The Integration Challenge

State-Federal RPS Collaborative Webinar

Hosted by Clean Energy States Alliance
August 28, 2012

CleanEnergy States Alliance

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CleanEnergy States Alliance

State-Federal RPS Collaborative

- With funding from the **Energy Foundation** and the **US Department of Energy**, the **Clean Energy States Alliance** facilitates the **Collaborative**.
- Includes **state RPS administrators and regulators**, **federal agency representatives**, and other stakeholders.
- Advances dialogue and learning about RPS programs by **examining the challenges and potential solutions** for successful implementation of state RPS programs, including **identification of best practices**.
- To get the **monthly newsletter** and announcements of **upcoming events**, sign up for the listserv at: www.cleanenergystates.org/projects/state-federal-rps-collaborative

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The Integration Challenge

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Integrating Renewable Energy Into the Western U.S. Grid: Challenges and Opportunities

State-Federal RPS Collaborative

Lisa Schwartz

Aug. 28, 2012

The Regulatory Assistance Project

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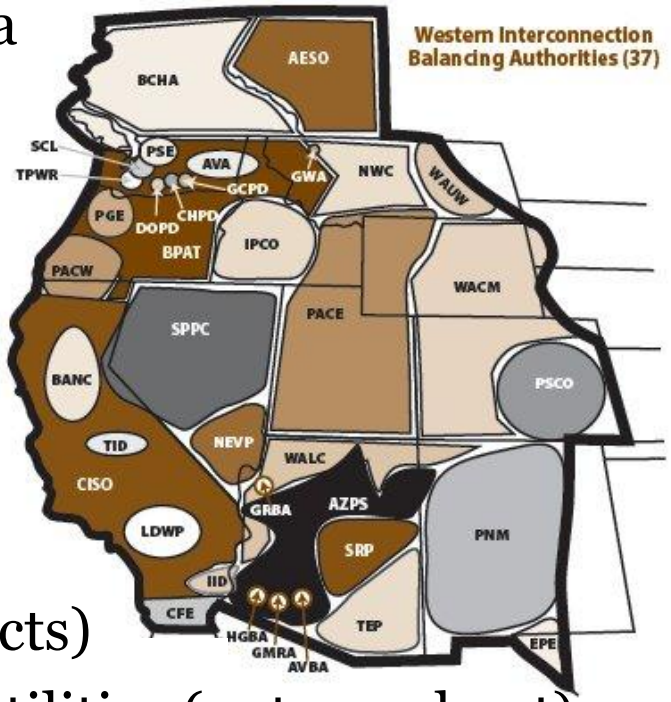
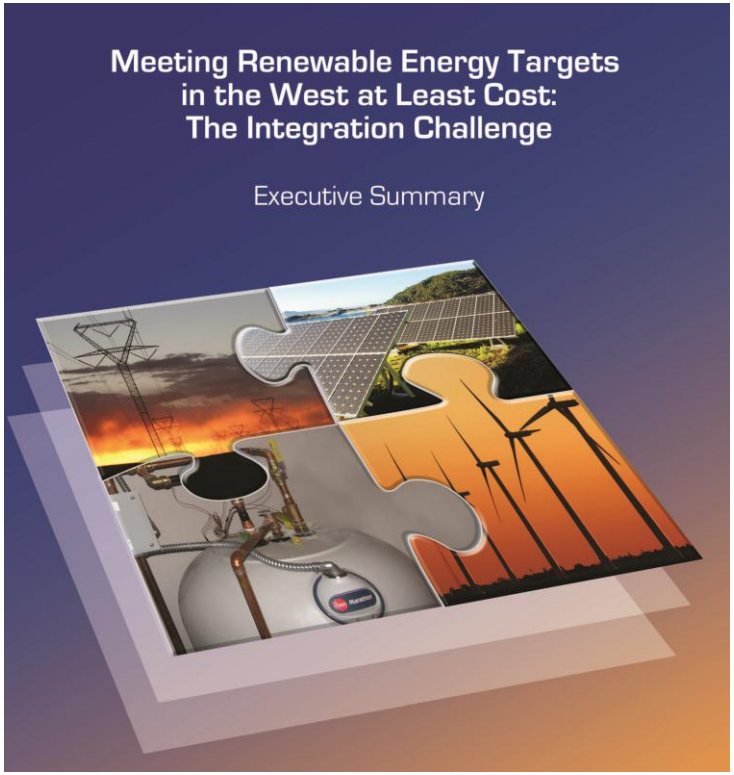
Western U.S. Electric System

