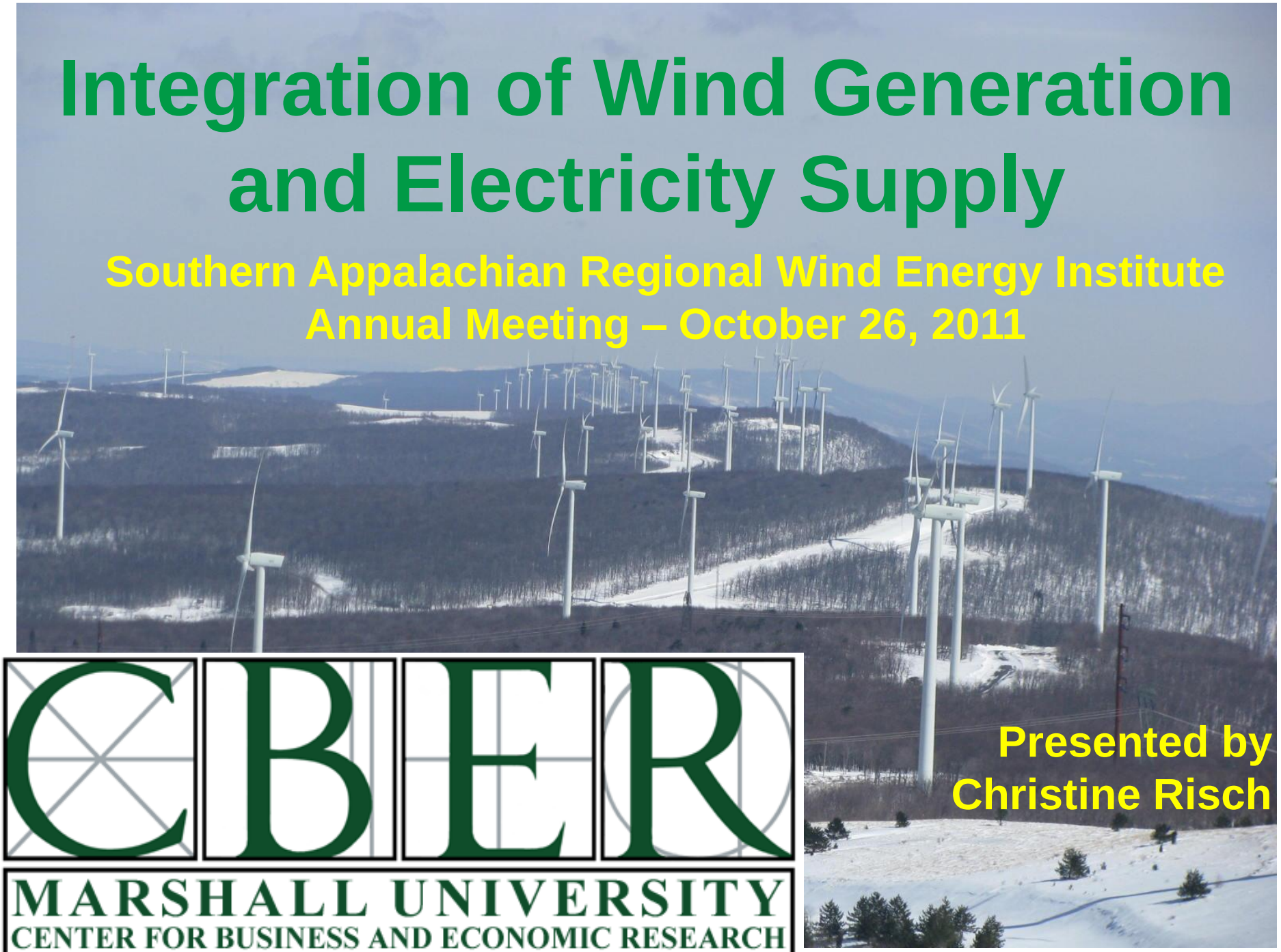
Integration of Wind Generation and Electricity Supply

Southern Appalachian Regional Wind Energy Institute
Annual Meeting – October 26, 2011



