Integrating Wind Power and Other Renewable Resources into the Electric Grid

September 2009
BPA Has Substantial Wind Energy Experience

- Over 2,200 MW of wind in its 10,500 MW peak load balancing area.
- 21 wind farms interconnected.
- More than 1,000 wind turbines on line.
- Five new substations for wind farms.
- Six new substations for wind farms.
- Approximately 75% of the wind serves load outside of the BPA balancing area.
- 4,716 MW, (74 percent) Network Open Season requests were 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
BPA Has Very High Wind Penetration

<table>
<thead>
<tr>
<th>Utility Balancing Authority</th>
<th>Installed Wind (A)</th>
<th>Peak Load (B)</th>
<th>Wind Penetration (A/B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PacifiCorp East</td>
<td>860</td>
<td>5,689</td>
<td>15%</td>
</tr>
<tr>
<td>PacifiCorp West</td>
<td>250</td>
<td>3,555</td>
<td>7%</td>
</tr>
<tr>
<td>PNM</td>
<td>200</td>
<td>2,500</td>
<td>8%</td>
</tr>
<tr>
<td>Northwestern Energy</td>
<td>150</td>
<td>1,724</td>
<td>8%</td>
</tr>
<tr>
<td>CAISO</td>
<td>2,800</td>
<td>49,071</td>
<td>6%</td>
</tr>
<tr>
<td>ERCOT</td>
<td>5,800</td>
<td>62,400</td>
<td>9%</td>
</tr>
<tr>
<td>BPA 2009</td>
<td>2,200</td>
<td>10,500</td>
<td>21%</td>
</tr>
<tr>
<td>BPA 2010</td>
<td>3,200</td>
<td>10,500</td>
<td><strong>31%</strong></td>
</tr>
</tbody>
</table>
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 cannot.
  - 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 almost 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
Jan. 5-25, 2009

MW
Date/Time (5-min increments)
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
More Than Hydro Alone Can Handle

- Demands on federal hydro power system:
  - Serve load
  - Meet non-power requirements
  - Support variable generation

- Current estimated support capability:
  - 3,000 – 3,500 MW of wind generation

- New tools required beyond this level.
BPA’s Wind Integration Goal/Strategy

*BPA is committed to helping the Pacific Northwest meet its renewable resource objectives by reliably and cost-effectively extending the integration capability of the BPA Balancing Authority while honoring our statutory obligations to our preference customers and the operational limitations on the Federal hydroelectric system.*
How, specifically, are we planning to accomplish this?
BPA Steps Taken So Far

- Transmission Network Open Season offered
- Conditional Firm Service offered
- Area Control Error (ACE) diversity interchange
- New transmission construction financed
- Automatic Generation Control improved
- New approach to reserves and reliability developed, operating protocols implemented
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 is on track to be implemented as planned on October 1, 2009.
Dynamic Transfer Limits Study

- This project will identify the dynamic transfer limit associated with various paths. Scope includes:
  - Define how the path limit is established
  - Identify the reliability concerns restricting dynamic signals across PNW transmission paths
  - Establish a credible, repeatable, and timely methodology to allow dynamic scheduling in BPA’s transmission network and interties no later than February 15, 2010.

- Paths/Flowgates under study:
  - California-Oregon Intertie (COI)
  - Northern Intertie
  - West of Garrison
  - NW-to-Idaho (LaGrande)
  - West of Cascades - North
  - West of Cascades - South
  - North of Hanford
  - North of John Day
  - South of Allston
  - West of McNary
  - West of Slatt
Forecasting

- This project will improve BPA’s ability to forecast wind power generation and will develop, test and deploy tools for dispatchers and hydro duty schedulers to achieve greater understanding and awareness of wind generation patterns and operational risks to improve reserve management and use.
  - BPA will install meteorological equipment on 14 BPA facilities by October 1st, 2009. Data Feeds from Met Sites will be in place by December 1st 2009 for forecast displays.
  - BPA is developing in-house wind generation forecasting capability and has also contracted for wind forecasting research and development. A buy vs. build decision is scheduled for January 2010.
  - Dispatchers and duty schedulers will be working with wind generation and forecast displays by October 1st, 2010.
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.

- Four responses were received to a survey BPA released to determine which wind parties were interested in participating in the pilot project.
  - BPA has begun working with 1 participant, another participant is discussing the pilot in more detail, and 2 other participants are on hold and may participate at a later date.

- The Customer Supplied Generation Imbalance pilot will start October 1, 2010.

- Participants will supply their own Generation Imbalance.

- BPA will continue to supply load following and regulation.
Sub-hour Scheduling

- The purpose of this pilot is to provide the ability for wind customers to submit schedules on a sub-hourly basis.
- BPA will implement systems and processes that will enable purchasing/selling entities to schedule excess wind generation from BPA Balancing Authority Area (on the half hour).
- The Business Practice was posted on September 8, 2009 for review. Customer comments on the business practice should be submitted no later than September 25, 2009.
- Phase 1 Pilot will be implemented December 1, 2009.
WIT Work Plan

Projects
- DSO - 216 Implementation
- Dynamic Transfer Limits Studies
- Forecasting
  - Met sites
  - Forecast System
  - State Awareness tools
- Customer Supply of GI (Self Supply with Netting)
- Sub-hourly Scheduling
- Commercial Systems
- Third Party Supply Pilot (on hold)

Timeline:
- Oct 2009
- March 2010
- Oct 2010
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
Continued Stakeholder Involvement

BPA worked collaboratively with our utility customers and the wind power community in developing the current Wind Integration Work Plan. As we move forward in carrying it out, BPA is continuing to keep stakeholders appraised and involved through such avenues as:

- JOC meetings
- Transmission Customer Forums
- External WIT e-mailings
- NW Wind Integration Technical Forum
- Release of Business Practices for comments
- Collaborative studies with ColumbiaGrid and NTTG
- Joint Initiative
- Engagement of customers and interested parties in specific areas
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
Questions?