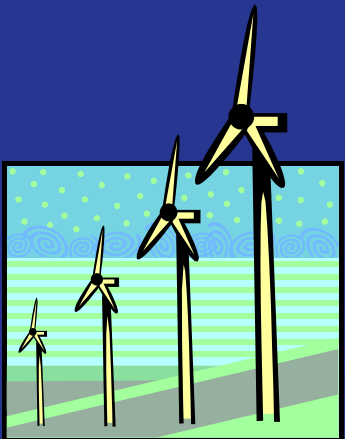


Integrating Renewable Resources into the Electric Grid

**BPA Transmission and Operational Planning
October 28 , 2010**

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Bonneville Power Administration



of PPM
Energy



About BPA

BPA established	1937
Service area size (square miles)	300,000
Pacific Northwest population	11,300,885
Transmission line (circuit miles)	15,397
BPA-owned substations	284
Employees (staff years)	3,000



Grand Coulee Dam

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's 300,000 square mile service area includes Oregon, Washington, Idaho, western Montana and small parts of Wyoming, Nevada, Utah, California and eastern Montana
- 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
- \$3.5 billion in annual revenues
- Headquarters in Portland, OR



	Columbia Basin
	BPA Service Area
	BPA Transmission Grid
	Federal Dams
	Corps of Engineers
	Dept. of Reclamation
	Non-Federal Dams
	Canadian Dams

Federal Columbia River Power System

- The US Army Corps of Engineers and the Bureau of Reclamation operate the federal dams for multiple public purposes
 - Flood Control, irrigation, power production, navigation, recreation, fish protection (Endangered Species Act, Clean Water Act)
 - Some purposes (such as system reliability, flood control and fish protection) take precedence over resource integration
 - Balancing all these purposes can be challenging when there is insufficient operational flexibility at the dams to manage uncertainty in water supply or demand for power
- BPA's Role
 - BPA is one of 18 Balancing Area Authorities operating in the Northwest Power Pool area
 - Markets the power produced from the federal dams within the constraints and requirements for other river purposes
 - Primary high-voltage transmission provider in the Columbia River Basin
 - BPA integrates new power sources into the transmission grid that request such service
 - Significant growth in wind power in the past few years that is far in advance of regional power demand

Federal Columbia River Transmission System

- BPA owns and operates 75% of the Pacific Northwest's high voltage electrical transmission system.
- The system enables a peak loading of about 30,000 megawatts and generates more than \$700 million a year in revenues from transmission services.
- BPA's Transmission Services operates under an Open Access Transmission Tariff based on FERC's pro forma tariff as a non-jurisdictional entity.
- BPA has 245 "currently active" transmission customers.

ColumbiaGrid Planning and Expansion Functional Agreement (PEFA)

- As a PEFA Participant, BPA works with ColumbiaGrid on sub-regional and WECC-wide transmission planning related issues
- ColumbiaGrid PEFA Process Overview
 - Produces annual independent system assessment
 - Coordinates planning work and, when needed, resolve issue
 - Recommends cost allocation if parties cannot agree
 - Develops a biennial transmission expansion plan
 - Uses independent ColumbiaGrid Board to approve plan and resolve disputes
 - Includes mechanisms to assure implementation of reliability-related projects
- ColumbiaGrid planning answers these questions for reliability-related projects:
 - What should be built?
 - Who should build it?
 - Who should pay for it?

Open Season

- BPA has successfully conducted Network Open Season (NOS) in 2008, 2009 and 2010 is underway
 - NOS enables BPA to cluster transmission requests and study the aggregate impacts of those requests, facility requirements, and estimated costs of facilities necessary to accept service
 - Customers that decline the precedent service agreement have their application for service withdrawn from the transmission request queue, but may resubmit at any time
- BPA is scoping Intertie Open Season (IOS) in consultation with PAC, PGE, CAISO, PG&E, TANC, SMUD, WAPA, LADWP, SCE, PPC, and NRU
 - The objective of the initial February 2010 scoping report was to provide an assessment of interest in proceeding with efforts to increase Southern Intertie transfer capacity between the Northwest and California. The report also identifies several areas that should be further developed to establish a framework for an Intertie Open Season.
- ColumbiaGrid is facilitating an Open Season Scoping Process through which regional transmission providers, transmission customers and interested persons are examining alternative transmission service business practices.
 - Primary goal is to address in a comprehensive manner a service request that might span more than one transmission owner's system. Other goals are to investigate cost allocation issues and to coordinate the construction of needed new transmission across multiple systems.
 - Should the process be implemented, ColumbiaGrid process and BPA IOS is intended to work together.