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Presented by
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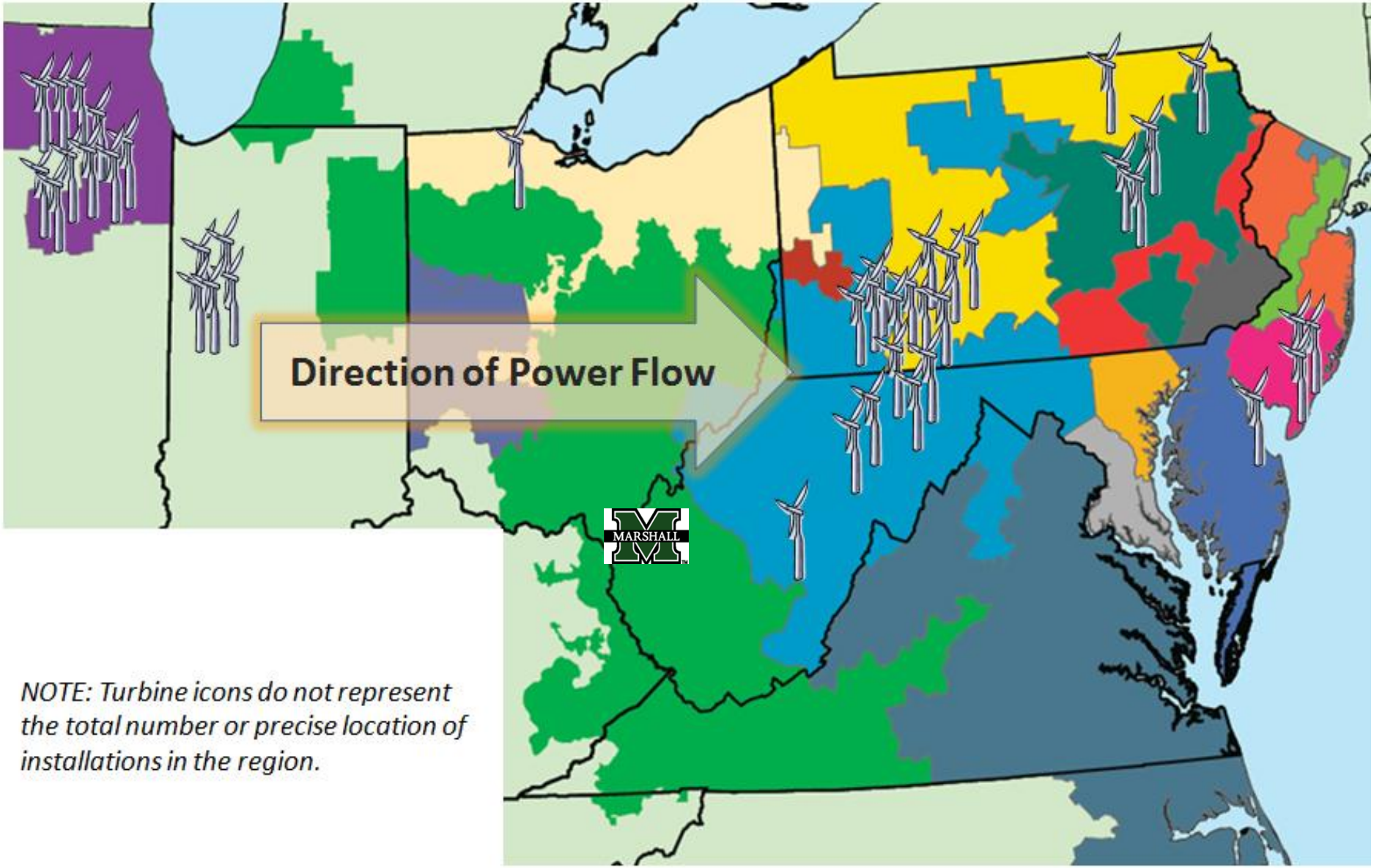
PJM Territory



NOTE: Turbine icons do not represent the total number or precise location of installations in the region.

