

# 2009 ANNUAL CONFERENCE Regional Hydro: Power Solutions

## *Integrating Wind Energy into the Northwest Energy System*

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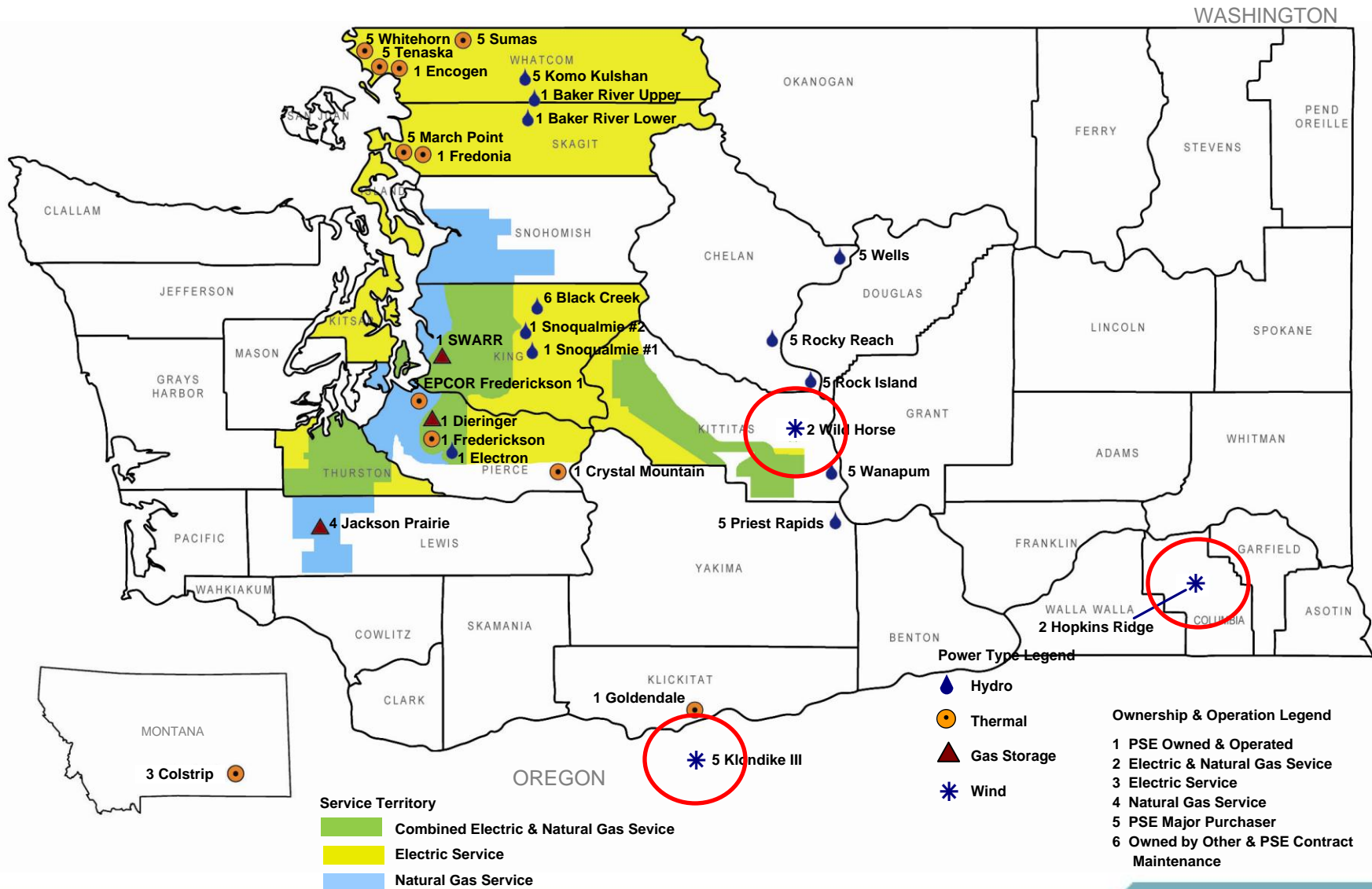


