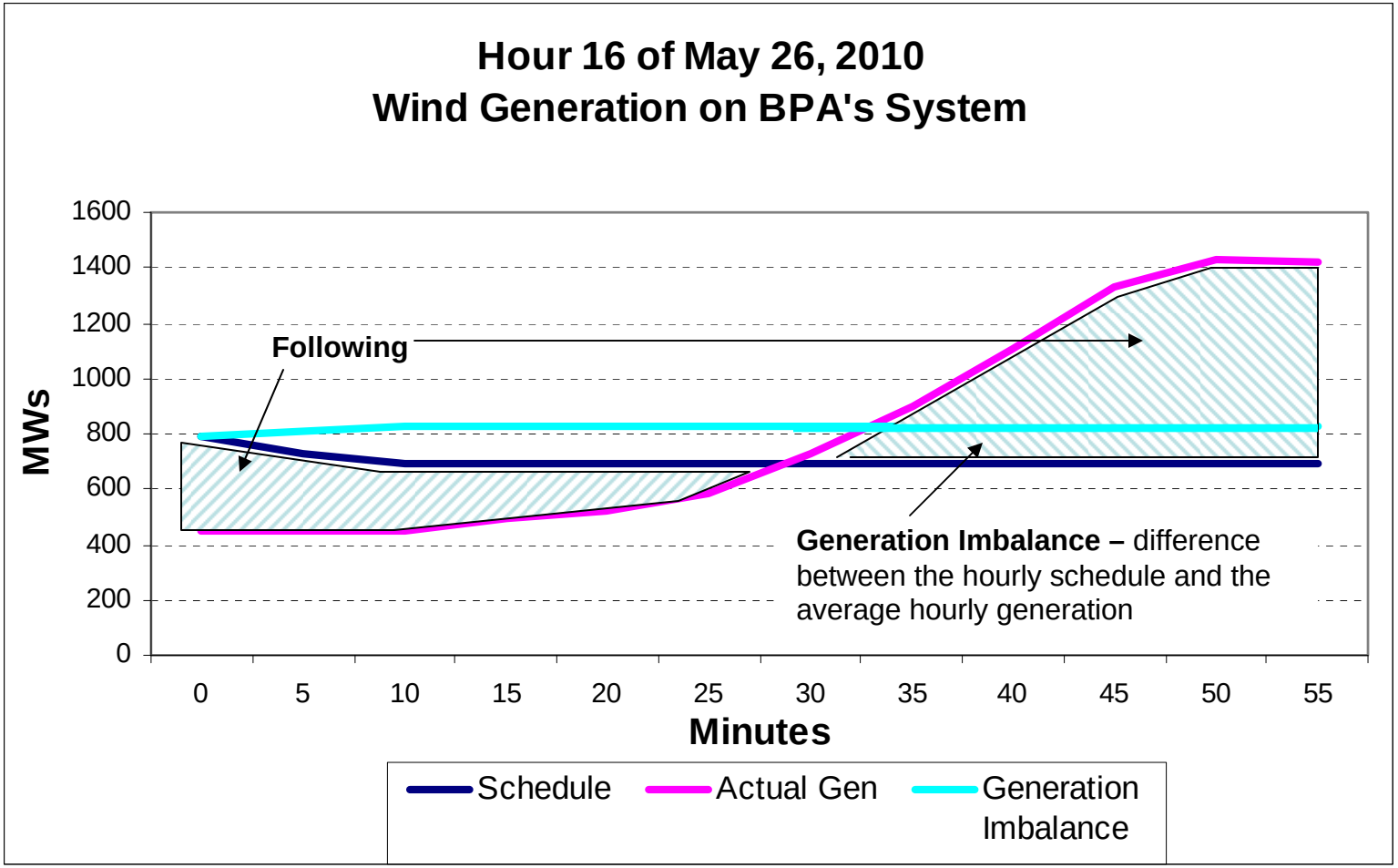


Based on 5-min. readings from the BPA SCADA system for points 79687, 103349

Balancing Authority Wind Generation in **Blue**, Wind Basepoint in **Red**; Installed Wind Capacity = 1592 MW

