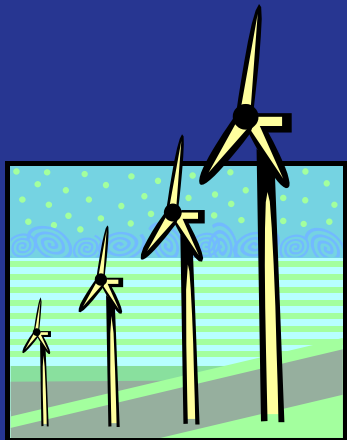


Integrating Renewable Resources into the Electric Grid

National Summit on RPS 2010
October 22, 2010



Sydney Berwager
Director, Strategy Integration
Bonneville Power Administration



BPA has substantial wind energy experience



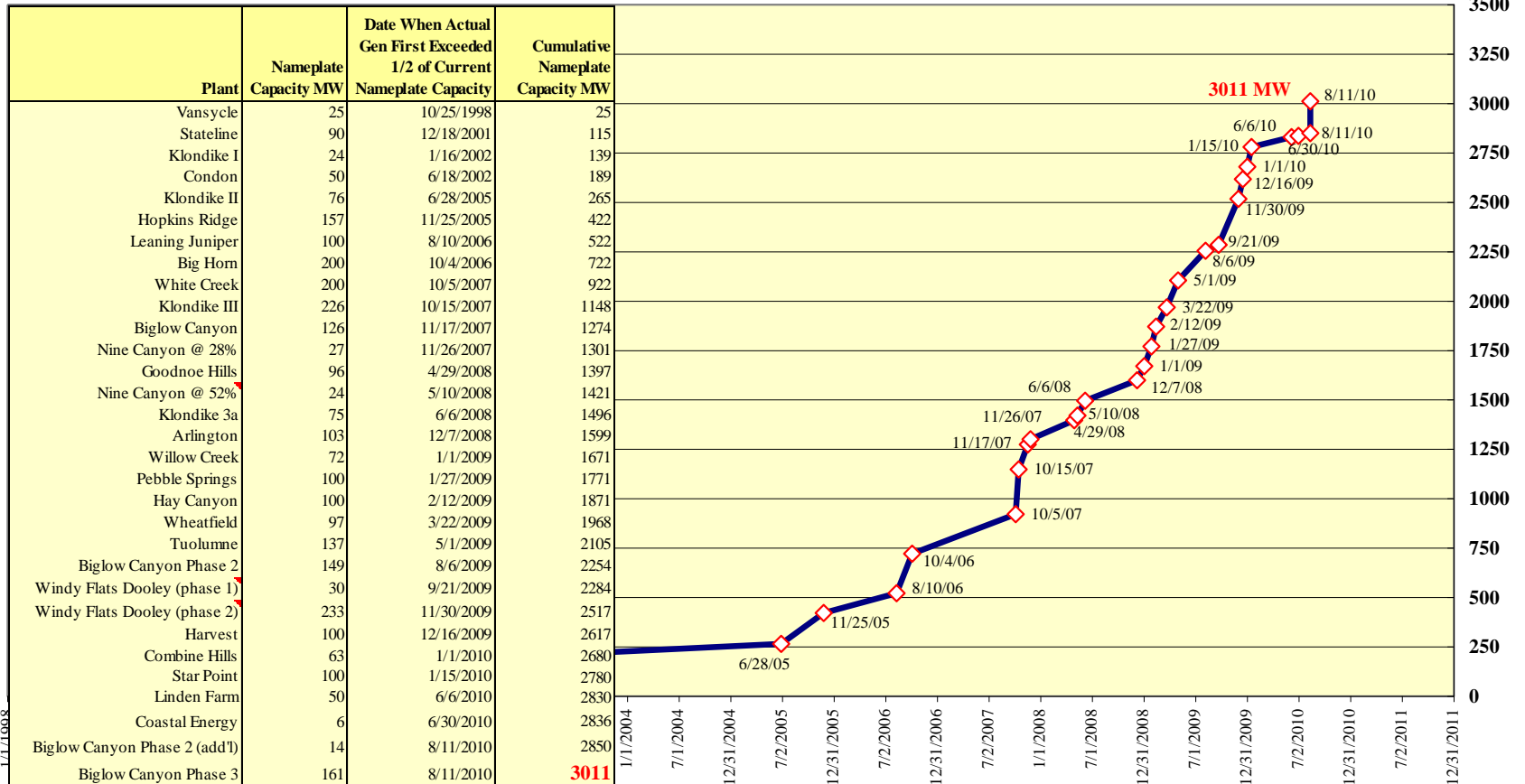
- Over 3,000 MW of wind in its 10,500 MW peak load balancing area
- 25 wind farms interconnected
- More than 1,800 wind turbines on line
- Five new substations for wind farms
- Six new taps for wind farms
- Approximately 85% of the wind serves load outside of the BPA balancing area
- In 2010, approximately 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