**PUGET SOUND ENERGY**

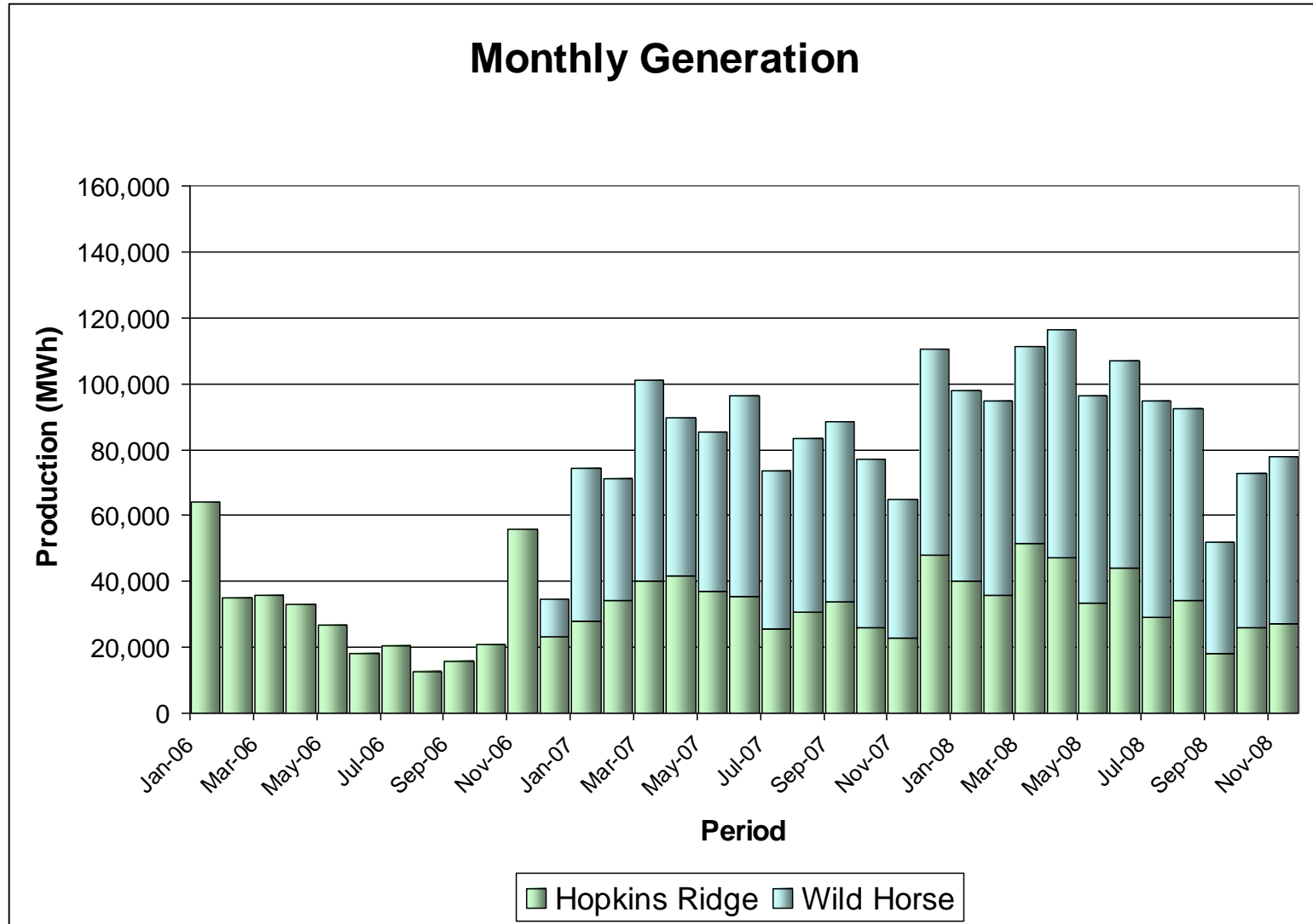
*The Energy To Do Great Things*



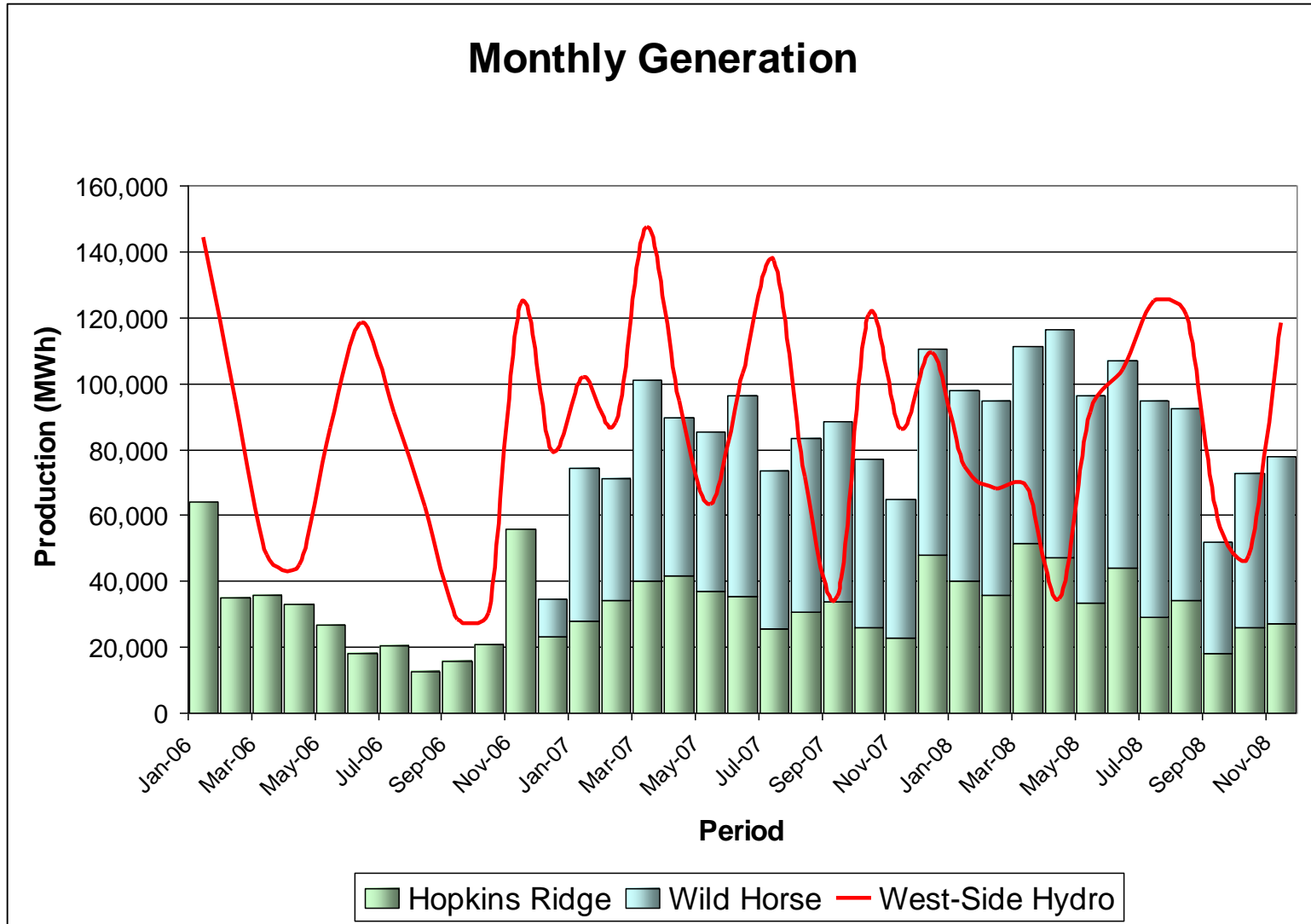
# PSE Existing Resources



# Wind Production



# Wind Production w/ Hydro

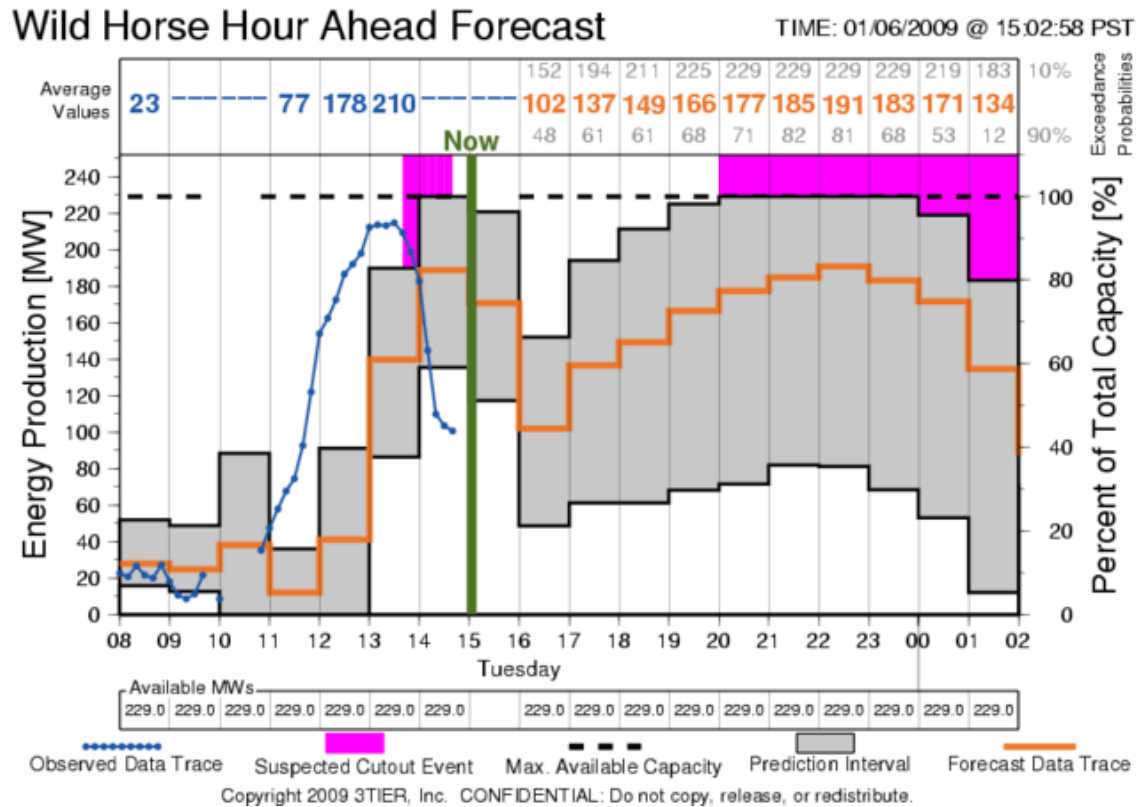


# Wind Interconnection Challenges

- ◆ Wind Variability
  - ◆ Hourly
  - ◆ Daily or Weekly
  - ◆ Annual
- ◆ Voltage Control
- ◆ Reactive Power
- ◆ System Harmonics
- ◆ Low (or Zero) Voltage Ride-Through