- 37 balancing authorities* in the Western Interconnection
- 14 states, 2 Canadian provinces, N. Baja
- Outside organized energy markets (AESO, CAISO) + some pilots, energy and transmission are scheduled hourly
- 2 federal agencies market power from dams, own/control much transmission
- Utilities choose resources based on their long-term plans and competitive bidding (utility-owned plants or contracts)
- Transmission development largely by utilities (not merchant)
- State renewable energy standards in place today will more than double renewable resources in Western U.S. by 2022, compared to 2010



**Balancing authorities maintain load-interchange-generation balance within their area and support interconnection frequency in real time*

- New Western Governors' Association report explores ways to reduce costs for integrating wind and solar resources, barriers and possible state actions
- By RAP (lead), Exeter Associates & National Renewable Energy Laboratory
- Funded by Energy Foundation and U.S. Department of Energy



- Technical committee helped with scope, resources, review
- Focuses on operational and market tools, flexible demand and supply resources (not storage or expanding transmission)

Executive summary: http://www.westgov.org/index.php?option=com_joomdoc&task=doc_download&gid=1602
Full report: http://www.westgov.org/index.php?option=com_joomdoc&task=doc_download&gid=1610

Integration Challenges for Renewable Energy

- **Variability** – *The range of expected generation and load*
  - Variability is reduced with more resources spread over a wider area because of the diversity of weather patterns.
- **Uncertainty** – *When and how much generation and load will change*
  - Operators plan based on forecasts of loads and generation sources.
  - Uncertainty of wind and solar output is due to unknown changes in weather.

SunEdison facility, Aurora, Colo.

NREL

- **Conventional units also impose integration costs.**
  - For example, new inexpensive baseload plants can cause other units to incur cycling costs and lower their capacity factor.

How Can Grid Flexibility Be Increased?

- **Improved institutional flexibility**
  - Fast energy markets and short scheduling intervals for transmission
  - Balancing wind and solar resources over a large geographic area to net out changes in load and generation
  - Use advanced solar and wind forecasting techniques
  - Make better use of existing transmission capacity
- **A more flexible generating fleet**
  - Cost-effective modifications of existing plants may be possible to improve load-following capability (ramp rate up and down, lower minimum load and faster startup capability)
  - For new generating plants, focus on flexibility
- **Demand response** – Some loads can respond rapidly (up and down) with automation
- **Adequate transmission**
- **Energy storage** – Such as pumped hydro, batteries, compressed air, plug-in electric vehicles

Broad Conclusions of Report

- The Western grid is operated inefficiently.
  - Hourly scheduling
  - Insufficient automation
- We're spending more than needed for integration.
  - Carrying too many reserves, and dispatching higher cost generation when lower cost generation is available
- Integrating high levels of renewable resources reliably and affordably will require unprecedented cooperative action.
- States can accelerate efforts to reduce costs, such as:
  - Asking utilities and transmission providers what they are doing to put in place the recommendations in the report
  - Convening parties to discuss benefits of least-cost delivery of wind and solar resources and develop solutions to institutional barriers

1. Improve Institutional Flexibility

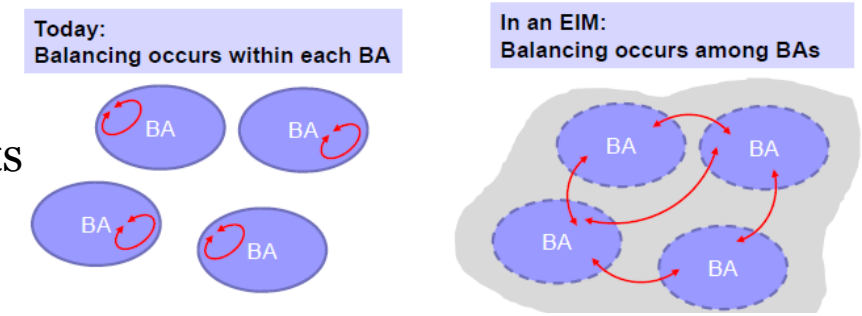
- Expand subhourly dispatch and scheduling
  - Some 30-min. pilots in Western U.S. New FERC rules require all transmission providers to offer 15-minute scheduling or consistent/superior alternatives.
  - **Key recommendations**
    - Evaluate costs/benefits, standardize intra-hour scheduling across West
- Facilitate dynamic transfers
  - They allow the balancing authority receiving energy from wind or solar in another area to manage the intra-hour integration.
  - **Key recommendation**
    - Prioritize transmission improvements to increase transfer capability
- Improve reserves management
  - **Key recommendations**
    - Expand reserve-sharing
    - Explore calculating reserves dynamically
    - Assess benefits of using contingency reserves* for wind
    - Equip more generation with Automatic Generation Control**

