



# Wind Integration

*Understanding the relationship between  
Hydro and other Renewables -  
A Utility's Perspective*

**Irena Netik**

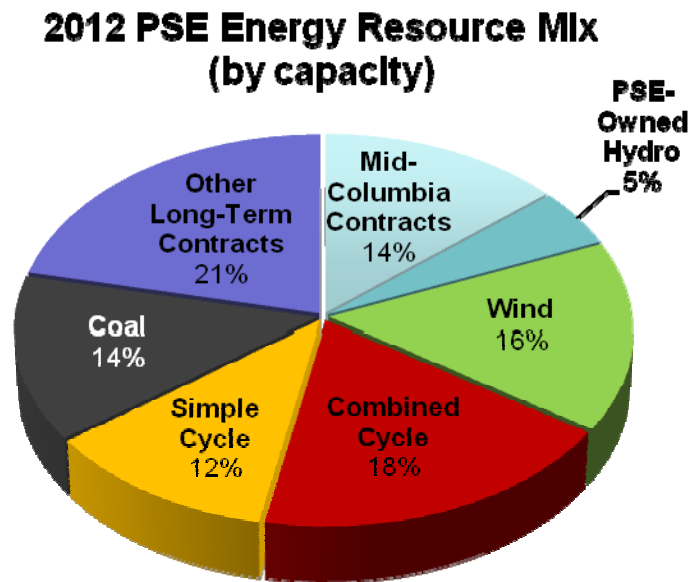
*Manager, Generation Operations*



October 4, 2011



# PSE's Resource Portfolio and Hydro's Role



## Hydro provides numerous benefits:

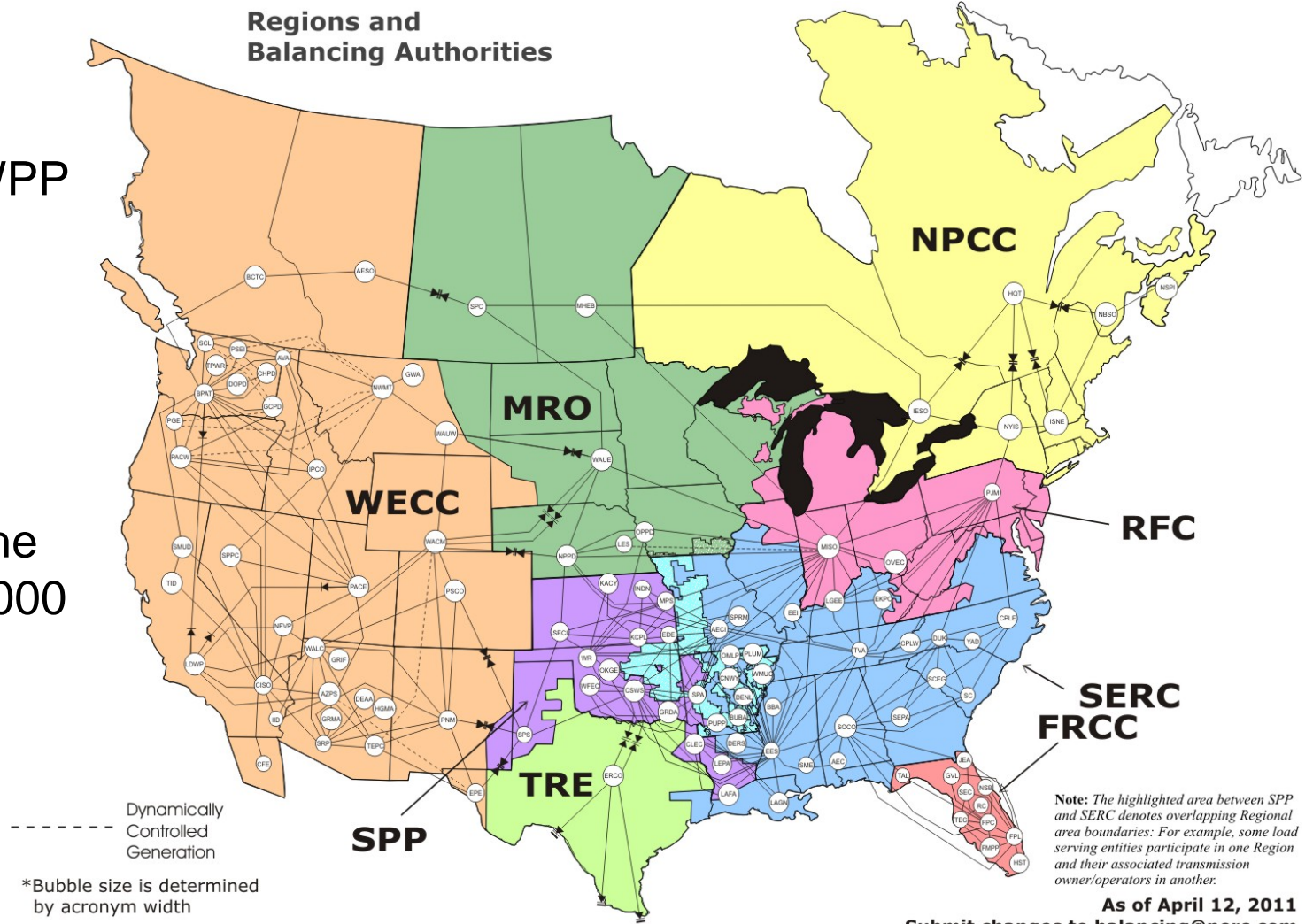
- Energy production
- Capacity
- **Load following**
- **Regulation**
- **Contingency reserves**
- **Wind balancing and managing wind uncertainty**
- Sustained peaking
- Remedial Action Scheme