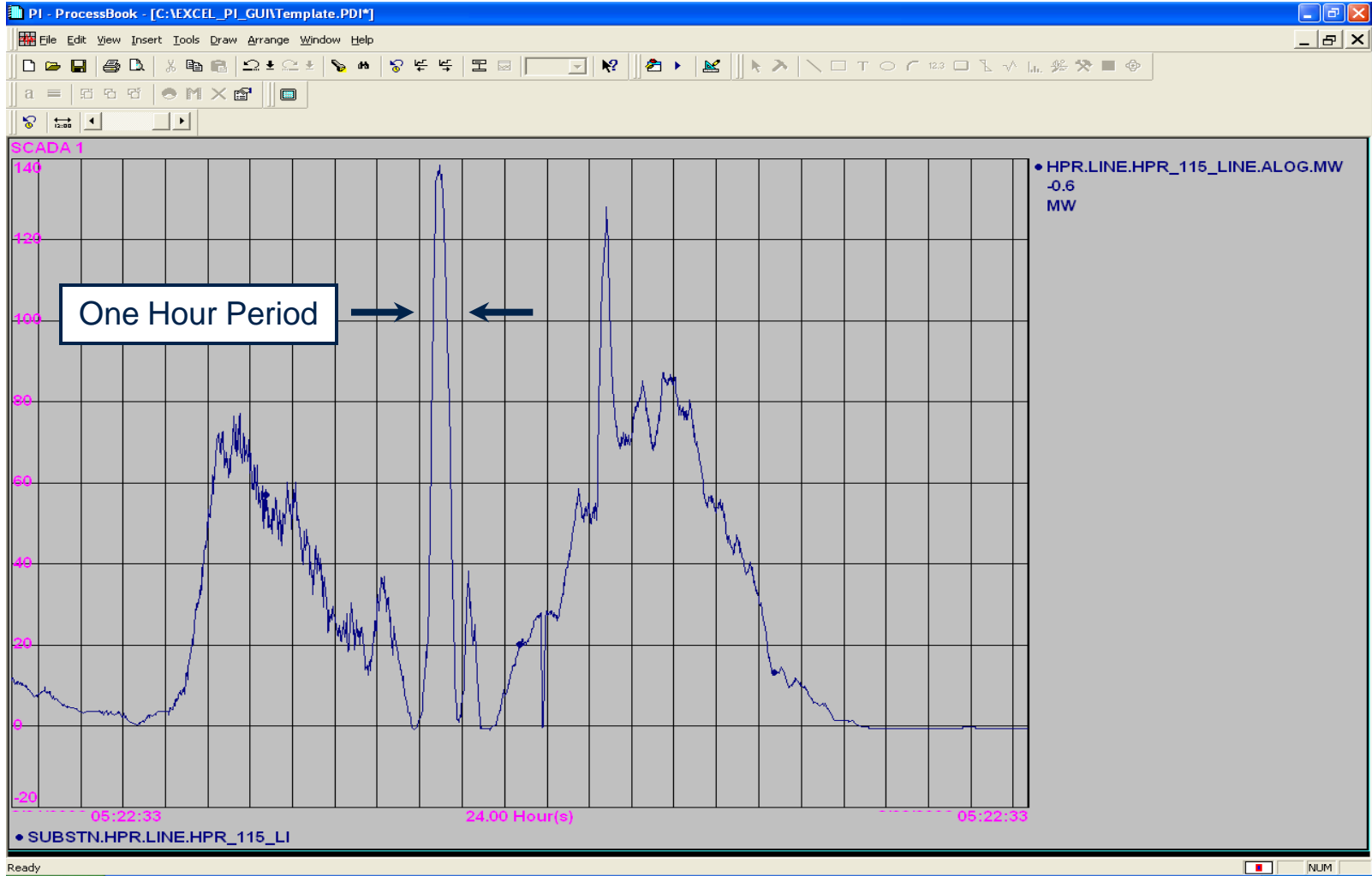


# Wind Forecasting



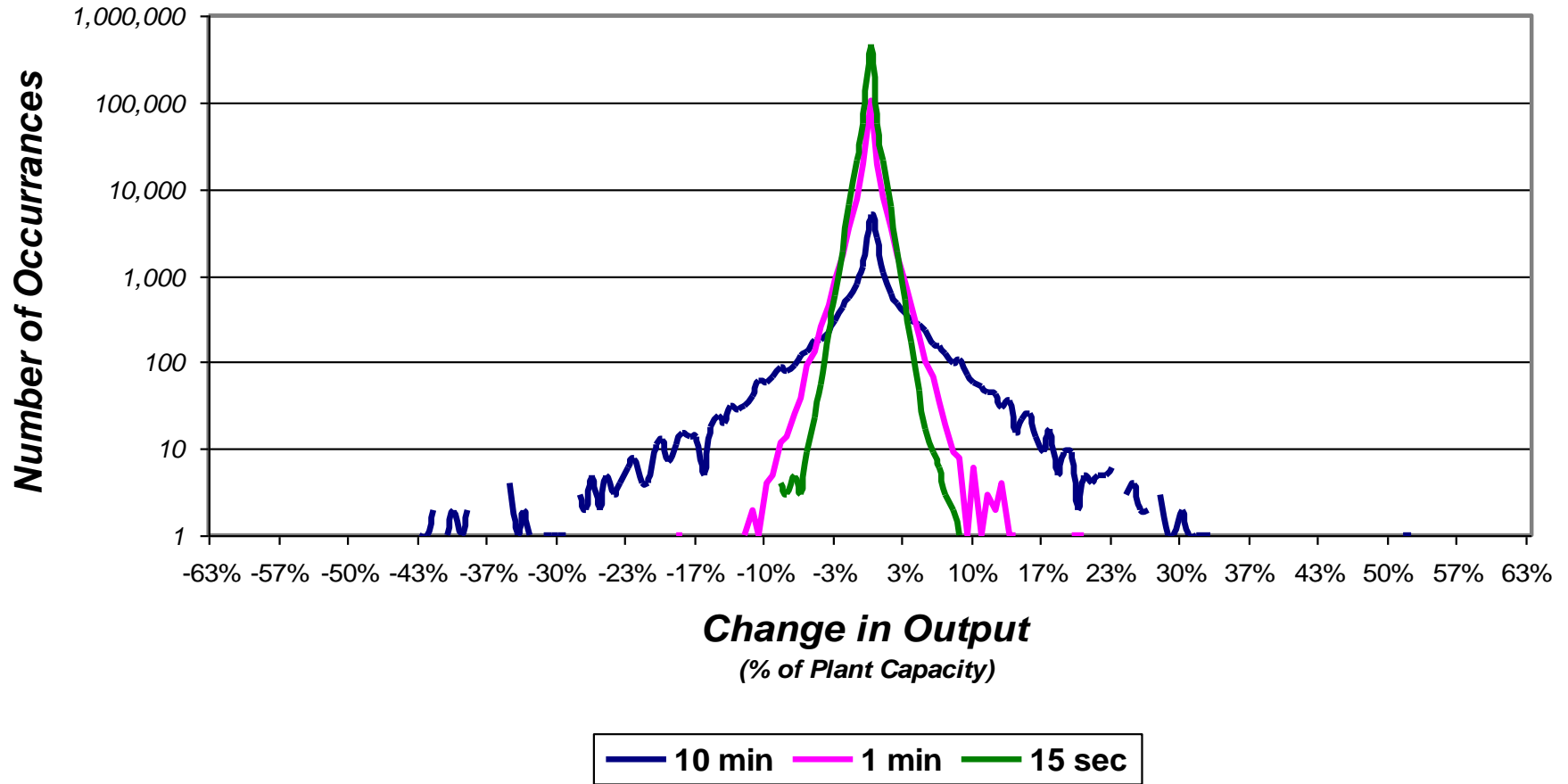
- ◆ Automated forecasts for Seasonal, Week-, Day-, and Hour-ahead periods
- ◆ Plant Ramps and High Wind Speed Cut-outs are the biggest challenge
- ◆ Schedule position set 90 minutes prior to end of next hour

