Challenges and Opportunities for Wind on Power Systems
Renewable Northwest Project (RNP)

Non Profit Renewable Resource Advocacy Organization
Promoting renewable energy in Oregon, Washington, Idaho and Montana through:
• Policies (laws, regulations, and utility business practices)
• Responsible siting
• Retail markets.

Members
Businesses, non-profits, educational institutions
Wind generation is inherently variable and not entirely predictable.

Wind integration refers to changes in power system operations that allow wind energy to be most efficiently used to reliably meet demand for power.
Can it Be Done?

- Yes!
  - Studies indicate wind can serve anywhere from 20% (US DOE) to 41% (Eir Grid) of electrical energy demand.
  - Denmark currently generates 20% of its electric energy from wind and targets 50% in ten years.
  - Germany has more than 25,000 MW of wind, 7% of demand.
  - Spain has about 20,000 MW of wind, 12% of demand.
Top Wind Countries by Penetration Rates

- **DENMARK** 20%
- **SPAIN** 12%
- **GERMANY** 7%
- **GREAT BRITAIN** 2%
- **SWEDEN** 2%
- **USA** 1%
- **CHINA** 1%
- **BRAZIL** 0.5%
- **AUSTRALIA** 0.5%
- **INDIA** 0.5%
Wind is Fastest Growing Resource
The Balancing Challenge

Power Plants Adjust Output to Meet Demand

BPA Balancing Authority Load & Total Wind, Hydro, and Thermal Generation, Last 7 days

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=2836 MW
BPA Technical Operations (TOT-OpInfo@bpa.gov)
Hour-Ahead Schedule Errors

BPA Balancing Authority Total Wind Generation and Wind Basepoint, Last 7 days

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=2836 MW
BPA Technical Operations (TDS-OpInfo@bpa.gov)
Reserve Generation Makes the Difference

Differences met by reserves.
Reducing the Reserve Burden

- Sharing across time and geography needed.
  - More liquid markets
  - Fewer “Balancing Areas”
What About Storage?

- Co-author of Eir Grid 41% study, Dr. Mark O’Malley: “Storage is a fallacy!”
  - Likely to be less expensive to actively manage wind generation.

- FDR reservoir behind Grand Coulee Dam has energy storage equivalent of 150 million electric vehicle batteries.

- Need for storage is indicated by diurnal wholesale price spreads.
  - Recent price spreads have not been high enough to justify storage.
The biggest challenge for power systems with high levels of wind penetration is usually:

- **Accommodating high levels of wind generation when demand is low.**

This is a 180 degree turn around from power system concerns when I began my career (too little energy), and is by far the easier challenge.

- **Maybe Storage is not a fallacy?**
  - As wind becomes a larger share of the system, the value of storage rises.
Denmark plans to supply half its demand with wind generation in ten years.

- Wind integration is a national focus and will require more radical changes in how their system operates.

Denmark’s Risø National Laboratory Executive Director Henrik Bindslev:

- *The power system will change from a system where supply meets demand to a new paradigm in which demand will respond to supply.*
Advantages of Thermal Storage

This one facility in Copenhagen has the capability of storing 2,500 MWh of thermal energy-- equivalent to 100,000 electric car batteries.

Cost of existing storage infrastructure MUCH cheaper than building new.

Lower losses, no cycling limits, low maintenance costs.
Island of Bornholm

- Danish Island off the coast of Sweden with a peak demand of about 65 MW will become the first utility-scale power system entirely fueled by renewable energy.
  - Wind
  - Solar
  - Bio fuels
  - Energy storage (thermal and EV batteries)
Victim of Our Success

- New challenges involve siting.
  - Wildlife—Eagles, Sage Grouse, Prairie Chicken
  - Radar
  - Visual Impacts
Summary

- Much larger amounts of wind **can be** accommodated than current levels with existing infrastructure.
  - Not counting transmission, though even that is debatable.
- Much larger amounts of wind **are** being handled by power systems in Europe with no changes to the power system make-up.
- Largest impediments and cost contributors relate to the structure of markets, especially in the Northwest.
- New challenges relate to siting issues are beginning to arise in a serious way.