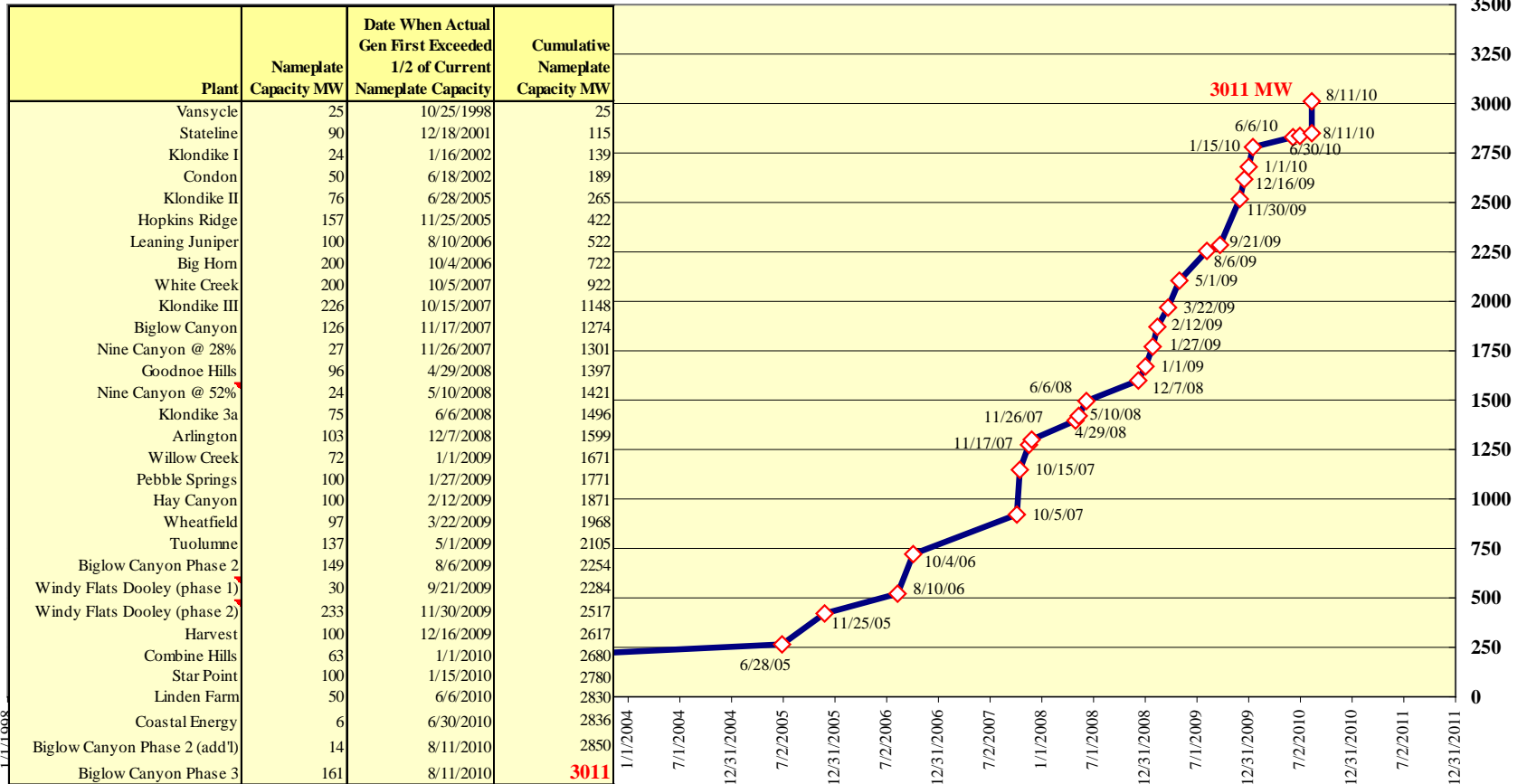
Changing Paradigm

- Strong movement from conventional to variable energy resources
- In today's environment, planning is a combination of art and science
 - Balance reliability, economic, environmental, renewable integration, & the other public purpose objectives to optimize transmission and resources to meet the needs of the region
 - How can transmission & resources be optimized to best meet the needs?
- Increased coordination and collaboration required among various sub-regional organization (i.e., ColumbiaGrid, NTTG, WestConnect, CAISO) and WECC TEPPC efforts.