# A Day in the Life...

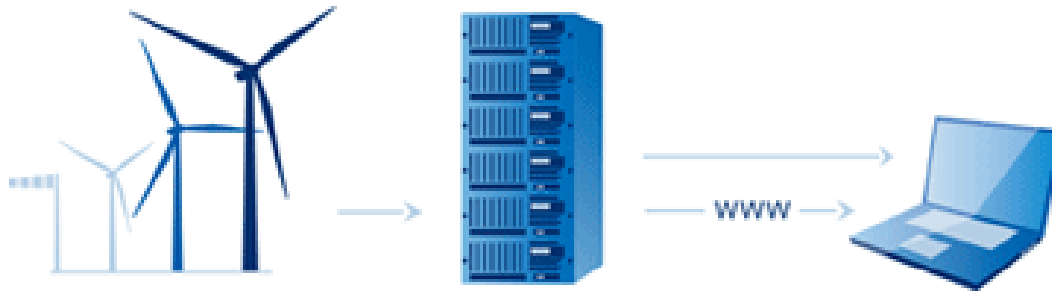


# Wind Variability Distribution

## Typical 4-month Variance Period for 150 MW Wind Farm



# Wind Farm Dispatch and Control



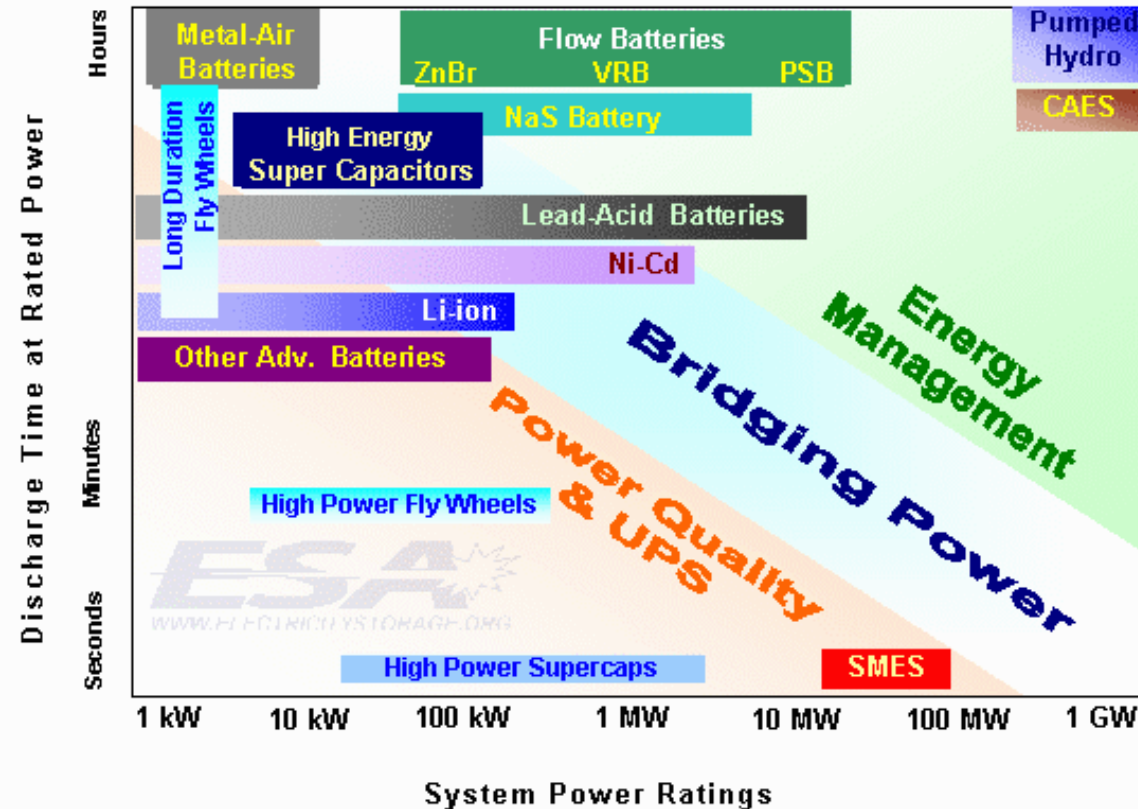
- ◆ Operated like any other Generation Plant
- ◆ SCADA System Allows Remote Access
  - ◆ Troubleshooting and O&M Support (Engineering)
  - ◆ Monitoring and Reporting (Trading & Marketing)
  - ◆ Command and Control (System Operations)
- ◆ Potentially Competing Interests
  - ◆ Assure System Reliability (always wins)
  - ◆ Optimize Costs for Customers
- ◆ Wind Capacity can be 15% of Load

# Wind Resource Balancing

- ◆ Utilize Entire Resource Portfolio to Balance Wind
  - ◆ Hydroelectric (Fast response to AGC)
  - ◆ Gas fired CCCT (Set-point control, flexible)
  - ◆ Gas fired SCCT (Fast ramp capacity)
  - ◆ Long-term Contracts (Some flexibility)
  - ◆ Spot Market Buy/Sell (Opportunity cost)
  - ◆ Coal fired Steam (Slow response)
  - ◆ Wind Spill (Set-point control, Curtailment option)
- ◆ Differing Resource Stack to Balance Wind
  - ◆ System Conditions
  - ◆ Wind Up-ramp
  - ◆ Wind Down-Ramp
  - ◆ Voltage Control Needs
  - ◆ Unit Status
  - ◆ Unit Load
  - ◆ Boundary Conditions
  - ◆ Plant / Market Economics
- ◆ Bulk Energy Storage is a Key Enabling Technology