Within Hour balancing



FCRPS is a Large Storage Machine

- Demands on federal hydro power system:
  - Serve load
  - Meet ESA requirements
  - Meet non-power requirements
  - Support variable generation
- BPA uses FCRPS to supply Balancing Reserves required to integrate wind generation
- With traditional tools, FCRPS could have supported only 3,000 – 3,500 MW of wind

BPA Wind Integration Support Actions

- Transmission Network Open Season Offered
- Conditional Firm Service Offered
- Area Control Error (ACE) Diversity Interchange
- New transmission construction financed
- Automatic Generation Control improved
- Spring 2009: New Wind Integration Initiatives Announced
  - New Operating Protocols (DSO 216)
  - Intra-Hourly Scheduling
  - Dynamic Transfer Offering
  - Wind Generation Forecasting
  - Customer-Supplied Generation Imbalance

Thinking Long-Term

Wind is a valuable addition to the Pacific Northwest renewable generation mix and it will continue to grow rapidly.

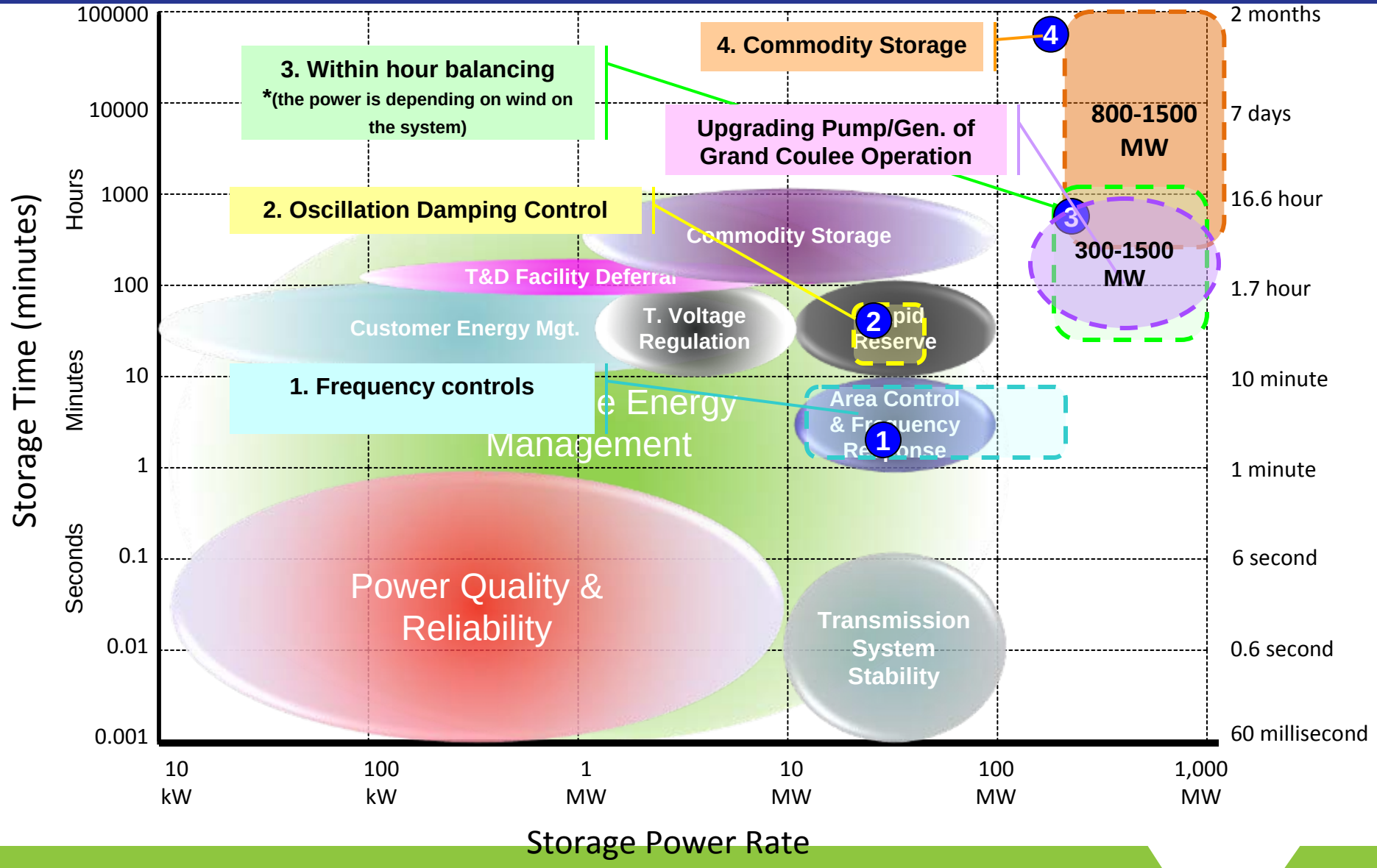
Successfully integrating renewable variable-generation resources will take coordination among utilities in the Northwest

