

Synchro-Phasors and Renewable Generation Integration in Pacific Northwest

February 2010 NASPI Meeting

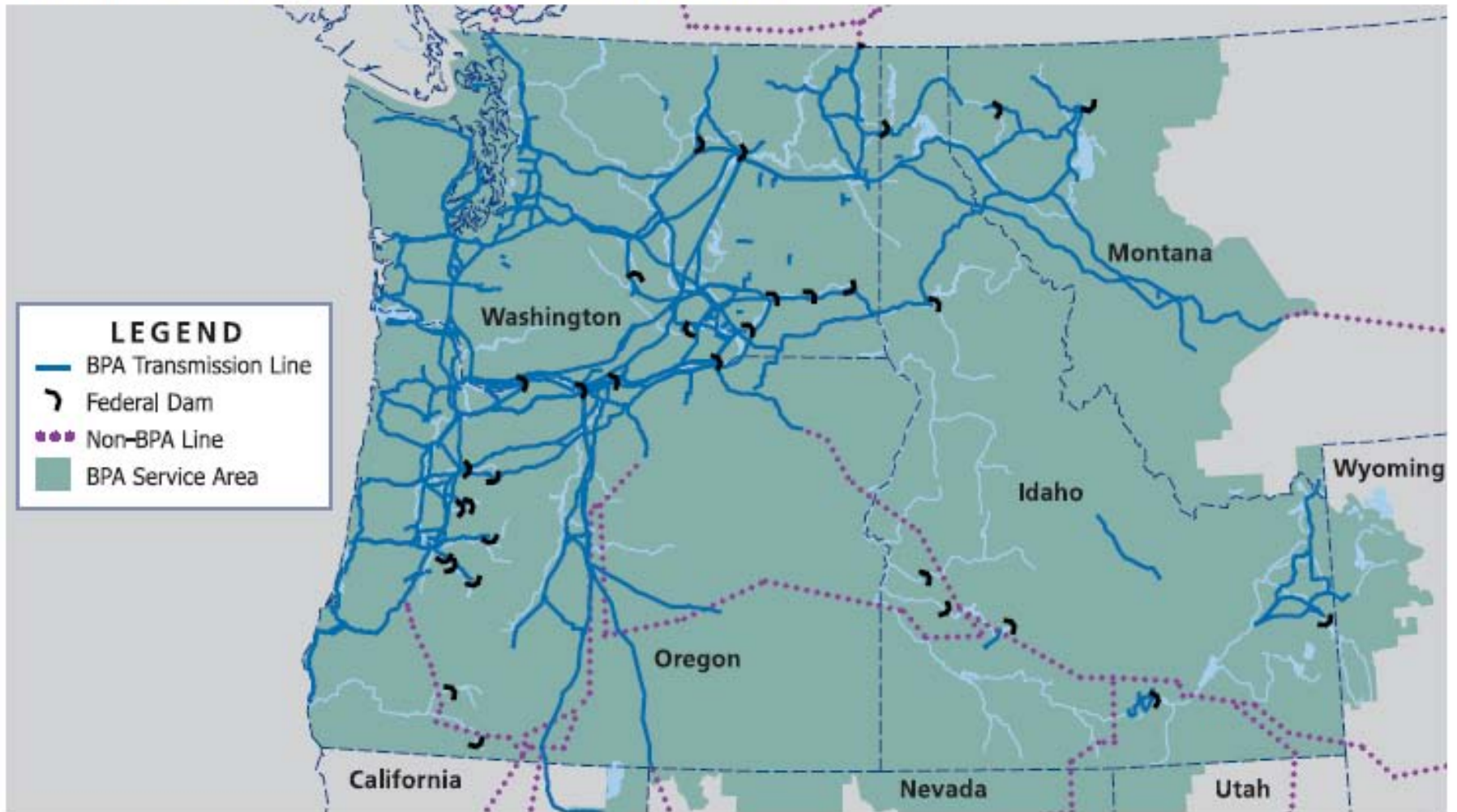
Dmitry Kosterev

Transmission Planning

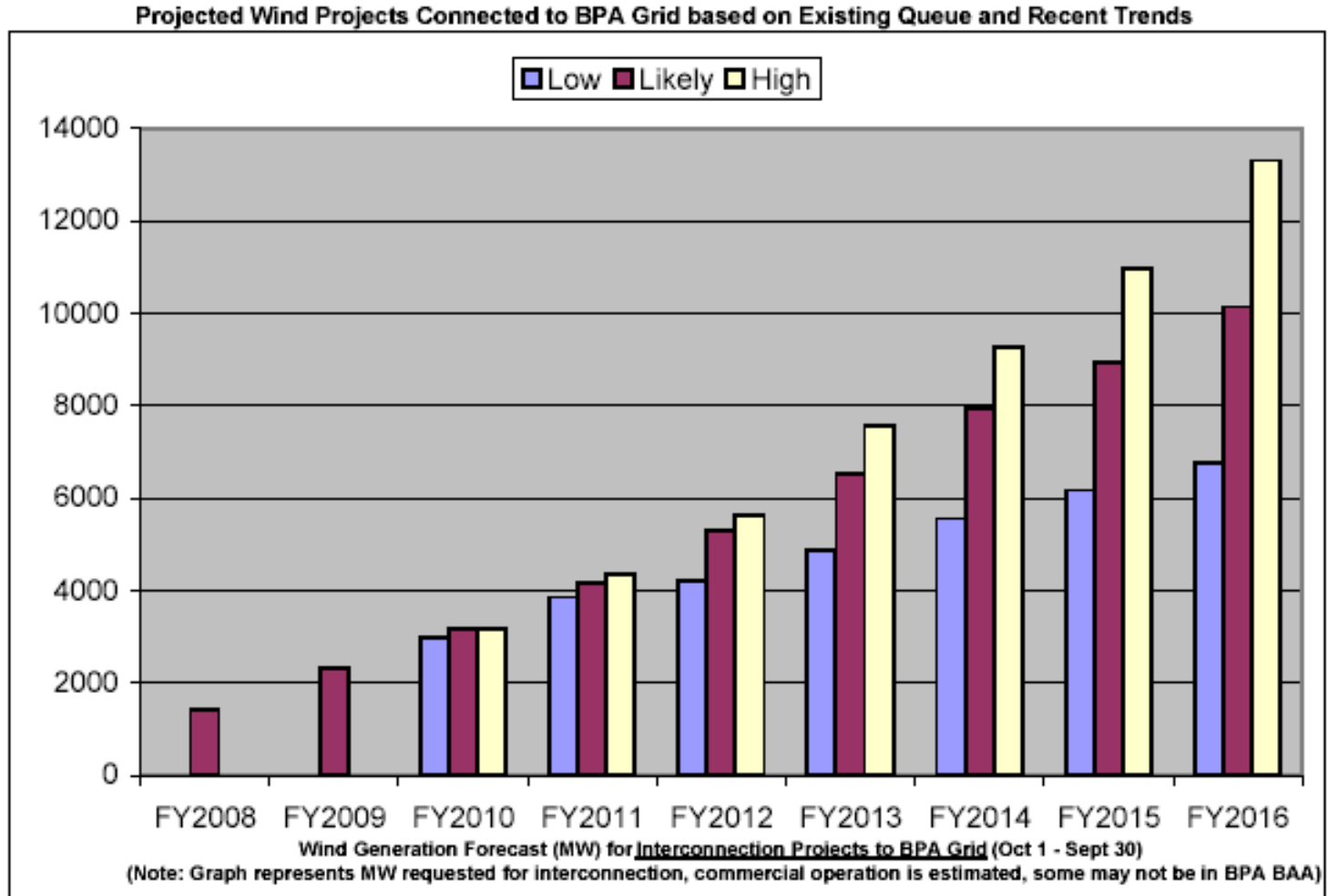
Bonneville Power Administration



Transmission System and Federal Dams



Wind Generation Projections



2,780 MW of wind generating capacity as of January 15, 2010



Drivers for Wind Generation

- Public policy
 - Increasing state Renewable Portfolio Standards (RPS)
 - Increasing restrictions on CO2 emissions from power plants at the state and federal level
 - Limitations on new coal, nuclear, and hydro facilities
 - Financial incentives for qualifying renewables
- Economic
 - Large resource potential compared with other renewables in the NW
 - Commercially mature technology
 - Reduced exposure to volatile fossil fuel costs



Wind Generation Issues

- Transmission Access
 - most transmission paths are fully subscribed
 - 2008 network open season: 6,410 MW of firm transmission requests, 75% from wind
- Regulation and Load Following
 - High correlation among wind power plants due to geographic concentration
 - No correlation between load and generation
- Wind Power Plant Modeling in Power System Studies
- Wind Generation Dynamic Performance
 - Disturbance ride-through
 - Voltage control (primary and secondary)
 - Frequency control
 - Oscillation Damping



