



BPA's wind power efforts surge forward

As the nation seeks new sources of clean electricity, wind has emerged as the most mature and promising new resource. It is free of CO₂ emissions, relatively cost effective compared to other new generating resources and is, thus far, the most viable non-hydro renewable resource available on a large scale. Its assimilation into the U.S. and Pacific Northwest generation resource base is advancing rapidly, thanks to concerted efforts to meet and overcome challenges to dealing with wind's variability.

Others, primarily independent companies, are developing wind resources. The Bonneville Power Administration's major role is to provide the reliable transmission that delivers electricity from wind farms, often located in remote areas, to the region's communities. Bringing a variable and difficult to predict energy resource, such as wind, onto the power grid in large amounts is one of the great engineering and economic challenges in the power industry today. BPA is maintaining a remarkable pace of connecting wind power onto its transmission system and has among the highest levels of wind power in its transmission system compared to load of any grid balancing authority in the country.

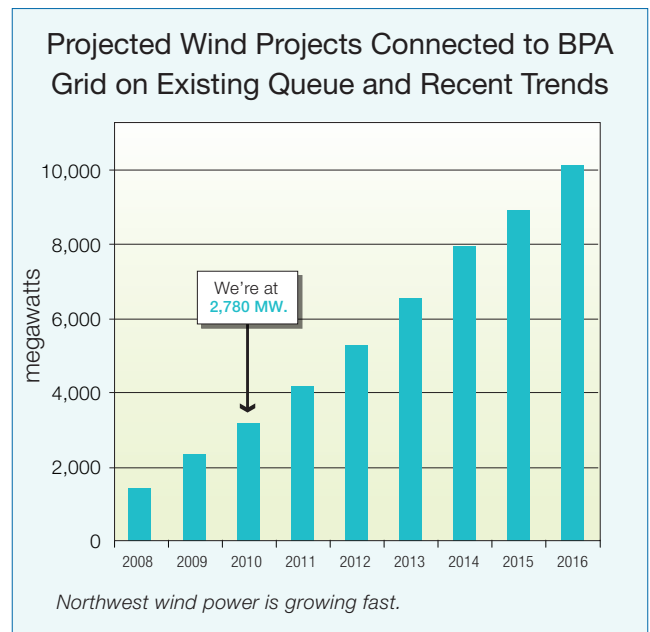
Growth rate fuels progress

All but one of the states in BPA's service territory have enacted renewable electric generation standards for their retail utilities. These requirements, coupled with those of other Western states, have set off a "gold rush" of wind developers to the region.

The growth rate of wind interconnections is astounding. In 2009 alone, the amount of wind power integrated into BPA's transmission system went from 1,500 megawatts to more than 2,500 megawatts. It is now above 2,700 megawatts. In the next two years, BPA expects a near doubling of wind on its system. By 2013, BPA may have more than 6,000 MW of wind power on its system.

As wind power continues to grow, the energy industry faces dramatic change. This is an exciting time for the industry, and BPA is helping lead the nation into a new age of renewable power.

BPA and the region's wind community have been working aggressively to adapt to wind power's rapid growth. In 2009, the agency released an accelerated



18-month work plan for wind integration activities. BPA's Wind Integration Team is tackling five projects to better manage large amounts of wind power in BPA's balancing authority area. All of these projects, summarized below, are on or ahead of schedule.

Making it work

Given the challenges, how can 6,000 megawatts of wind, and perhaps more ultimately, successfully operate in a balancing area with just under 11,000 megawatts of peak load? BPA is focusing its efforts in four areas to make it work.

- Building transmission to support wind integration.
- Using existing transmission capacity in new ways.
- Exploring new sources of generation capacity reserves.
- Developing partnerships with other utilities and the wind power community.

Building transmission to support wind integration

The region needs new transmission to meet growing demand for energy, particularly renewable energy. Because BPA owns and operates three-quarters of the region's high-voltage transmission, the agency plays a vital role in facilitating the development of renewable energy. Simply put, wind and other resources will not be developed unless transmission is available to get those resources to market. This is particularly challenging because, on average, wind projects in the BPA service territory only operate at about 30 percent of their capacity.

To determine transmission needed to support additional wind generation, as well as to shore up reliability, BPA initiated a new process called Network Open Season in 2008 to better manage the queue of customers seeking BPA's transmission services. Previously, many potential developers had sought to reserve transmission for plants still in the planning stage or plants that might never be built. The result was a long and unmanageable queue. Under Network Open Season, BPA offers firm network transmission service to customers who request it, but the customers must make a financial commitment for that service. This winnows out the speculative requests for transmission.