➤ In 2012, PSE will own and operate 743 MW of wind.



# Numerous Balancing Authorities in a single region

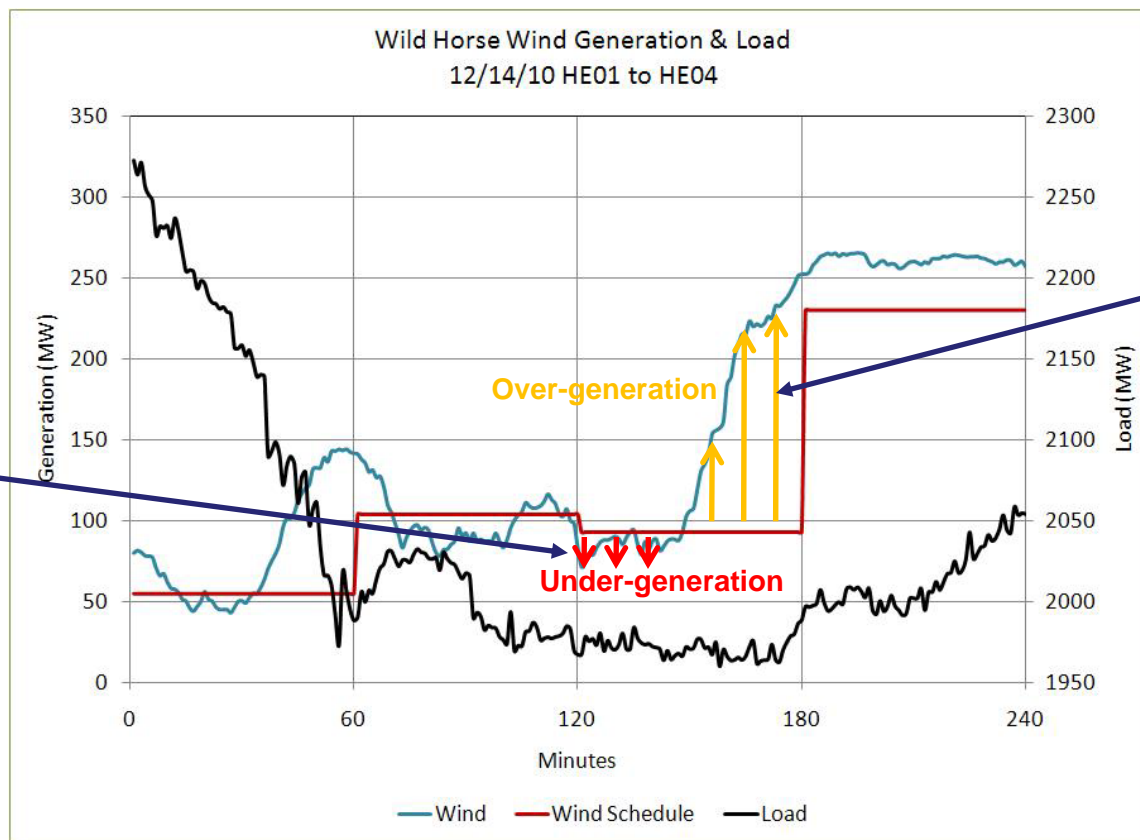
- 30+ BAs in WECC
- 19 BAs in NWPP
- No organized sub-hourly market
- Almost 5,000 MW of wind operating in the region and 2,000 MW under construction





# Wind is a variable and uncertain resource

- Load and wind are both **variable** and require balancing.
- Wind introduces additional **uncertainty** because it is less predictable than load.