Wind power is growing fast

WIND GENERATION CAPACITY IN THE BPA BALANCING AUTHORITY AREA

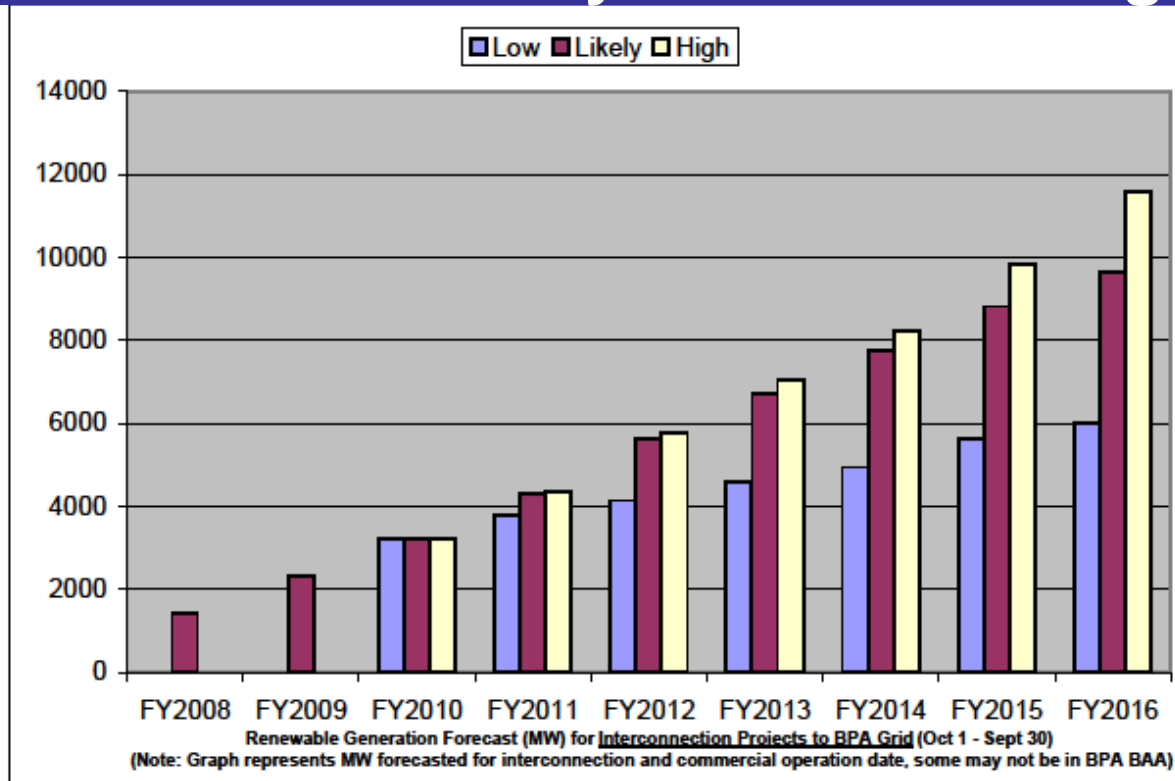
Sequential Increases in Capacity, Based on Date When Actual Generation First Exceeded 50% of Nameplate