In 2009, BPA confirmed financial commitments for 6,410 megawatts of transmission service requests. Three-quarters of the requested service capacity were for wind generation.

BPA was able to accommodate more than 20 percent of the requests with existing capacity. It was also able to offer a new "conditional firm service" to provide still more transmission service from existing capacity of the system. Conditional firm allows some curtailment of service under certain conditions. This allowed BPA to make the most efficient use of its existing system before proposing new construction.

Network Open Season did show, however, that BPA needs to move forward with four new transmission

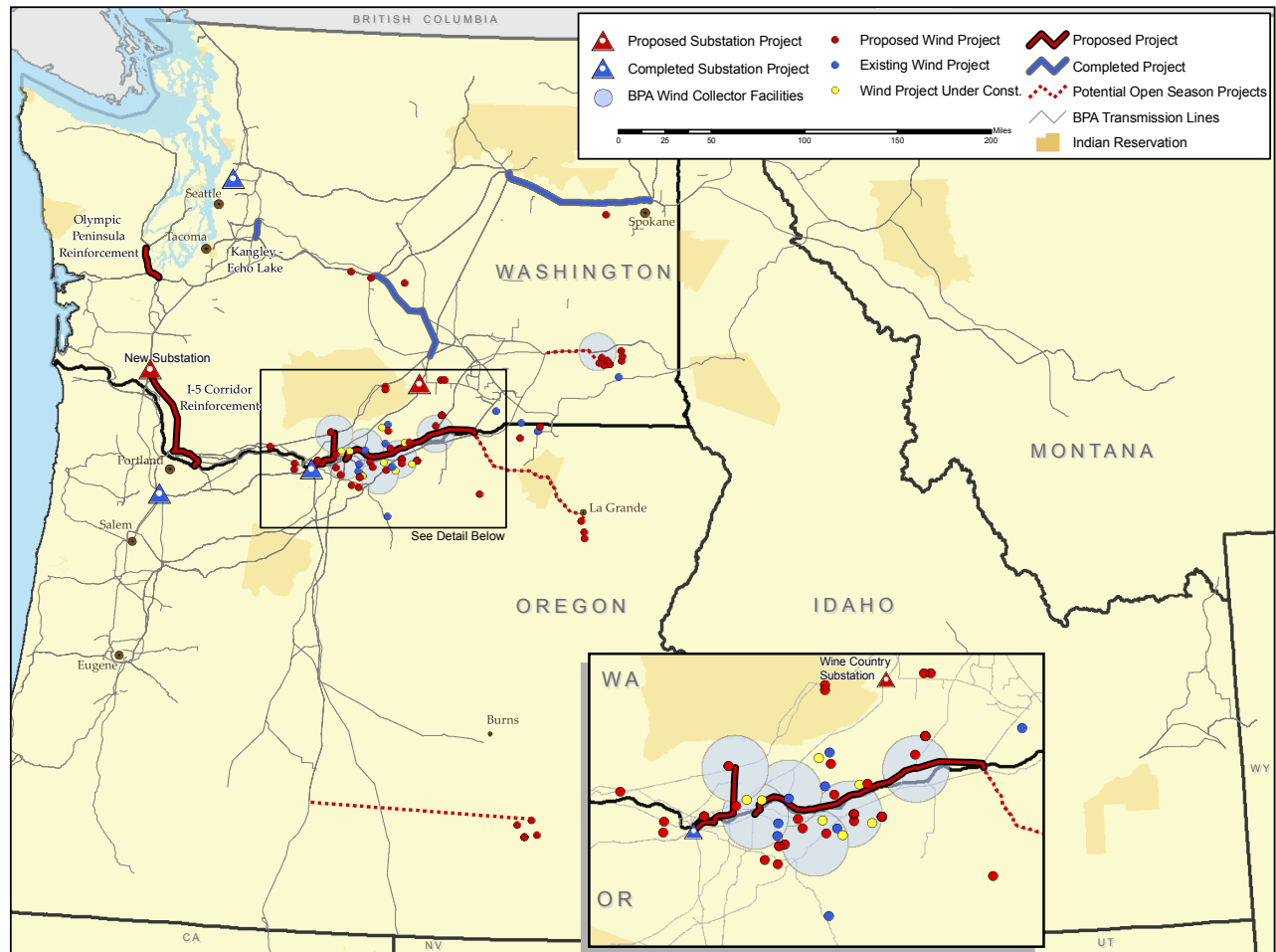
BPA wind initiatives are stretching the capability of the existing system.

projects. Together, these projects would bring 1,800 megawatts of new wind generation to the region. BPA is ahead of schedule on the construction of the first project and is conducting environmental work on the others. The feasibility of these projects was enhanced by access to increased borrowing authority granted BPA under the American Recovery and Reinvestment Act. BPA will pay this money back with interest to U.S. taxpayers, but the expanded borrowing authority provides increased capital for critical projects. BPA is completing its second Network Open Season and plans to conduct the process annually.

