How BPA supports Northwest wind power

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BPA has one of the highest concentrations of wind power on its system of any U.S. balancing authority (about 30 percent). BPA technical, policy and financial innovations to spur wind power are a significant reason why. This paper reviews what BPA has done and is doing to support the Northwest wind power industry.

BPA now has more than 3,500 megawatts of wind generation connected to its transmission system. An additional 3,700 megawatts of wind generation now have firm rights that could connect to our system over the next three to four years. Four years ago, a regional task force on wind integration believed that connecting 3,000 megawatts of wind to the BPA system could be achieved over a 20-year planning horizon.

BPA has built new transmission for wind integration and system reliability has moved ahead at an aggressive pace. Projects requiring an average build time of 10-12 years nationally have been completed by BPA in 4 to 5 years.

I. Expanding grid capacity

Network Open Season: In 2008, BPA launched a new approach to managing its queue of transmission requests. Under our Network Open Season approach, BPA has signed up 11,722 megawatts of additional transmission service, including 7,105 megawatts from wind power projects, in 263 Precedent Transmission Service Agreements with 57 customers.

The first Network Open Season resulted in BPA moving forward with four new 500-kilovolt transmission projects. Together they would add more than 225 miles of high-voltage transmission capacity, improve reliability and add 3,700 megawatts of transfer capability, including 2,800 megawatts contracted to additional wind power. These projects are:

- McNary-John Day (79 miles), now under construction.
- Central-Ferry Lower Monumental (48 miles), construction begins this summer.
- Big Eddy-Knight (28 miles), under environmental review.
- I-5 Corridor Reinforcement (70 miles), under environmental review.

Project Integration: We're also expanding the grid for wind power from the bottom up. So far, BPA has built eight new substations, expanded three others and constructed six new tap lines to physically integrate the 37 wind projects, with total generation capacity of 3,522 megawatts, connected to its grid. More integration projects are in the planning or construction phase.

Intertie Expansion: Expanding transmission between the Northwest and other regions could increase markets for Northwest wind power and increase opportunities to manage variable resource output cost-effectively. BPA is now working with others to explore an Intertie Open Season, similar to its Network

Open Season to determine if there is sufficient interest. This effort would take five to 10 years to complete and would likely cost billions of dollars. BPA is also discussing expansion of its direct-current intertie to Los Angeles with other utilities.

II. Finding more space within the grid

BPA also has found ways to increase transfer capacity available to the wind fleet by almost 3,000 megawatts in the past few years, before completion of new transmission construction.

The first result of BPA's Network Open Season was to identify 1,780 megawatts of existing transmission capacity that could be offered and was sold to purchasers on a firm basis without new construction.

In 2006, BPA conceived a new form of transmission service to increase capacity available to wind and other new generation while waiting for transmission construction to be completed. In March 2009, BPA offered 1,200 megawatts of this new Conditional Firm service.

III. Creating new tools to manage new resources: The Wind Integration Team

In 2009, BPA worked with its customers and the wind community to identify and prioritize the key technical tools needed for continued growth of the wind power resource. It created a BPA Wind Integration Team. So far, this team has:

Created an operational fail-safe: In 2009, the team developed a fail-safe tool that is allowing BPA to support the amount of wind on its system today. This operating protocol[1] limits the amount of federal hydropower BPA must set aside to back wind while maintaining reliable power service. It automatically signals wind projects when all reserves are consumed. This tool has reinforced system reliability.

Improved wind forecasting: In 2009, BPA added 14 wind anemometers to its existing wind measurement system that provide data at five-minute intervals. It developed visual systems to help dispatchers and wind operators better forecast wind power output. BPA then developed a world-class three-day wind forecast for the Columbia Basin for use by all parties, and in 2011 made the new tool publicly available.

Improved visibility for power dispatchers: The more power dispatchers know about the weather and the performance of all generators in their balancing area, the more efficiently they can keep power loads and generation in balance. BPA staff invented new visibility tools that allow dispatchers to intuitively see how, where and how strongly the wind is blowing; how much each wind plant is producing and how closely that corresponds to scheduled output; and other crucial system information impossible to track through data printouts.

Giving customers a choice of reserve suppliers: Since October 2010, Iberdrola Renewables, Inc., the largest wind power supplier on BPA's grid, has been supplying its own generation imbalance reserves for its 1,100 megawatts of wind turbines in the Columbia River basin. Iberdrola reports that supplying its own reserves has proved technically challenging, but it has agreed to extend this pilot effort.

[1] Dispatchers Standing Order 216.

BPA reserve purchases: Similarly, BPA is now exploring the purchase of power from other sources to increase reserves. BPA tried this out last fall with a 75-megawatt, three-month purchase of generation imbalance reserves from a Calpine natural gas-fired plant in Hermiston. BPA expects to apply what it learned to a second, broader pilot for its 2012-2013 rate period.