1-1-1008



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



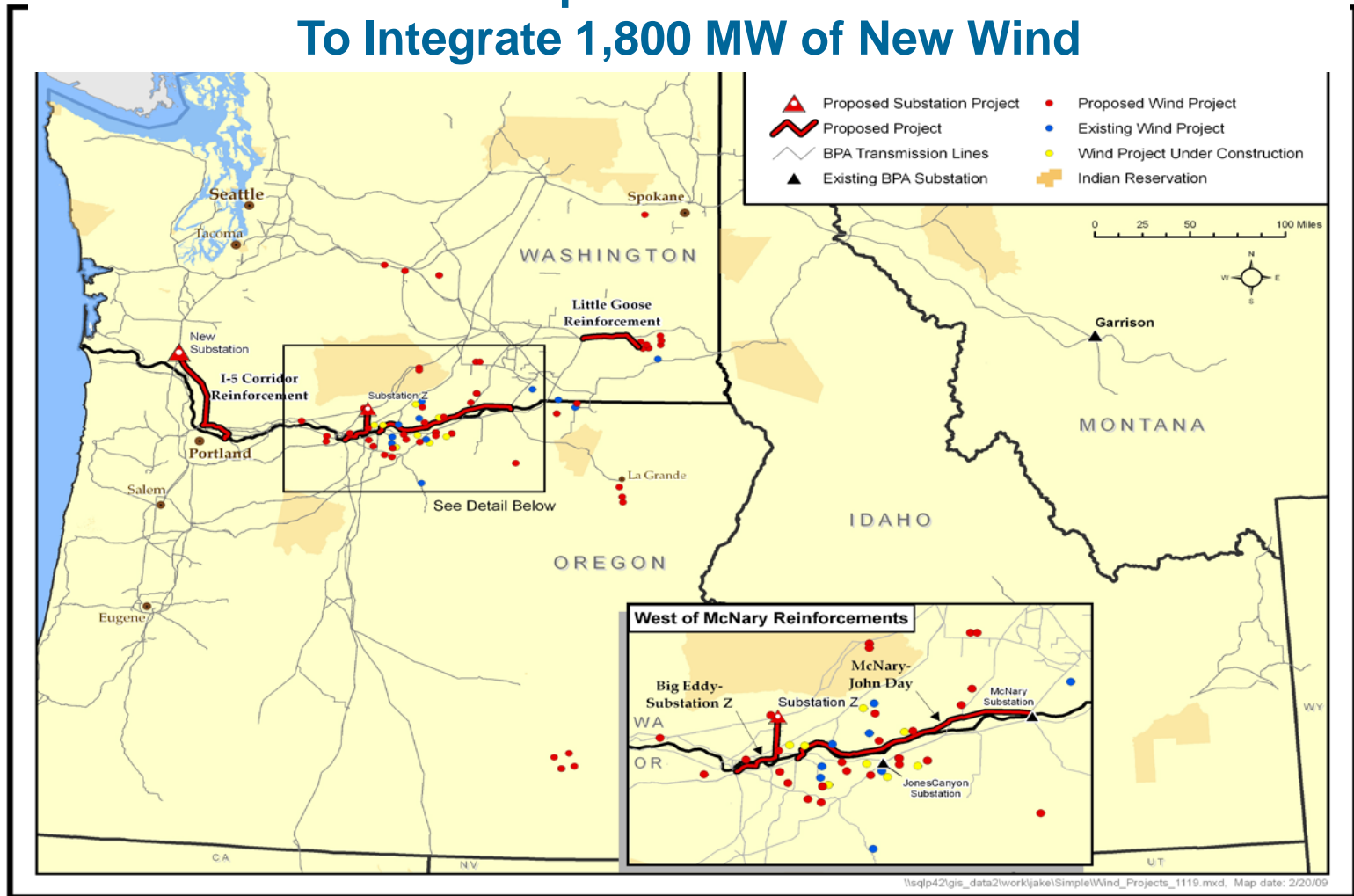
NOTES:

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.