Changing grid management for wind power integration

BPA's Wind Integration Team is developing new processes and systems to wring as much efficiency as possible out of existing transmission and generating reserve assets. Basically, BPA is stretching the capability of the existing system through efficiencies from operational improvements. If these initiatives succeed and are implemented over the long term,

Completed and Proposed BPA Transmission Line & Wind Projects



Most of the wind power in the Northwest is clustering in the heart of BPA's grid.

they could make a significant dent in the amount of balancing reserves needed to support a tripling of the wind generation interconnected to BPA's system.

New protocols manage extreme wind ramps

BPA has seen unscheduled wind generation swings of more than 1,000 megawatts in less than an hour on its system. New operating protocols introduced in 2009 help manage sudden fluctuations in wind generation. When wind picks up and unscheduled generation threatens to deplete BPA's balancing reserves, BPA dispatch now automatically sends an electronic signal to wind plants to reduce their generation to scheduled levels. So far, BPA dispatchers have applied the protocols several times a month. Likewise, when large decreases

in scheduled wind generation deplete BPA's ability to provide balancing energy, BPA revises the wind schedules downward, and receiving utilities must make up the difference with their own resources.

Shorter scheduling intervals

Historically, utilities schedule power deliveries by the hour. As a pilot project, BPA is allowing within-hour changes to power schedules for wind projects that are exceeding their hourly schedule. Intra-hour scheduling can help wind generators avoid curtailment of excess generation and could make it possible for them to sell excess power that otherwise might be limited. This has the potential to help reduce reserve requirements and generation imbalance charges. BPA is evaluating possible expansion of this project.

The challenge

Wind is a variable power resource that is hard to predict. That's a challenge because, unless generation matches demand second by second, the transmission system will destabilize. If the system becomes unbalanced, blackouts can result. Think of it in terms of a computer. We use surge protectors to prevent a sudden increase in electricity. Some sensitive electronic equipment also incorporates voltage sag protectors. Without these protections, equipment can suffer the equivalent of a "black out."

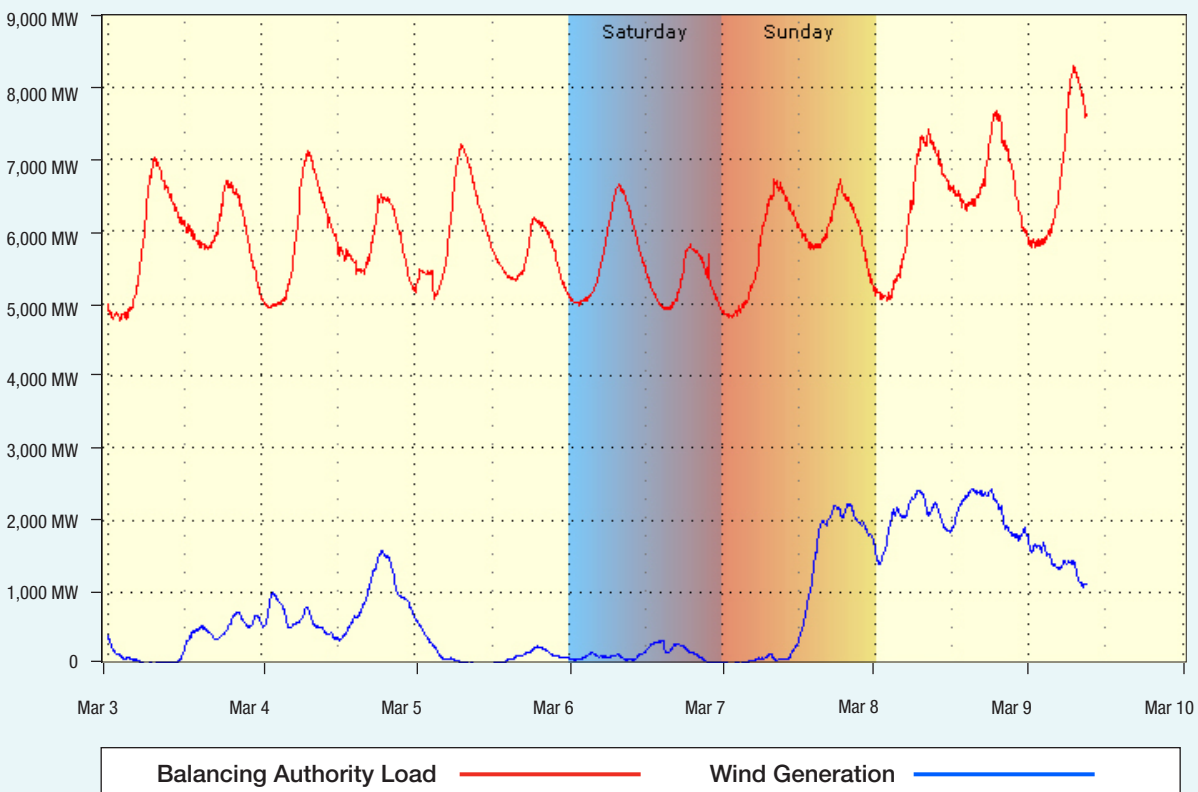
To maintain system balance in the high-voltage grid, utilities use balancing reserves, or generation held available to manage fluctuations between power load