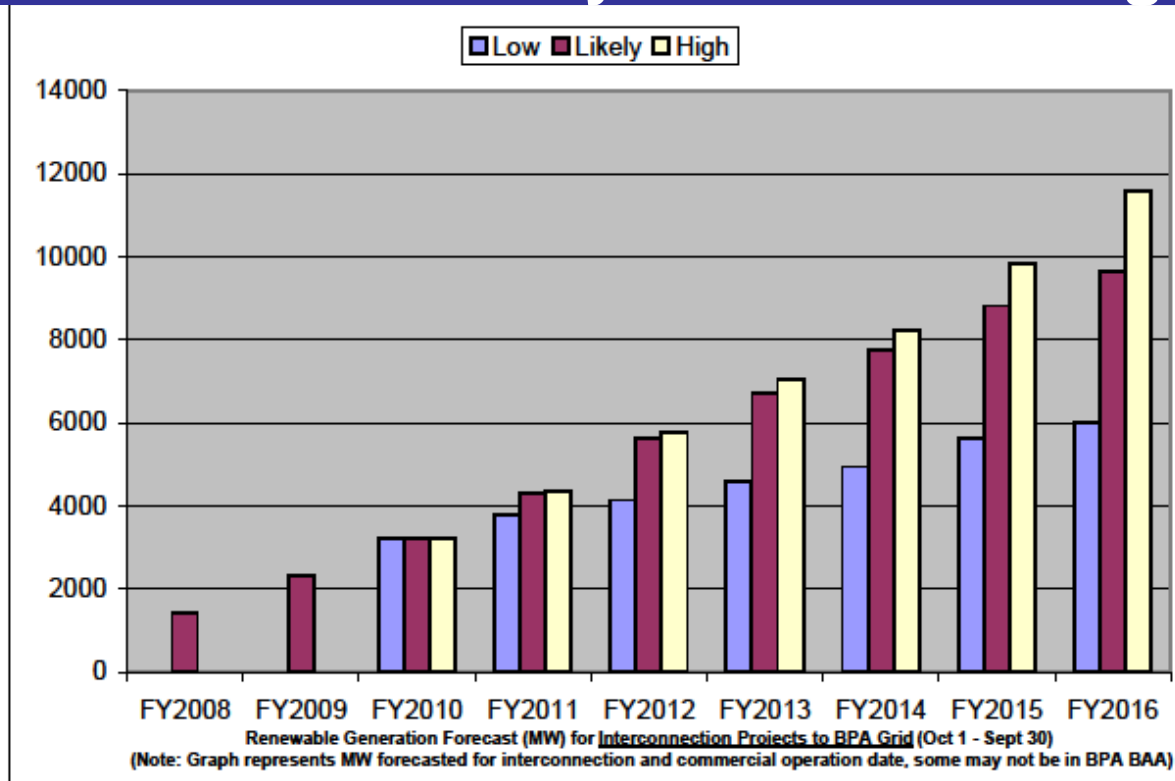
Sequential Increases in Capacity, Based on Date When Actual Generation First Exceeded 50% of Nameplate