I. PLAN & BUILD TRANSMISSION

Three New Proposed Transmission Lines To Integrate 1,800 MW of New Wind

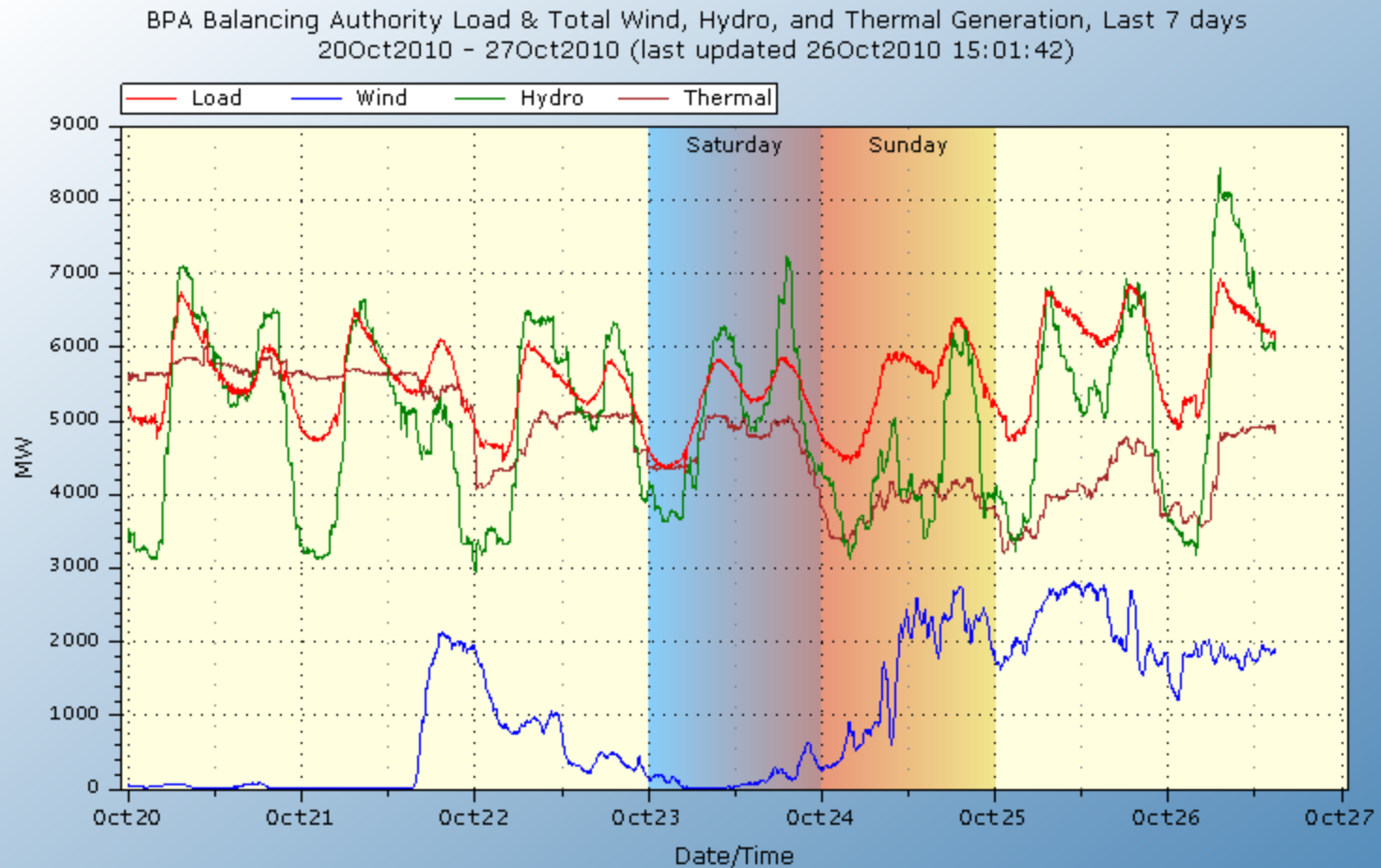


Much of the Wind Resource Serving Load Outside BPA Balancing Authority (BA)

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 Generation Experiences Significant Ramps