and power generation. In the Northwest, the hydro system has historically provided all the balancing reserves we need, because hydro generation can be increased or decreased quickly. But the hydro system has limits. To support continued large-scale wind power growth, we are learning to operate the existing system in new ways.

As with most coastal climates, Northwest winds are not steady. They tend to ramp up or down quickly and often unexpectedly. System operators are inventing new techniques to maintain the constant balance needed between power loads and generation levels. Some solutions already have been put in practice; others are on the way.

BPA Balancing Authority Load & Total Wind Generation

March 3–10, 2010



BPA now operates the hydro system to respond to and balance both variations in power loads and unexpected changes — up and down — in wind power output.

New wind forecasting applications

Wind output is difficult to predict, making it hard to schedule accurately. This uncertainty increases the amount of reserves BPA must hold to keep loads and generation in balance. BPA has installed 14 anemometers throughout the region to better predict wind availability and is using the data to develop a more accurate wind power forecast system for the Columbia Basin.

Dynamic transfer

Dynamic transfer is one of the most important techniques to reliably and cost-effectively integrate large amounts of variable renewable generation resources. This technique would allow a dispatcher in one balancing authority to control and take responsibility for supplying balancing reserves for a generator located in another balancing authority. A study identifying available dynamic transfer capacity on 11 key transmission paths completed in February 2010 found moderate amounts of available dynamic transfer capability. BPA is making this capability available to its customers on a pilot basis.

Managing large wind fleets
is proving most efficient when
handled across large
geographic areas.

Customer-supplied imbalance reserves

Also known as self-supply, this project would allow wind generators in the BPA balancing authority area to supply their own imbalance reserves rather than relying on BPA for such services. BPA plans to launch this project on a pilot basis in October 2010, once the necessary technical adjustments are in place on both BPA and participating wind project systems. Wind project owners likely will use the Joint Initiative's Dynamic Scheduling System to facilitate supplying their reserves.

There are more than 30 discrete balancing authorities in the Western Electricity Coordinating Council

(see box, page 6.). The result is numerous system operators, each of whom has individual requirements to maintain a constant balance between load and generation. This fragmentation is a challenge for the development of wind power in the Northwest, because wind generated in one balancing authority often serves consumers in another balancing authority that may be located across several intervening balancing authorities.

Exploring generation capacity reserves

Wind project operators in BPA's balancing authority pay for integration services for their projects, so that the consumers who pay to purchase wind power both receive the benefits of wind power and pay the costs of the resource. For 2010–2011, the rate reflects the costs of generation imbalance reserves provided from federal hydropower resources.

As the wind resource grows, even with efficiencies, new resources likely will be needed to provide balancing services for variable renewable resources. In preparation, BPA has begun to explore options for adding flexibility capacity.

Key terms

Balancing Authority: A balancing authority is an entity that is responsible for maintaining a constant balance between power load and power generation in a geographic area. It is usually a utility or other transmission provider such as a regional transmission organization. There are 14 balancing authorities in the Pacific Northwest. BPA's balancing authority area includes primarily rural portions of Oregon and Washington, plus small portions of northern Idaho and northwest Montana.

Balancing Reserves: Generation held available to be ready to use if needed to maintain the balance between power load and power generation as loads fluctuate and/or as real-time generation differs from scheduled generation.