1/1/2008



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



NOTES:

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

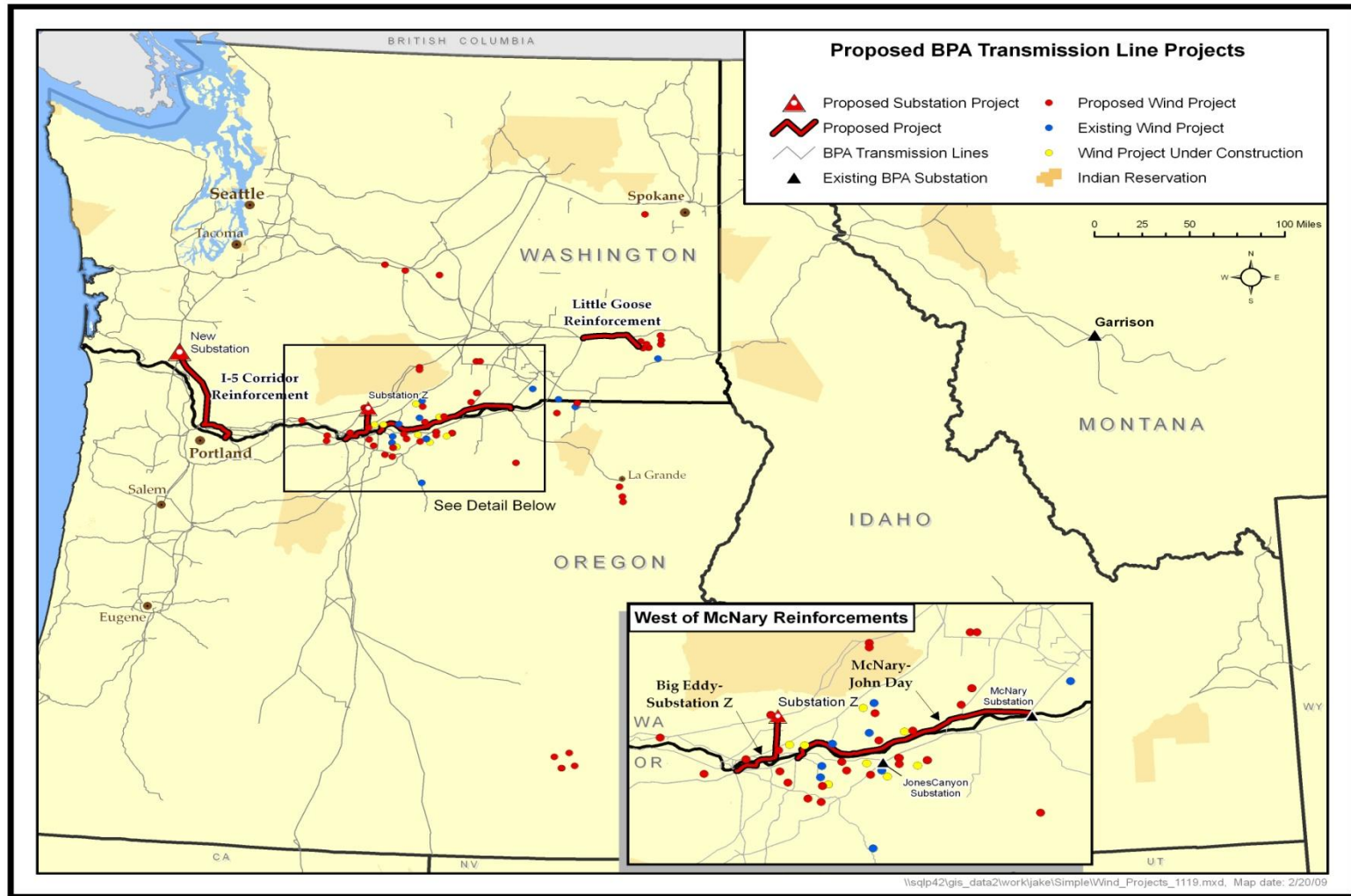
1. Projections beyond FY11 may be impacted or delayed due to a need for Transmission system expansion.
2. Projected totals based on previous experience and present growth factors including Production Tax Credits and RPS Demand.
3. Total Renewable Projects / GI Study Request: **23,511** Megawatts
4. Wind 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