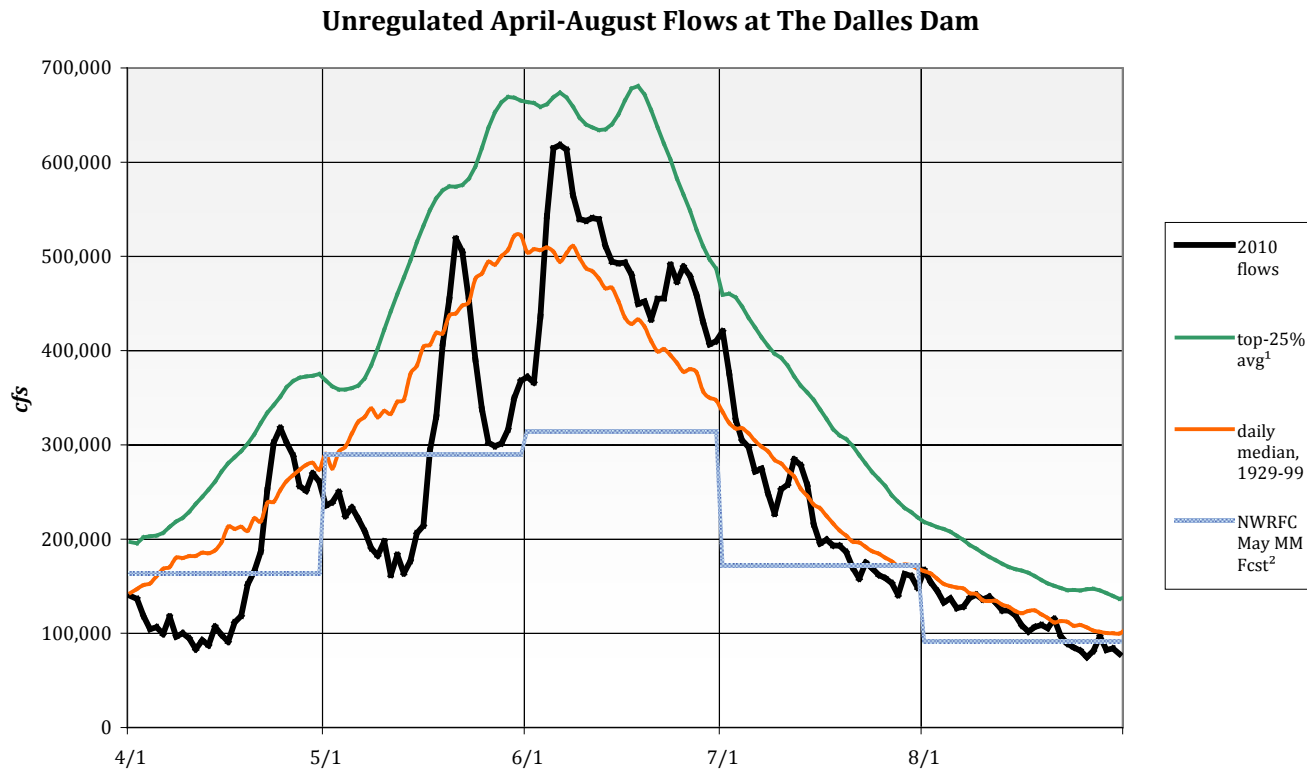


Based on 5-min readings from the BPA SCADA system for points 45583, 79687, 79682, and 79685
Balancing Authority Load in Red, Wind Gen. in Blue, Hydro Gen. in Green, and Thermal Gen. in Brown
Installed Wind Capacity=3011 MW
BPA Technical Operations (TOT-OpInfo@bpa.gov)



Background

- The timing of the runoff is a huge factor in FCRPS operations



¹ Average daily flows of the 18 highest April-August volume years (top 25%), 1929-99.

² May Mid-Month forecast for April-August volume from the NW River Forecast Center; plotting April observed and distributing remainder of forecast equally by month based on percent of average flows.

II. MAINTAIN RELIABILITY

New Operating Protocols to Ensure Reliability



- Established new reliability protocols (DSO216)
- Establish amount of reserves we will hold, then require wind generators to:
 - adjust their schedules down to actual output if they substantially **under-generate** relative to schedule
 - reduce output if they substantially **over-generate** relative to their schedule



II. MAINTAIN RELIABILITY

Situational Awareness

- Installed 14 wind measurement sites
- Developed a wind forecasting system
- Adding a BPA “Wind Desk” to support dispatchers in the efficient use of wind, hydro and other generation