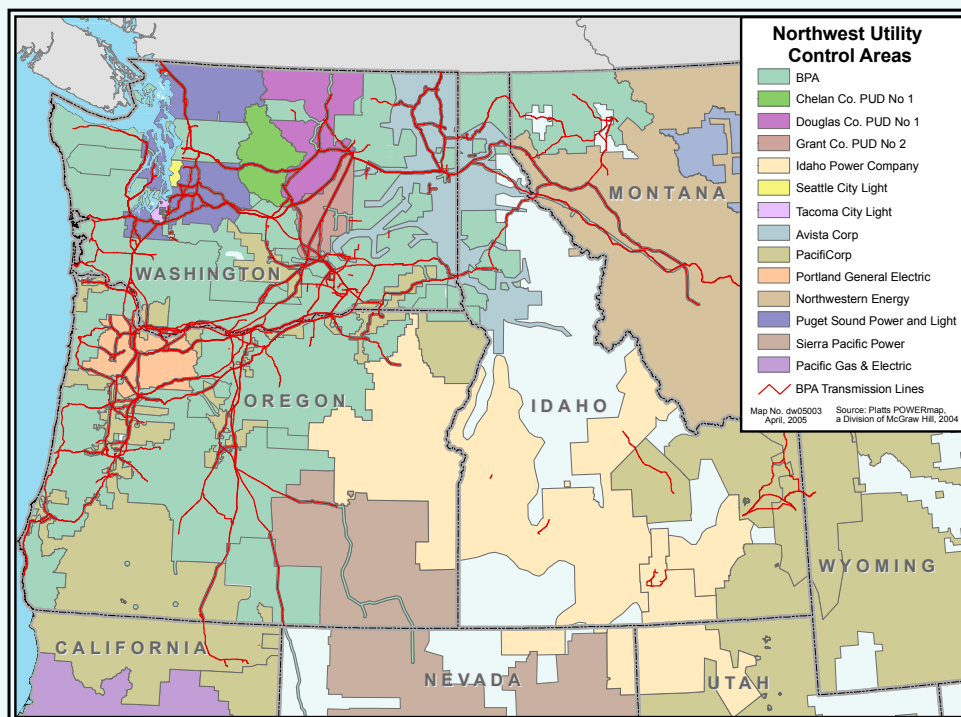
Part of a much larger picture

Most of the Northwest's wind generation is in rural portions of eastern Oregon and Washington, while most consumers of wind power are in larger metropolitan areas in balancing authorities managed by other utilities. Worldwide, managing large wind fleets is proving most efficient when handled in unified systems that cover large geographic areas with millions of people and many, diverse power sources, such as in Spain and Texas.

Utilities in the Northwest are working together to realize similar benefits across their smaller balancing authorities. BPA is among many Western utilities participating in a Joint Initiative of ColumbiaGrid, WestConnect and the Northern Tier Transmission Group — entities managing and coordinating some transmission issues among utilities — to develop

common approaches to wind integration. For example, the Joint Initiative is creating a common system for dynamically scheduling control of a wind generator from a resident balancing authority to another balancing authority where the wind power is being consumed.

On a still larger scale, utilities throughout the Western Interconnection — the interconnected power system of the Western United States, British Columbia, Alberta and small parts of Mexico — are working to redesign transmission and power resource planning and adapt the way the grid works to help meet state and national renewable power objectives. The Western Electricity Coordinating Council, the reliability organization for the Western Interconnection, is leading this effort.



BPA is the balancing authority responsible for maintaining a constant balance between the power load and power generation in the area shown in teal. (A balancing authority is also known as a control area.) Most of the wind power on line and planned for the Pacific Northwest is clustered in BPA's balancing authority at the eastern end of the Columbia River Gorge. However, 80 percent of the wind power in BPA's balancing authority area serves loads in other utilities' balancing authorities.

Energy storage technologies could be a valuable source of such flexibility to the degree they can absorb excess wind energy when it is not needed and return it to the grid during periods of greater demand. For example, BPA is working with the Pacific Northwest National Laboratory on its study of various options including pumped storage, compressed air storage, batteries and flywheels. PNNL is also examining residential applications such as hot water heaters as potential sources of energy storage for the grid.

BPA is working with the U.S. Army Corps of Engineers and the Bureau of Reclamation on the potential for pumped hydro storage in the Northwest. This represents a new application of an existing but evolving technology that could help fill the need for more

BPA has begun to explore options for adding flexibility capacity.

frequent uses of ramping generation to respond to wind variability.

Follow our progress

To follow BPA's wind integration work or participate in its efforts, go to www.bpa.gov/go/wind, contact Eric King at evking@bpa.gov or call BPA at 1-800-622-4519.