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



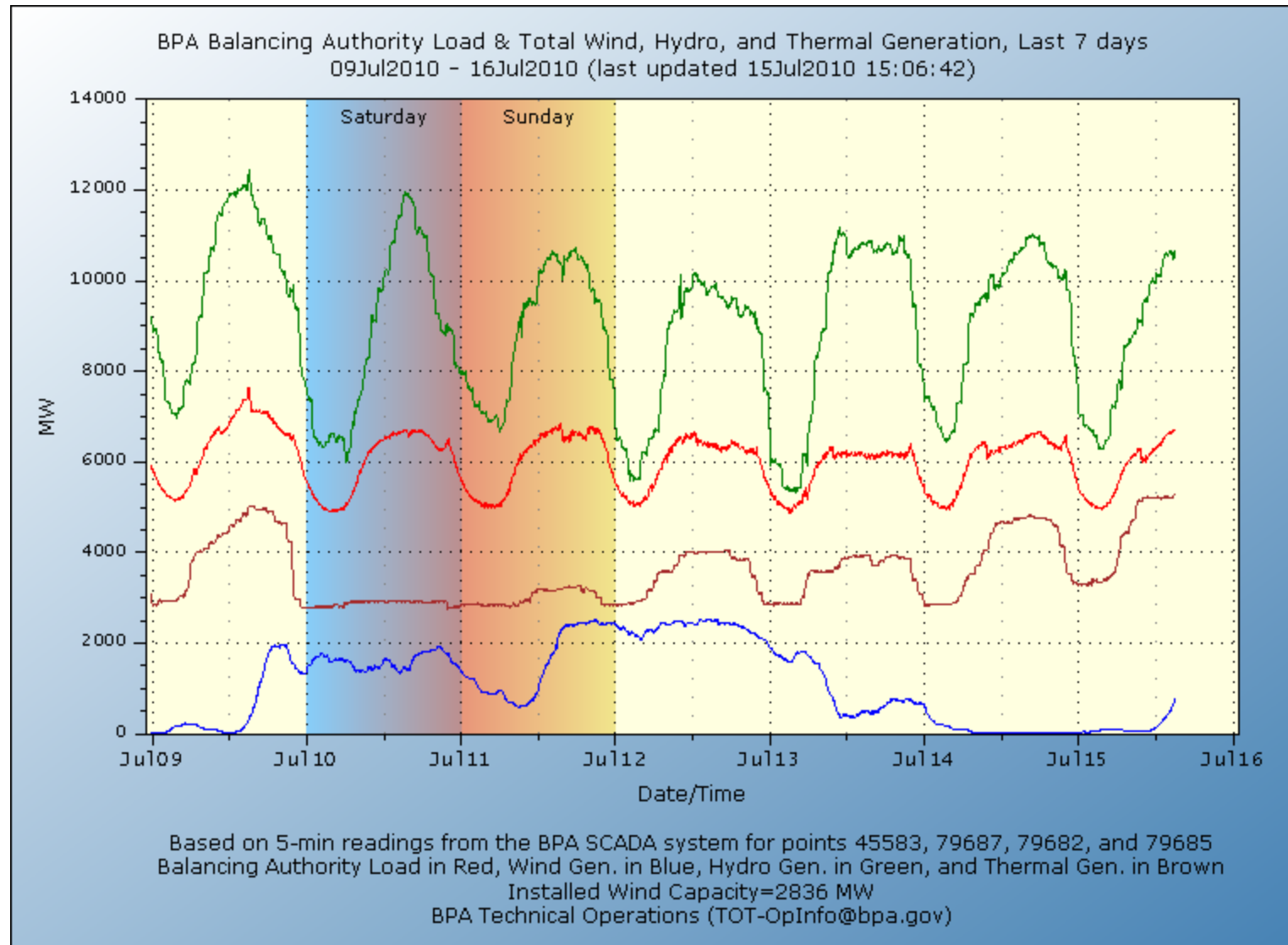
Understanding wind energy

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

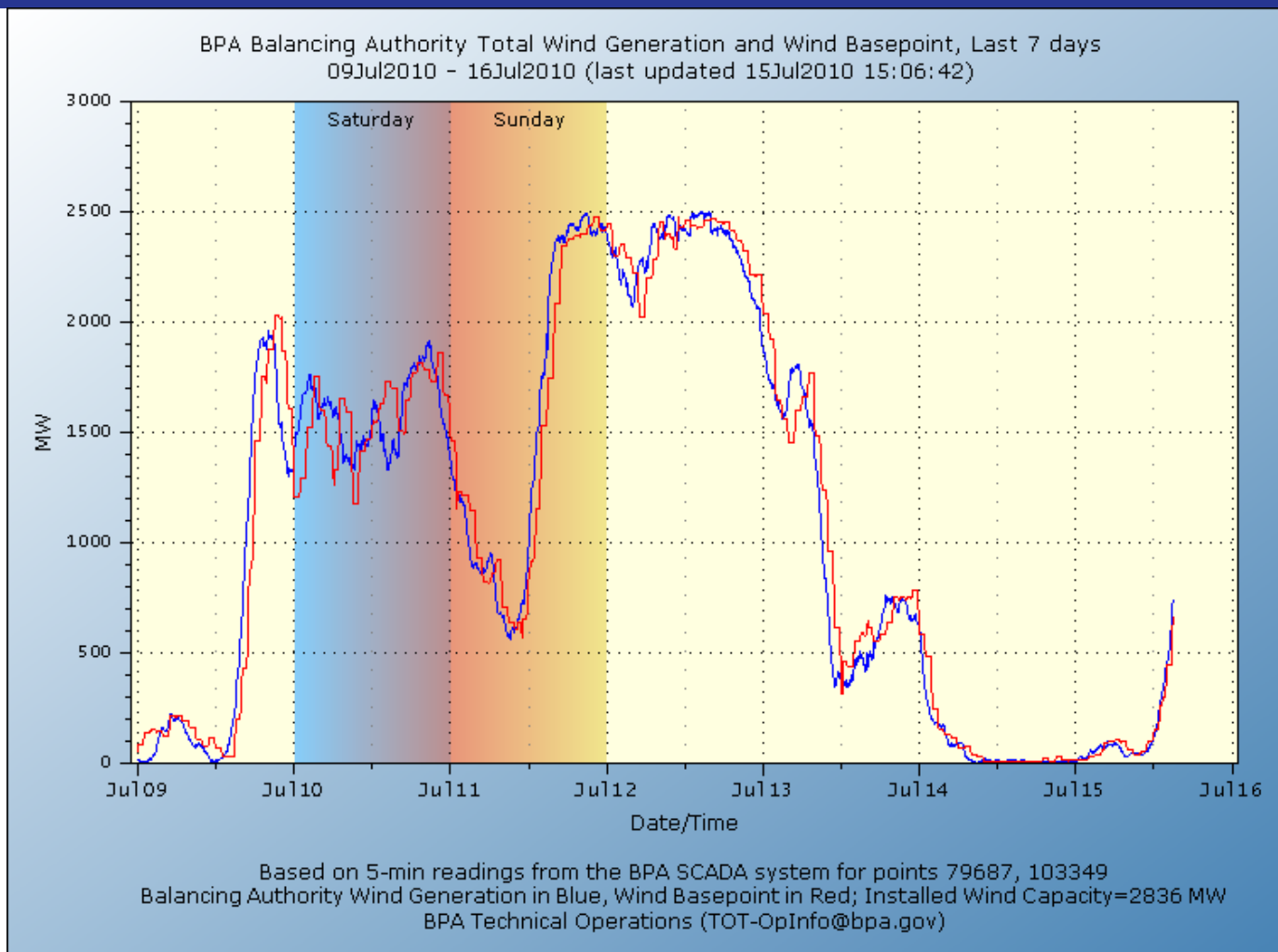
- **High value, similar to hydro electricity's value. Both reduce carbon emissions and offer low, stable fuel price.**
- **Variability and supply uncertainty also similar to hydro, but differs in three ways:**
 - **Hydro can be stored, wind can not**
 - **Time scale of the variability**
 - **Hydro's 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 Total Wind Generation and Wind Basepoint