Accurate Forecasts and Situational Awareness are Key



II. MAINTAIN RELIABILITY

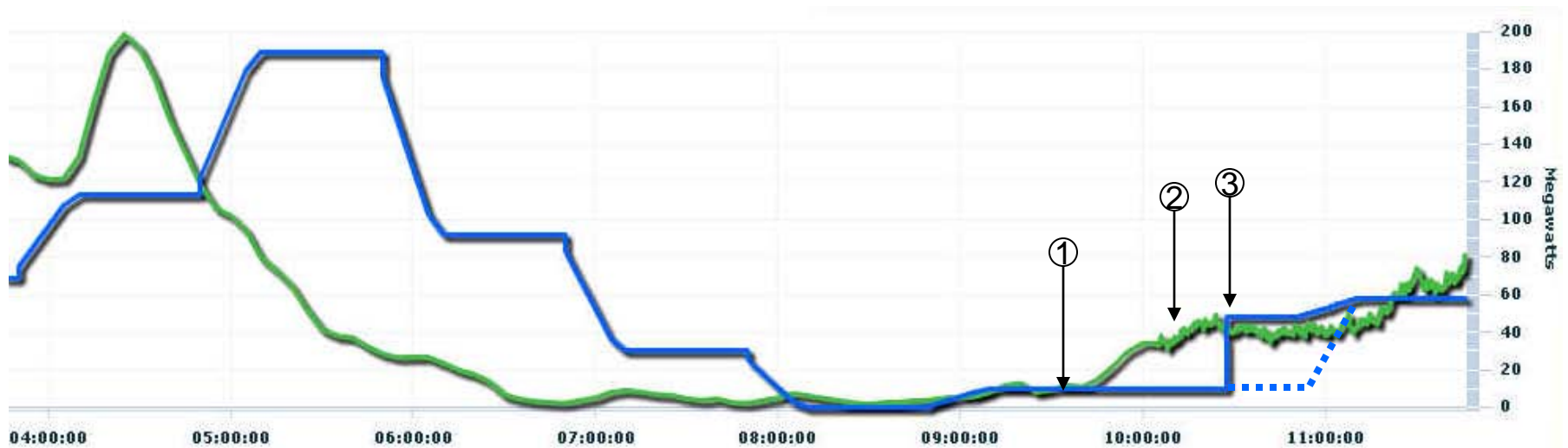
Intra-hour Scheduling



- Historic transmission scheduling protocols was for hourly schedules
- Created **intra-hourly** transmission scheduling protocols to allow power schedule changes to better match within-hour variations in wind generation



Inaccuracy in Wind Generation Forecasts Increase the Need for Other Generation Resources to Maintain Reliability



Legend

Total Schedule without Intra-Hour
Total Schedule With Intra-Hour ———
Total Generation ———

1. Hour Ending 11 scheduling window closes
2. Hour Ending 11 intra-hour scheduling window closes
3. Hour Ending 11 intra-hour schedule

II. MAINTAIN RELIABILITY

Customer Supplied Generation Imbalance

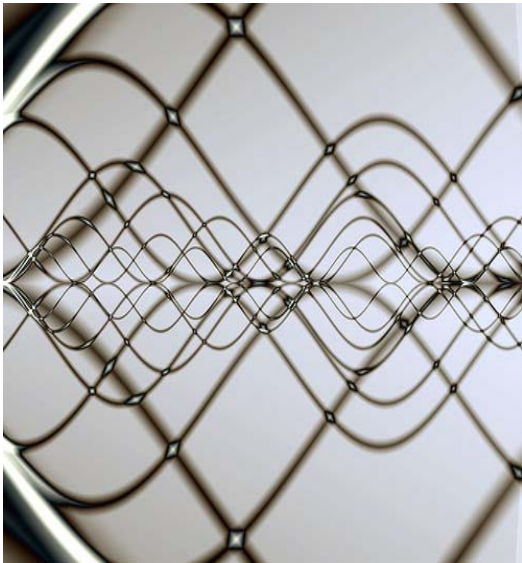
- Enable customers to self-supply their within hour balancing requirements from their own and/or contracted dispatchable resources for one or more wind plants.
- Participants supply their own Generation Imbalance.
- BPA continues to supply load following and regulation.



II. MAINTAIN RELIABILITY

Become More Dynamic

- Study and Increase **Dynamic Transfer Capability**
 - Allows wind generators physically located on BPA's system to be remotely balanced by other utilities using electronic signals



Near and Long-term Solutions

- **Transmission Additions**
- **Continued Scheduling, Operating, and Forecasting Improvements**
- **Development of Within-hour Energy Markets**
- **Improved Cross-Balancing Area Coordination**
- **Storage**
 - **Pumped Storage, Batteries, Compressed Air, Flywheels**
 - **Plug-in Electric Vehicles and Demand-side storage**
- **Load management**