Intra-hour power sales: Wind power output can vary widely within an hour. Utilities historically sell power by the hour, and power management systems have been developed based on this assumption. For wind and solar power, shorter sales periods would be more efficient. In 2009, BPA worked with regional partners to develop systems to allow limited sales of wind power on the half-hour. We are now expanding that capability. Other Northwest utilities are developing similar tools, and within-hour power sales are slowly growing.

IV. Providing Reliability Services

It is very difficult to schedule wind power accurately. Wind resources on the BPA system produce large ramp events—that is, wind output moving both up and down—over short periods of time. During these ramps, wind output in BPA's grid often deviates from its schedule by hundreds or even a thousand megawatts within a single hour.[2]

To keep the lights on, the amount of power being used and being generated in the grid must constantly balance. BPA therefore provides generation imbalance services to compensate for unscheduled deviations between wind plants' schedules and their actual output. Until 2008, BPA did not charge for this service, because the amount of wind power on its grid was small enough that the cost could be absorbed by the hydro system without affecting other ratepayers.

Establishing generation Imbalance Service for Variable Resources: Beginning in 2009, BPA established a wind integration service charge. The agency now reserves a substantial portion of the Northwest's federal hydroelectric system, over 1,000 megawatts,[3] to back up wind in case unscheduled wind ramps occur unexpectedly.

So far, BPA has used the federal hydro system to provide reserves for all variability in its transmission network. By summer 2009, the size of the wind fleet and unscheduled ramps led BPA to become concerned that it was fast approaching the limits of what its system could physically provide. The fail-safe protocol described above has allowed BPA to support more wind with reserves available from federal hydropower, stretching that limit.

Giving wind operators choices: In its 2010 draft rate Record of Decision, BPA assumed wind projects would meet a certain level of scheduling accuracy and based the price of balancing reserves accordingly. The final rate, now in effect, carries a lower price, made possible by the fail-safe operating protocol BPA had created to assure reliability of the federal system. In setting this rate, BPA put the wind fleet on notice that failure to achieve this level of scheduling accuracy would result in increased generation reductions and schedule curtailments, because BPA set aside fewer reserves.

[2] 1,000 megawatts is roughly the average power consumption of Seattle.
[3] Total firm federal hydro energy capability is 6,867 average megawatts.

In response to wind project operators' requests, as we develop rates for 2012-2013, BPA is exploring providing optional supplemental balancing reserve capacity from non-federal resources for Variable Energy Resource Balancing Service coupled with expanded intra-hour scheduling.

Tailoring terms to wind's characteristics: In 2002, BPA exempted wind operators from generation imbalance penalties otherwise applied to all generators. The existing penalties were designed to stop generation operators who were seeking to take advantage of market prices by knowingly providing inaccurate schedules. Wind was a relatively small resource at the time, so the cost of its scheduling inaccuracies was modest. The Federal Energy Regulatory Commission subsequently adopted BPA's practice. As wind grew on our system, it became clear that this policy was not sustainable. To address this without disadvantaging wind power, in 2010 rates, BPA devised a charge that addresses schedule deviations wind projects can manage, without reimposing the broad imbalance penalty.

V. Working with the region

BPA is one of 14 balancing authority areas in the Northwest Power Pool and one of 33 in the larger Western Interconnection.[4] About 80 percent of the wind power in BPA's balancing authority area is consumed in one of these other areas. Managing wind energy is a Western Interconnection issue. BPA is working closely with parties throughout the West on ways to improve operations for wind power and other variable resources. Here are aspects of this very broad, continuing effort.

Northwest Wind Integration Action Plan 2007 and today: In 2007, BPA and the Northwest Power and Conservation Council completed a regional study that found it technically feasible to integrate up to 6,000 megawatts of wind power in the Northwest grid over 20 years. Half of this, 3,000 megawatts, was expected to locate on BPA's grid. The study outlined a 16-item regional action plan to realize this potential. BPA has completed the six Action Plan items assigned to it individually or in concert with the Council, and is working with regional parties on the broader regional action items.

BPA and the Council are reconvening the Steering Committee June 6 to review operating experiences, and evaluate emerging challenges resulting from the rapid development of wind power in the Pacific Northwest. These discussions may produce recommendations on how to best integrate additional amounts of wind energy in the coming years. Given the significant number of wind-related requests that customers submitted in the 2008, 2009, and 2010 NOS processes, recommendations from the Steering Committee discussions are likely to influence future BPA Network Open Season policies.