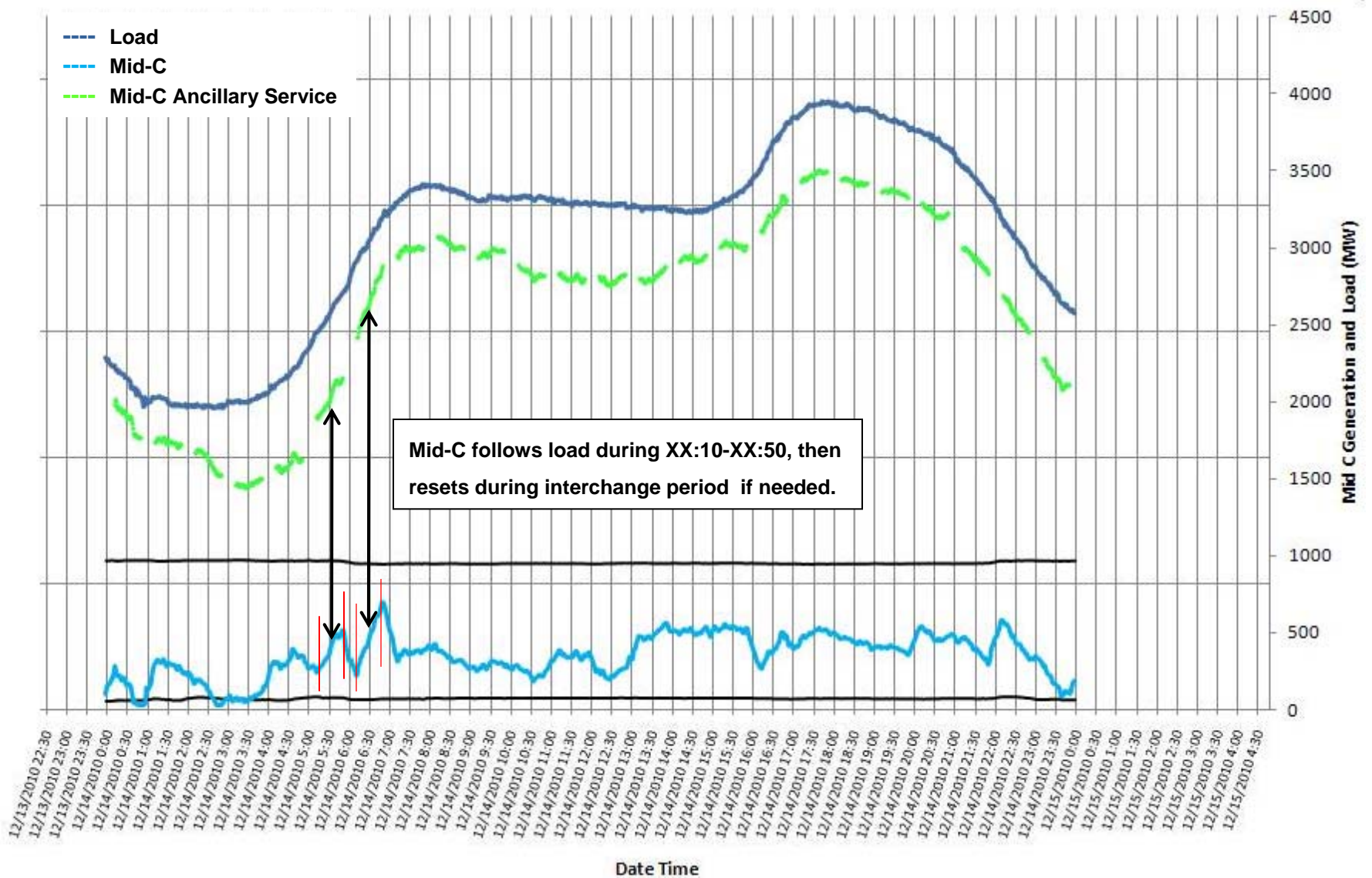


Wind generates less than schedule; system generation must be increased.

Wind generates more than schedule; system generation must be reduced.