# Energy Storage Technologies



- ◆ License Applications at FERC
  - ◆ 34,000 MW in New Hydro
  - ◆ 20,000 MW in Storage Projects

- ◆ Distributed Scale
  - ◆ Batteries
  - ◆ Flywheels
  - ◆ Thermal Storage
  - ◆ Regenerative Fuel Cells
  - ◆ Hydrogen Conversion
  - ◆ High-Power, High-Energy Super Capacitors
- ◆ Large Scale
  - ◆ Pumped-Hydro Storage
  - ◆ Compressed Air Energy Storage
- ◆ Problems
  - ◆ High \$/kW cost
  - ◆ Efficiency Penalty

# Variable Generation Solutions

- ◆ Operational Solutions
  - ◆ Central Dispatch of Wind Facilities
  - ◆ Automatic generation control on appropriate hydro & thermal units
  - ◆ Enhance turn-down of existing non-hydro generating units (gas or coal-fired)
  - ◆ Add generation projects having Load Following flexibility and/or Dispatch Capacity
  - ◆ Improved wind forecasting accuracy of Ramps and Hour-Ahead
  - ◆ Last Resort: Spill Wind Generation
- ◆ Policy Solutions
  - ◆ Balancing Authority pooling to share load-following & reserve capabilities
  - ◆ Schedule energy trading with smaller blocks and shorter durations
  - ◆ Build / Upgrade transmission paths to renewable energy zones
  - ◆ Smart-Grid technology deployment
  - ◆ NHA working with AWEA on national solutions
- ◆ Storage Solutions
  - ◆ Investment or combo tax incentives for Energy Storage
  - ◆ Deploy bulk energy storage systems