1. **Expand on the existing initiatives involving wind forecasting and new operational protocols and business practices**
2. **Plan and Build Transmission**
3. **Implement New Technologies, including Storage**
4. **Explore New Market Designs**
5. **Explore Consolidation of Balancing Authorities**

Summary of Top Storage Application that BPA Needs

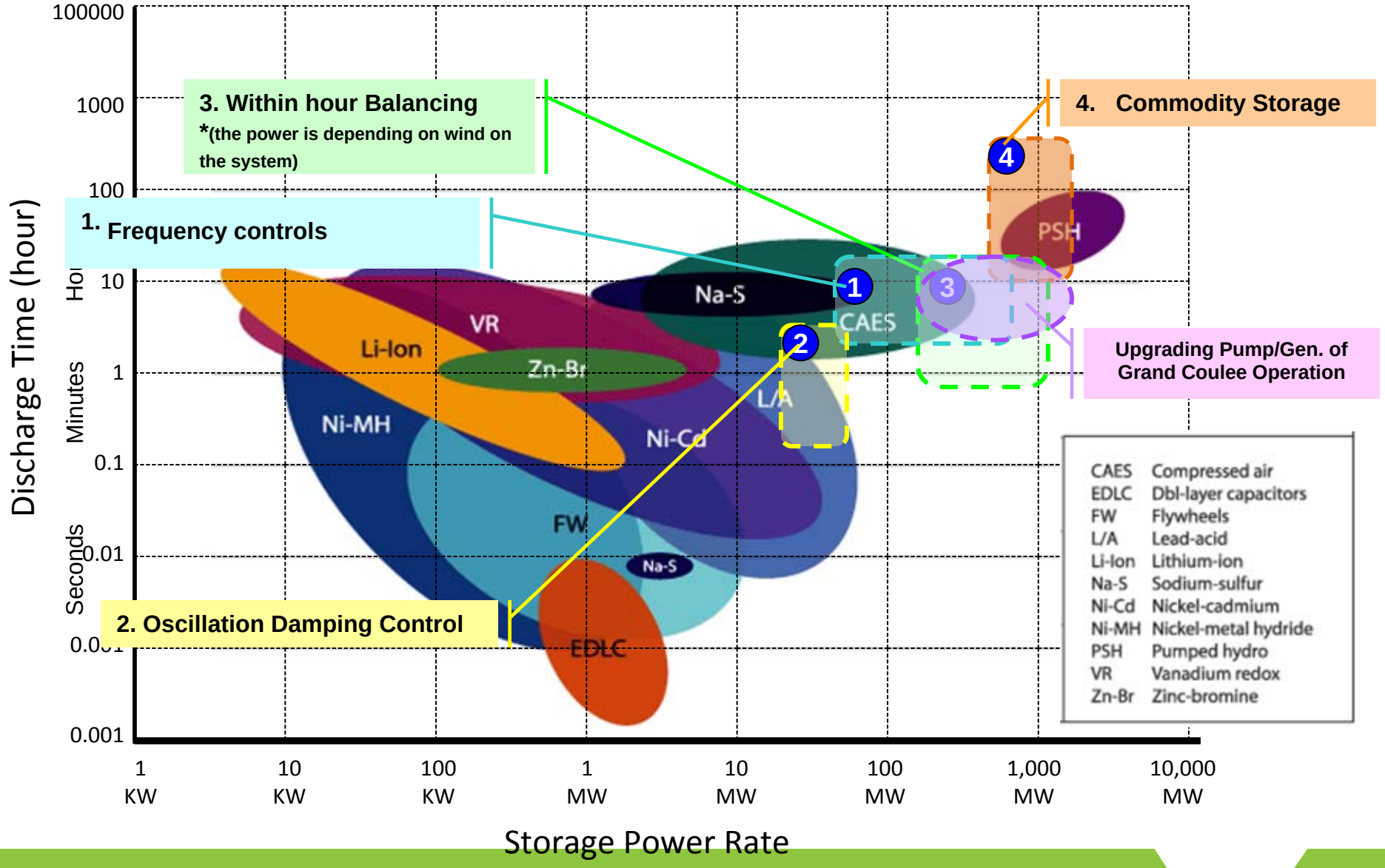
- Transmission Frequency Regulation Storage
  - Benefit: Replace overly conservative special protection schemes, and contribute toward the oscillation damping and area control.
  - Risk: Should be more competitive than hydro currently providing the resources.
- Contingency Service Storage
  - Benefit: Free up units supplying reserves, inter area oscillations damping, frequency and reactive support.
  - Risk: high cost, who pays.
- Intermittency Management Storage
  - Benefit: Within hr balancing, and wind integration rate.
  - Risk: Cost storage vs. generation, Ownership (BPA vs. wind plants).
- Commodity Storage
  - Benefit: Very reliable and proven resource maximizing value of energy, fill in behind the current variable generation (VG).
  - Risk: High capital cost (impact on rates), ownership & beneficiary.
- Other Non-Power Related Needs
  - Fishery and water management.

BPA Storage Needs Analysis



Source of the Generation Applications:
Electric Storage Association, http://www.electricitystorage.org/ESA/applications/