**Contingency reserves are generation or demand resources available as needed to maintain electric service reliability during unforeseen events, such as an unscheduled power plant outage.*
***AGC is equipment that automatically adjusts generation from a central location.*

• Implement an energy imbalance market

Imbalance energy = Scheduled energy - actual energy delivered

- Under proposed Western U.S. EIM, initial operating conditions for each hour would still be based on traditional bilateral transactions
- EIM would re-dispatch generation every 5 minutes to manage grid constraints and supply imbalance energy from least-cost resources
- Generation would be dispatched *across* balancing authority areas to resolve energy imbalances using the full geographic diversity in the EIM footprint.
- **Key recommendations**
  - Further study costs and benefits
  - Address governance issues and concerns
  - Define rates and terms for transmission service agreements
  - Support Northwest Power Pool's evaluation of an EIM and West-wide efforts to design an EIM for the broadest footprint



PUC EIM Group: http://www.westgov.org/PUCeim/index.htm; NWPP initiative: http://www.nwpp.org/mci/

- Improve weather, wind and solar forecasting
  - Wind and solar forecasts allow better scheduling of other resources
  - <1/2 of Western balancing authorities use wind and solar forecasts
  - **Key recommendation**
    - Encourage use of forecasts for day-ahead schedules/dispatch (uncommon in West now), not just same-day unit commitment
- Take advantage of geographic diversity
  - Spreading wind and solar plants over a larger area lowers aggregate variability and forecast errors, reducing reserves needs
  - **Key recommendations**
    - Consider sites that minimize variability of aggregate output and better match utility load profiles.
    - Support right-sizing* of interstate lines that access renewable resources from stakeholder-designated zones – when project benefits exceed costs.

Alstom 2010. Photo courtesy of DOE/NREL

**Right sizing – Increasing project size, voltage or both to account for credible future resource needs*

2. Explore Demand Response That Complements Variable Generation

- Some customer loads are flexible.
- Consider direct load control (e.g., for electric water heaters) and real-time pricing with automation to shift loads up and down to complement wind and solar resources.
- **Key recommendations**
  - Test value propositions to assess customer interest in strategies for demand response that complements wind and solar
  - Encourage participation of third-party aggregators
  - Allow demand response to compete on a par with supply-side alternatives for meeting resource needs

See papers by LBNL and Navigant: http://eetd.lbl.gov/ea/ems/sg-pubs.html; http://www.calmac.org/publications/7-18-12_Final_White_Paper_on_Use_of_DR_for_Renewable_Energy_Integration.pdf

3. Develop a More Flexible Generating Fleet

At high levels of wind and solar, simply counting megawatts is inadequate for determining capacity needs. Instead, consider flexible capabilities:

- Assess whether some existing generating plants can be retrofitted to increase flexibility
  - Lower min. loads, reduce cycling costs, increase ramp rates
- Focus on flexibility for new generating plants
  - **Key recommendations**
    - Rethink resource adequacy analysis to reflect flexibility needs
    - Amend guidance for planning
    - Use competitive procurement to evaluate alternative flexible capacity solutions

See new RAP paper, *What Lies Beyond Capacity Markets?*
http://raponline.org/document/download/id/6041

About RAP

The Regulatory Assistance Project (RAP) is a global, non-profit team of experts that focuses on the long-term economic and environmental sustainability of the power and natural gas sectors. RAP has deep expertise in regulatory and market policies that:

- Promote economic efficiency
- Protect the environment
- Ensure system reliability
- Allocate system benefits fairly among all consumers

Learn more about RAP at www.raponline.org

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Integrating Renewable Energy in PJM