BPA Balancing Authority Total Wind Generation and Wind Basepoint



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



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
- Supply is Limited, need New tools beyond this level



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



New Operating Protocols (DSO 216 Implementation)

- This project considers the performance of the wind projects, allocates the reserves, and determines the corrective actions for each individual wind plant.
- Actions include the use of automated tools and communication protocols to:
 - limit wind generation to the level of actual generation plus their allocated portion of DEC wind balancing reserves, or
 - curtail e-Tags to actual wind generation plus their allocated portion of INC balancing reserve.
- This project was implemented October 1, 2009.





BPAT Operational Analysis
DSO216 Report as of October 1, 2010

Limit (DEC) Events	October - December 2009 Q1 FY 2010		January - March 2010 Q2 FY 2010		April - June 2010 Q3 FY 2010		July - September 2010 Q4 FY 2010	
	Act	Est	Act	Est	Act	Est	Act	Est
Level 1	5	12.2	5	12.9	29	11.7	2	17.4
MW per L1 Event	380	277	198	264	262	204	52	173
L1 MW per Month	634	1126	330	1136	2536	794	34	1004
Average Number of Sources	11	n/a	8	n/a	11	n/a	5	n/a
Average MW by Source	36	n/a	26	n/a	22	n/a	11	n/a
Curtailment (INC) Events								
	Act	Est	Act	Est	Act	Est	Act	Est
Level 1	9	12.4	4	12.6	18	11.4	8	9.7
MW per L1 Event	267	277	402	235	237	311	185	288
L1 MW per Month	800	1146	536	986	1421	1181	493	932
Average Number of Sources	10	n/a	13	n/a	11	n/a	7	n/a
Average Number of PODs	10	n/a	10	n/a	10	n/a	5	n/a
Average MW by Source	27	n/a	35	n/a	22	n/a	25	n/a
Installed Capacity (as of the end of each month)								
	2680		2780		2829		3011	