Wind Integration

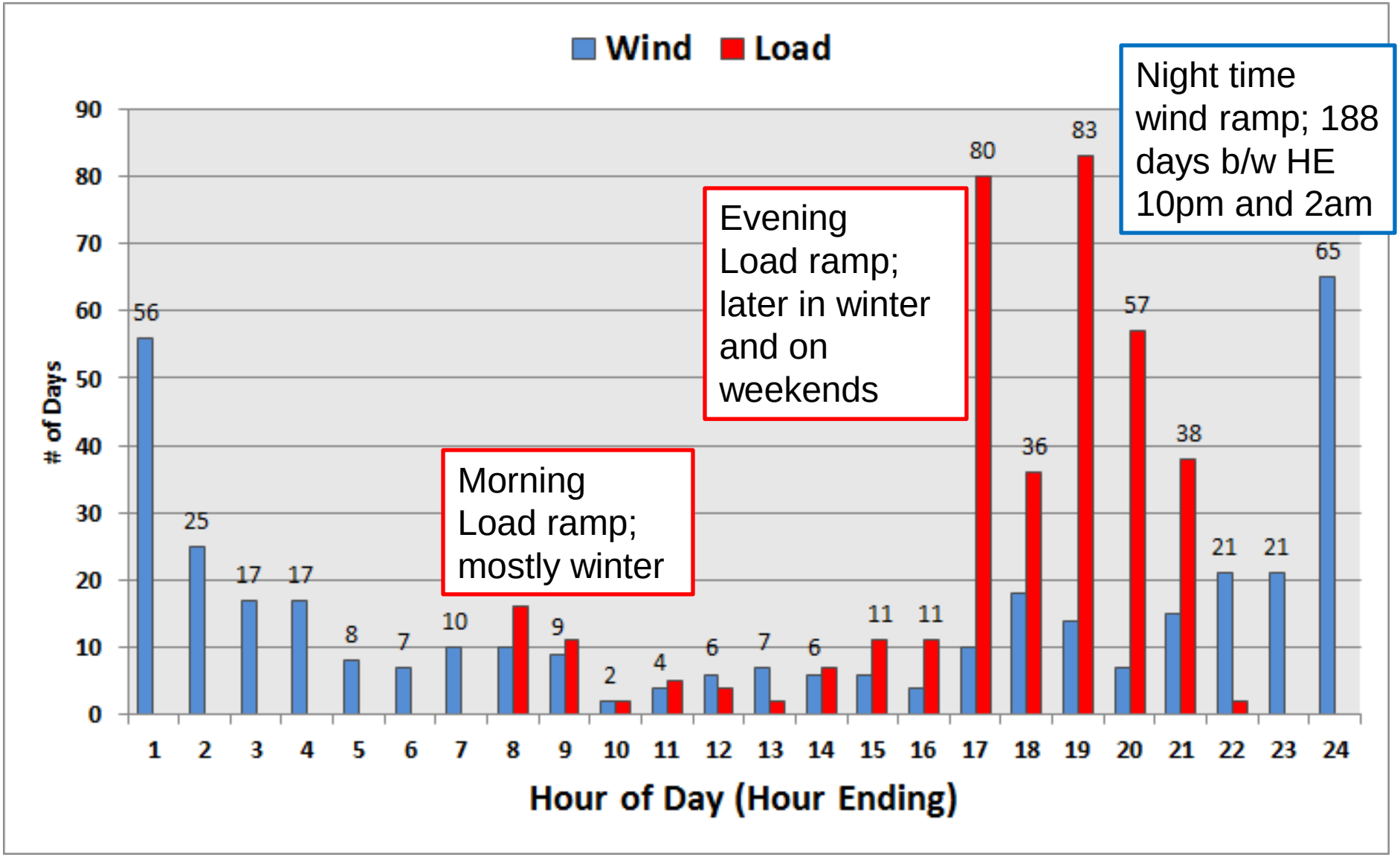
- How does wind impact the electricity delivery system?
  - Real-time: wind impacts system voltage and frequency; other generators compensate
  - Near-term (hour-to-hour): wind output is not constant; other resources must change output to compensate
  - Short-term (day-ahead) – most units commit to being available the day before
  - Long-term (years) – system planning requires firm capacity to meet future demand