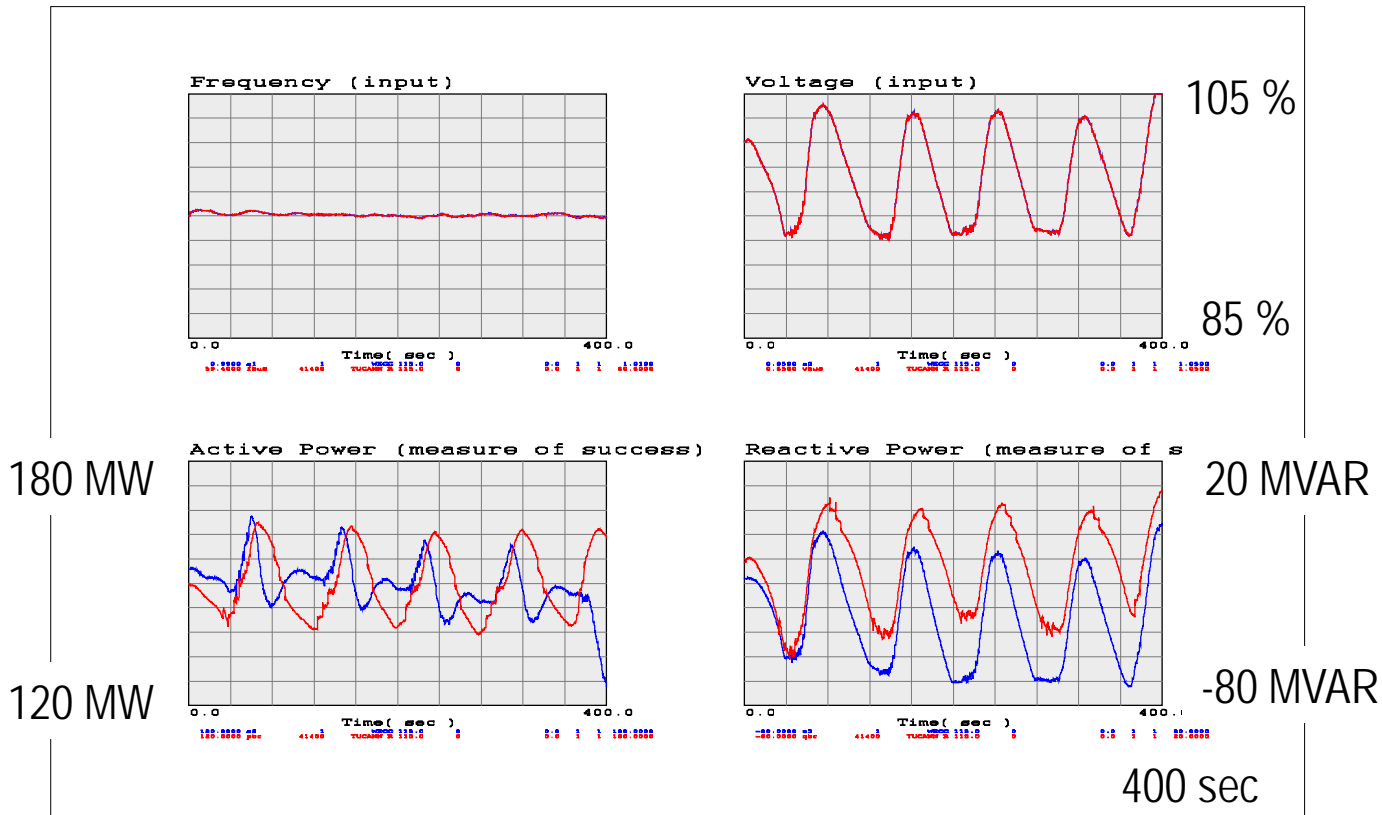
Value of Synchro-Phasors ...

- Wind power plant modeling:
 - Planning and operational decisions are based on the system studies, need good models to predict system behavior
 - WECC and IEEE are developing wind generation models
 - BPA is now requiring PMUs at POIs of wind power plants for performance monitoring and model verification
 - BPA developed tools for model verification using measurements taken at power plant POI
 - Lesson's learned sessions are performed



Lessons Learned example

- 150-MW wind power plant with type 2 machines
- Several random “instability” events observed, power output was curtailed
- PPSM data was used to study the events and develop appropriate solutions



Blue = actual
Red = model



... Value of Synchro-Phasors

- Wind generation state awareness:
 - Voltage control performance monitoring
 - Voltage stability indicators
- Voltage stability controls
 - Coordinated voltage control and reactive power management for wind mega-sites (1,250 MW of wind generation)
 - Wind voltage control monitoring and control tuning



Next Steps

- PMU is required by BPA Generation Interconnection Standards (www.bpa.gov)
- Existing projects will be retrofitted with PMUs
 - PPSMs are installed in meantime
- Model Validation tools are developed (presentation by Steve Yang at June 2009 NASPI meeting)
- Test procedures are being researched
 - Meaningful grid disturbances do not occur frequently
- Voltage control strategies are being developed



Frequency Response and Wind



Frequency Response and Wind

- Frequency Responsive Reserves:
 - viewed as replacement for today's spinning reserves
 - WECC has been working on a standard since 1999
- Frequency Responsive Reserves:
 - How much FRR is needed interconnection-wide
 - Reserve amount, deployment frequency, response time, sustainability
 - Encompass primary and secondary response time frames
 - Distribution of Frequency Response and requirement allocation
 - Reliability issue – unbalanced governor response can result in excessive power pick-up on stability-limited transmission paths
 - Frequency Response measurement
 - Need synchronized, high resolution measurements – sounds like synchro-phasors ?
 - How to factor response to schedule changes ?



Frequency Response and Wind

- BPA performed conceptual study of wind generation impact on frequency response in the Western Interconnection
 - WECC light off-peak load ~75GW, design event is 2,800 MW loss (3.73%)
 - 15GW of wind generation assumed in the study
 - Looking at Frequency Response requirements interconnection-wide
- Study observations:
 - Loss of inertia effects appear to have minimal impact on system frequency , “inertia emulator” benefits seem to be negligible (need to revisit with higher wind)
 - **Primary frequency response is the main issue** – certain amount of primary reserve is required
- We have not seen any technical evidence that wind power plants can provide meaningful primary frequency response
 - Please let us know if you have any information / performance tests