Intra-hour scheduling

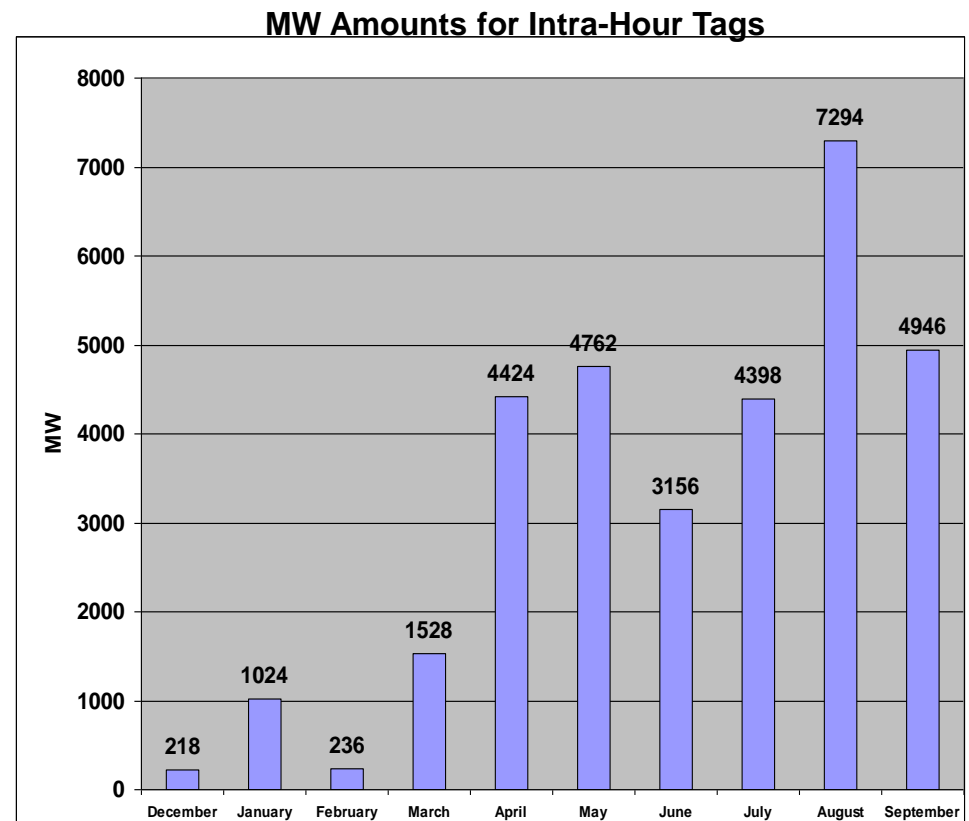
- The purpose of this pilot is to provide the ability for wind customers to submit schedules on a sub-hourly basis.
- Phase 1 Pilot was implemented December 1, 2009
- Pilot enables purchasing/selling entities to schedule excess wind generation from BPA Balancing Authority Area (on the half hour).
- The pilot was evaluated a success in March 2010 and has been extended indefinitely



Usage of Intra-hour Scheduling

Intra-hour Scheduling Phase I Results Through 9/30/10

	Tag Count	MW Count
December	7	218
January	27	1024
February	5	236
March	28	1528
April	55	4424
May	75	4762
June	52	3156
July	75	4398
August	98	7294
September	74	4946
Total	496	31986



Forecasting

- This project will improve BPA's ability to forecast wind power generation and will develop and deploy tools to help dispatchers and hydro duty schedulers better understand wind generation patterns and operational risks.
 - BPA has installed meteorological equipment on 14 BPA facilities. Data Feeds from Met Sites will be used for forecasts of wind generation.
 - BPA has developed in-house wind generation forecasting capability and has also contracted for vendor forecasts to benchmark against.



Customer Supplied Generation Imbalance

- This project will develop systems and processes to enable customers to self-supply their within hour balancing requirements from their own and/or contracted dispatchable resources for one or more wind plants.
- The Customer Supplied Generation Imbalance Pilot, with one participant, start September 1, 2010.
- Participant is supplying their own Generation Imbalance.
- BPA is continuing to supply load following and regulation.



Long-term solutions

- **Transmission Additions**
- **Continued Scheduling Improvements**
- **Explore virtual BA consolidation**
- **Storage**
 - **Pumped storage**
 - **Batteries**
 - **Compressed air**
 - **Flywheels**
 - **Plug-in Electric Vehicles**
 - **Demand-side storage**
- **Load management**



Conclusions

Wind is a valuable addition to the Pacific Northwest renewable generation mix.

Wind's contribution will continue to grow rapidly.

Integration of wind generation presents new challenges.

BPA has actively supported wind development and is pursuing further innovations.

Longer term solutions will involve advances in:

- **Wind-forecasting**
- **Utility operational protocols and business practices**
- **Technology**
- **Demand response**