An Near-Term Example: Fri Oct 15, 2010 and Wed Oct 20, 2011

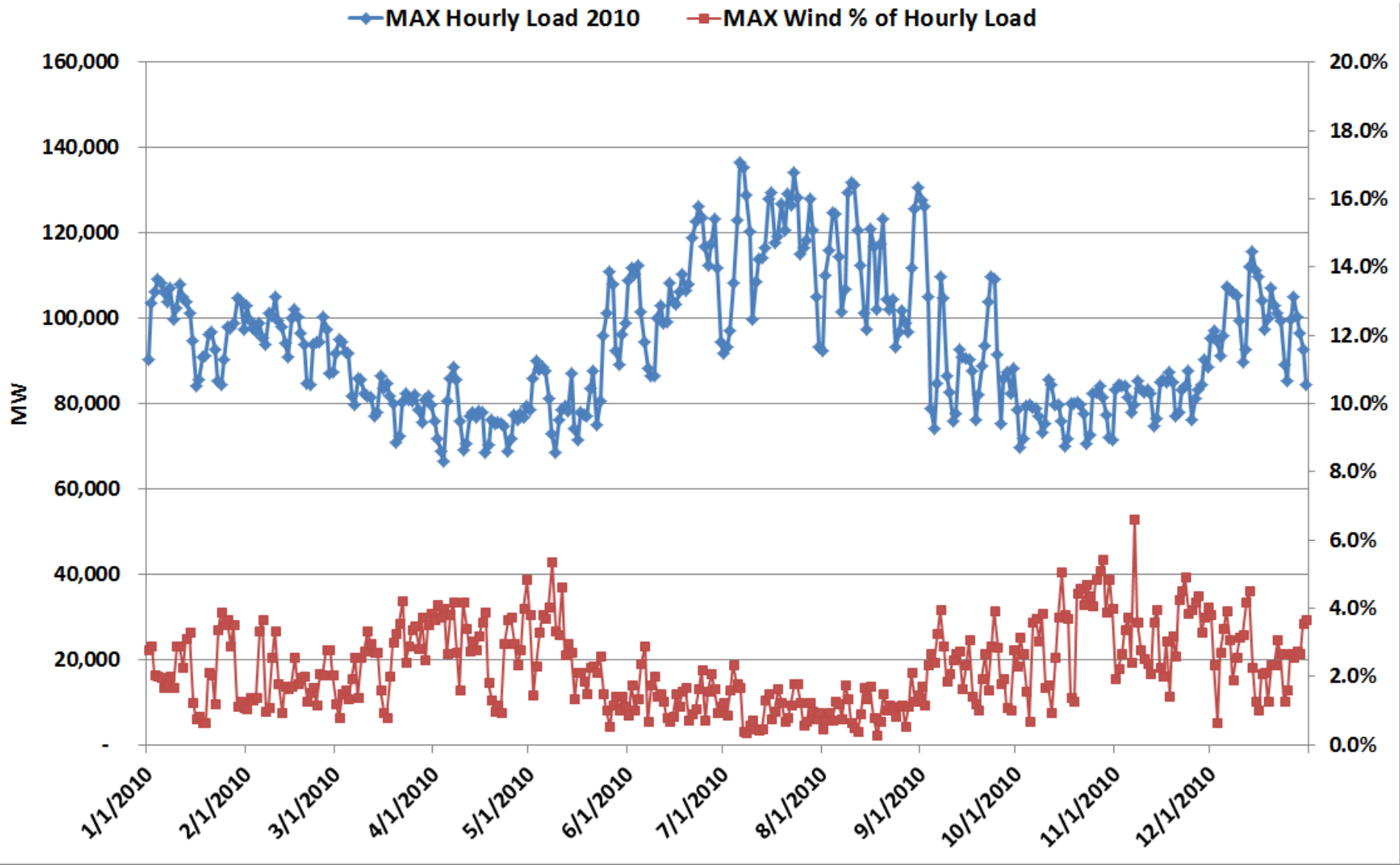
Time	PJM Load (MW)	Wind Output (MW)	Wind as % of Load
Friday October 15, 2010			
2:23 am	56,709	3,110	5.5%
7:53 am	74,304	2,446	3.3%
12:20 pm	75,717	1,131	1.5%
4:40 pm	72,653	1,154	1.5%
Thursday October 20, 2011			
3:00 am	64,544	3,805	5.9%
7:00 am	82,390	3,393	4.1%
11:00 am	87,093	3,404	3.9%
3:00 pm	85,951	3,281	3.8%

Getting bigger

Hour of Daily Peak Load & Wind Output in PJM, 2010 (# of Days at Hour - HE)



Max Hourly Load per Day & Wind as Max % in PJM, 2010



Wind Integration

- **What are some solutions to problems?**
  - Real-time: use electronic controls to make wind turbines like conventional generators; add more fast-acting reserves.
  - Near-term (hour-to-hour): add more flexible generation including demand response
  - Short-term (day-ahead): forecast wind output accurately to optimize unit commitment
  - Long-term (years): prove the capacity value of wind, demand response and flexible resources

Some NERC and FERC Comments

- FERC regulates transmission. Recommends:
  - Allowing utilities to charge wind facilities for regulation services; however, wind is not the only type of plant that causes a need for regulation
  - Mandating wind facilities share met data with utilities
  - Having RTOs find a way to allocation transmission costs
- NERC ensures reliability. Recommendations:
  - Make system more flexible; ramping, min gen levels, curtailment, demand response, storage; consolidate BAs; more intra-hour scheduling; expand transmission/ remove constraints
  - Improve wind forecasting; makes wind predictable
  - Real-time communication essential

Why PJM?

- RTOs play an important role:
  - Ensure NERC standards met
  - Set protocol for generators (negative LMP, payments for lost opportunity costs)
  - Charged with implementing FERC orders: are tasked to incorporate transmission costs into tariff
  - Help coordinate transmission of mid-west wind to east across many utilities
  - Has features of optimal organization for wind integration

General Recommendations to Maximize System Efficiency at Wind Grows

	pjm Doing?
1) Wind forecasting and integration of that information.	✓
2) Consolidation of balancing areas	✓
3) Use intra-hour markets (flexibility)	✓
4) Create supplementary markets with services or protocols to ramp supply up or down.	✓
5) Expand markets for demand response.	✓
6) Incorporate energy storage.	✓
7) Expand transmission.	✓

Summary

- The impact of wind integration is conditional:
  - Other generators and fuel prices
  - Time of day: morning ramp different from night-time
  - Load: is seasonal
  - Congestion on grid: geography
  - Weather


THANK YOU