# Ancillary Services In Action

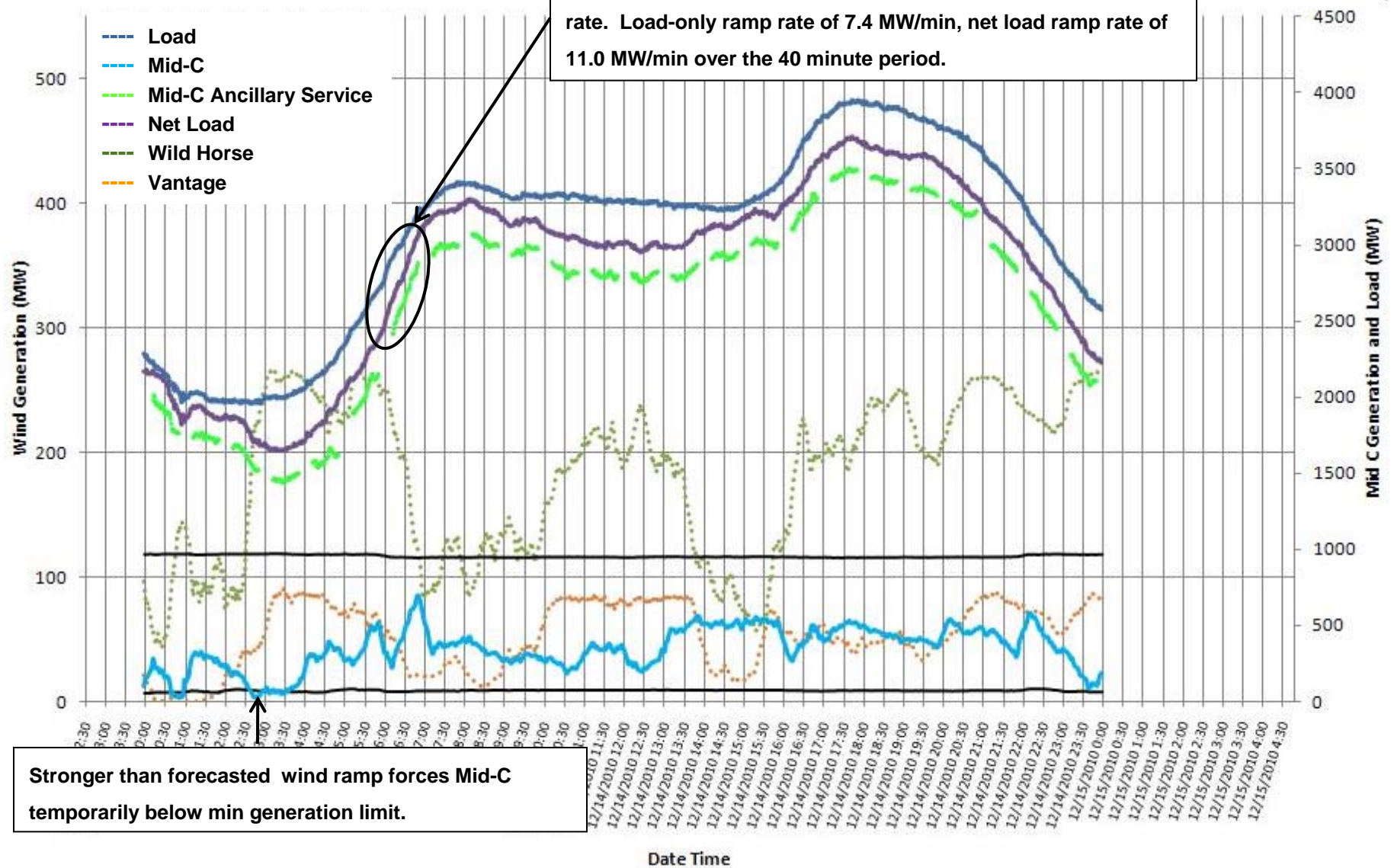




# Ancillary Services In Action



Unanticipated drop in wind generation increases net load ramp rate. Load-only ramp rate of 7.4 MW/min, net load ramp rate of 11.0 MW/min over the 40 minute period.



Stronger than forecasted wind ramp forces Mid-C temporarily below min generation limit.



## Final Thoughts

- Wind resources introduce additional uncertainty and variability to the system and can impact the reserves needed in every hour.
- The marketplace needs to improve our ability to take advantage of the benefits of geographic diversity of wind.
- The region needs to develop a functioning within-hour balancing market.