Collaborating across the West: BPA is working with many organizations across the Western Interconnection to create new power market and institutional arrangements to support wind and other variable energy resources. For example, we are working with:

- California Independent System Operator on a joint pilot project to meld its market approach with BPA intra-hour scheduling. This could provide a partial market solution to schedule deviations.
- Northwest Power Pool to adjust its defined power products to ensure they are consistent with wind power's characteristics.
- ColumbiaGrid and the Joint Initiative on potential new approaches to providing generation imbalance services among utilities.

[4] One large electrical system serves all contiguous U.S. states from the Rocky Mountains to the Pacific Ocean, British Columbia, Alberta and small portions of Mexico. This interconnected system is known as the Western Interconnection.

Smart Grid: Smart grid technologies offer great potential to absorb fluctuations in wind and other variable resources. BPA is sponsoring 12 utility-focused demand response pilots. The pilots test a variety of demand response technologies to meet different requirements For example, BPA is conducting a pilot project now with Pacific Northwest National Laboratory in which home water heaters are being controlled specifically to absorb excess wind energy. With DOE funds, we have installed electric car charging stations in our facilities with metering that could be used to test electric vehicles as a storage battery for light-load-hour energy. We're also exploring ways to test if we can tap into large industrial loads to help with wind integration.

BPA is a participant in a Pacific Northwest Smart Grid Demonstration Project led by Battelle Memorial Institute, Pacific Northwest Division. One of the project's primary objectives is to apply smart grid capabilities to support the integration of renewable resources. The project includes eleven utilities and five infrastructure partners. The five-year project involves 112 megawatts of responsive resources featuring both load and generation, scheduled to be running by Sept. 2012. These assets include everything from home energy systems, distributed generation, and numerous other resources on the targeted list of smart grid assets.

On a broader scale, we are a major participant in the Pacific Northwest Smart Grid Demonstration Project testing 112 megawatts of responsive resources. This project includes 11 utilities and five infrastructure partners. We also are participating in the DOE-funded. WECC Synchrophasor demonstration project that could greatly increase operators' visibility of power system fluctuations and diminish needed reserve margins.

BPA Technology Innovation: While the Wind Integration Team focuses on creating real-time technical innovations for immediate use, BPA's Technology Innovation program is also funding a number of wind-related research and development projects. Current projects include:

- Wind farm voltage controls
- Renewable integration model (Pacific Northwest National Laboratory)
- improved wind energy integration forecasting and control of energy storage systems (Oregon State University)
- U.S. Smart End use energy storage and integration of renewable energy (Ecofys)
- Bidirectional multiparty dynamic transfer analysis

Sharing what we learn: As an organization on the leading edge of large-scale wind integration, we are learning daily on how to make it work. As a public entity, we are sharing everything we learn as we learn it. Our wind data page is sourced constantly by the wind industry, academics, governments and members of the public world wide. It is far and away BPA's most popular web page.
See: http://transmission.bpa.gov/Business/Operations/Wind/default.aspx

VI. Historic support

The discussion above describes BPA's current initiatives to support wind power. But the agency has been actively working to promote wind power since 1976. Here are highlights of early BPA efforts that helped lead to today's Northwest wind power boom.

Wind power purchases: In 1997-2007, BPA purchased more than 250 megawatts of wind power capacity long-term, spurring commercial wind farm development in the region.

Environmentally Preferred Power Sales: Starting in the late 1990s, BPA sold power from wind farms and other certified environmentally preferable power plants at a premium as environmentally preferred power and put the premiums in additional renewable energy. (Customers asked BPA to include this power in their contracts for 2012-2028.)

Bonneville Environmental Foundation: In 1998, BPA helped launch and then worked with the Bonneville Environmental Foundation to promote Green Tags to further spur consumer interest in green power. This has evolved into a highly successful initiative that has sold Green Tags representing wind and other renewables worldwide.

Resource Assessments: Since 1976, BPA has funded research by Oregon State University to pinpoint where and when the wind blows in the Pacific Northwest. BPA installed a fleet of seven anemometers across its system to gather wind-resource data. Still working today, these formed the foundation for a precise map of the Northwest wind resource, much more detailed than that available in other parts of the nation. This has proved extremely useful to commercial wind farm developers, as much of the "wind prospecting" work has been done for them. BPA added another 14 anemometers to its wind forecasting system in 2009.

Wind Demonstration Projects: In 1979, BPA launched a pilot in which 12 homes received wind turbines to produce power for the home and to feed surplus into the grid. At least one is still operating. Also in 1979, the Department of Energy chose BPA to host a utility-scale wind power demonstration project. Located on the Goodnoe Hills by the Columbia River Gorge, this first multi-unit utility wind farm generated 2.5 megawatts from 1981-1986 and proved BPA's ability to use Columbia River hydropower to store wind energy. Today, the Goodnoe Hills are covered with commercial wind turbines.