BPA Applications and Current Technologies



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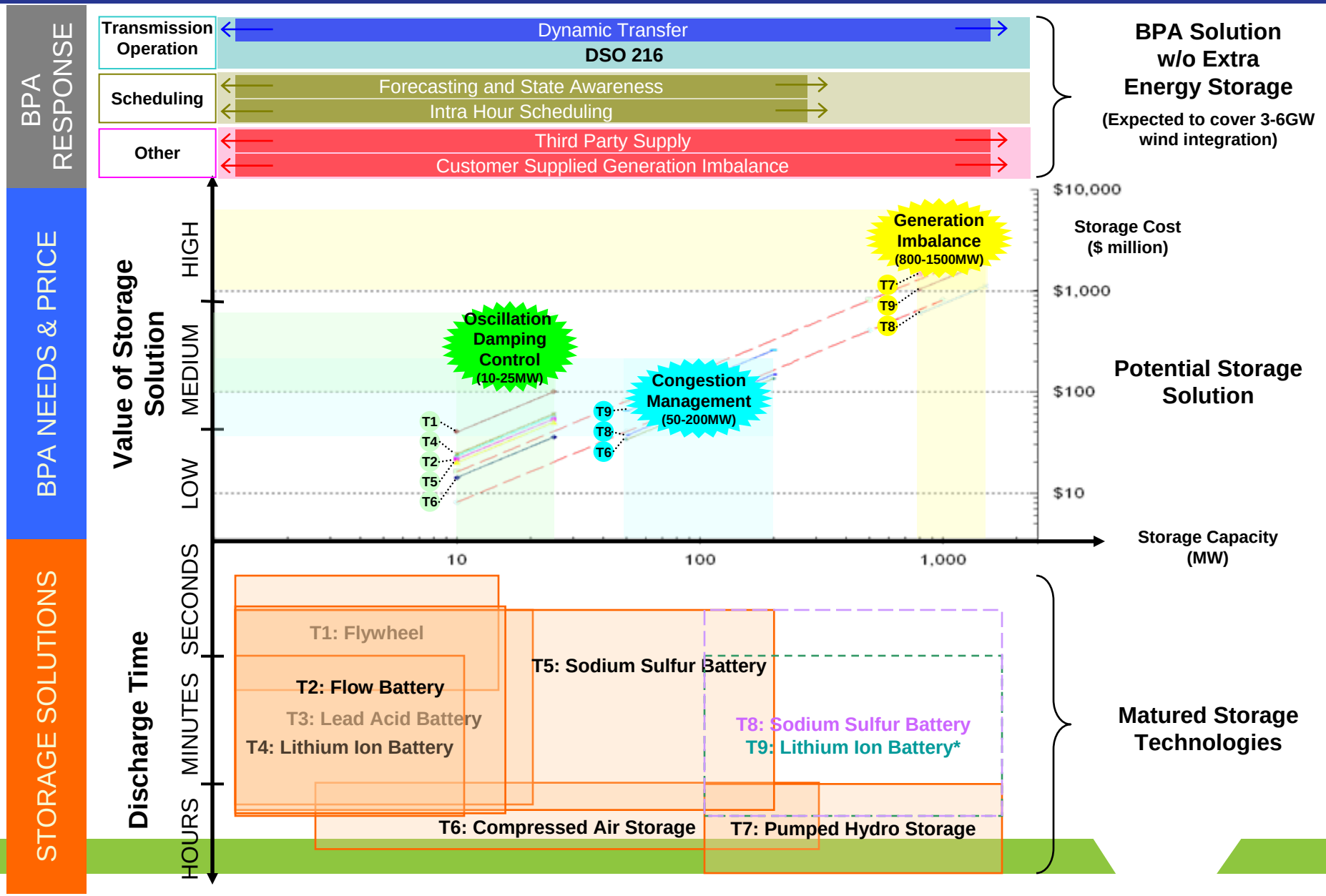
BPA Energy Storage Landscape



Example of 100 MWs Inc and Dec Balancing Reserves from Natural Gas Fired Generator

Illustrative purposes only

LLH Dec'ing

Pricing Methodology

Capacity Reservation Charge = $1.50/kw/Month * Billing Determinant

Above Market Dispatch costs = cost of production at full output vs. Hourly power prices

Variable Dispatch Charge = based on heat rate increase caused by dec

Pay BPA for energy used to meet load = based on HLH heat Rate

Assume that dec is use 25% of LLH on average

Capacity Reservation Charge	=	$ 2 million
Above Market Dispatch cost	=	$ 1 million
Variable Dispatch Charge	=	$ 2 million
Pay to BPA	=	$- 4 million
Total yearly cost		$ 1 million

HLH Inc'ing

Pricing Methodology

Capacity Reservation Charge = $20/kw/Month * Billing Determinant

Variable Dispatch Charge = 110% of daily gas index * unit heat rate

Assume that inc is use 25% of HLHs on average

Capacity Reservation Charge	=	$24 million
Variable Dispatch Charge	=	$ 3 million
Total yearly cost		$27 million

Total cost of 100 MWs of Inc and Dec Balancing Reserves from a Natural Gas fired generator

Total = $28 million per year