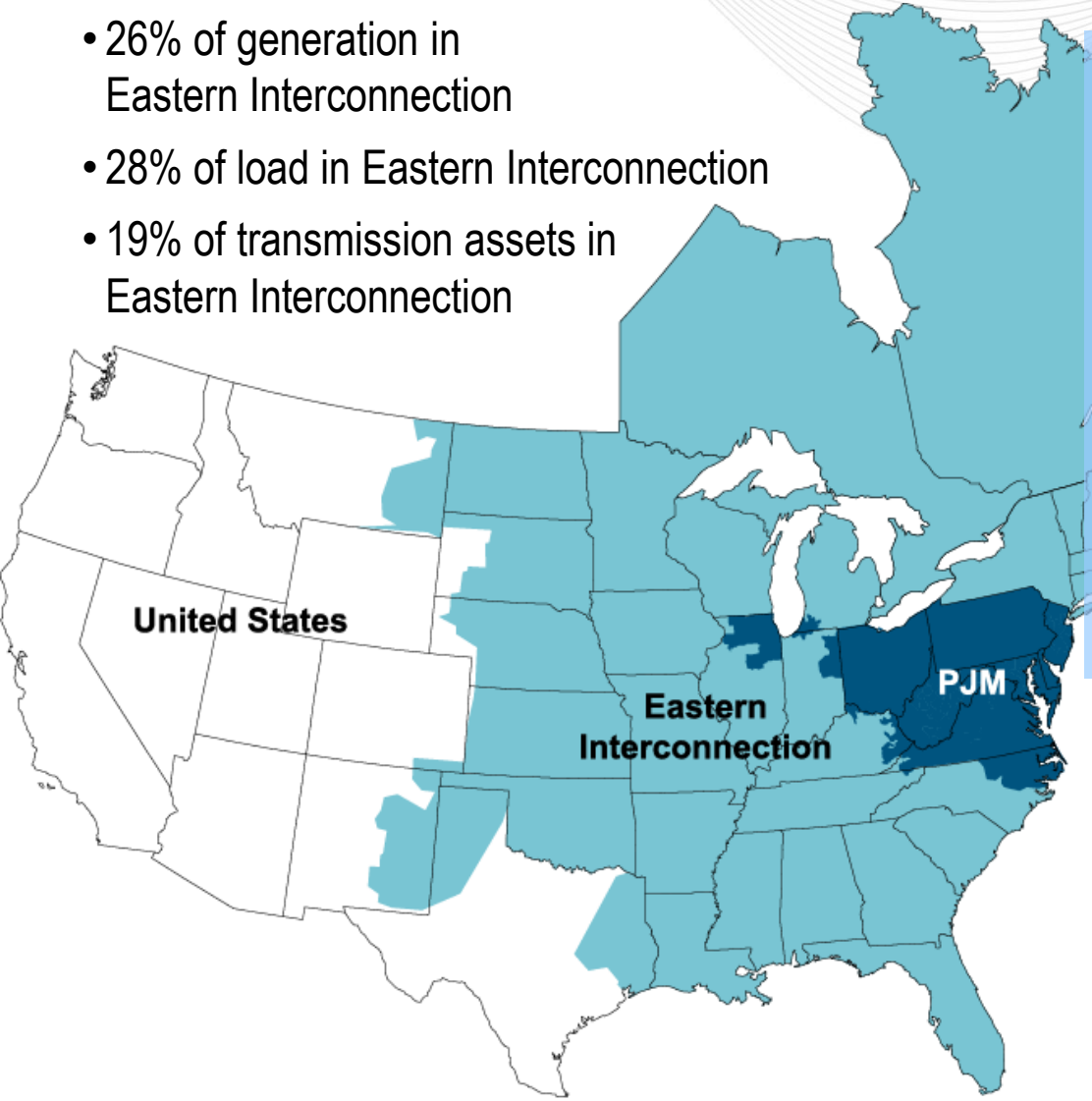
State-Federal RPS Collaborative

August 28, 2012

Ken Schuyler
Renewable Services
PJM Interconnection

PJM Interconnection, LLC

- 26% of generation in Eastern Interconnection
- 28% of load in Eastern Interconnection
- 19% of transmission assets in Eastern Interconnection



KEY STATISTICS

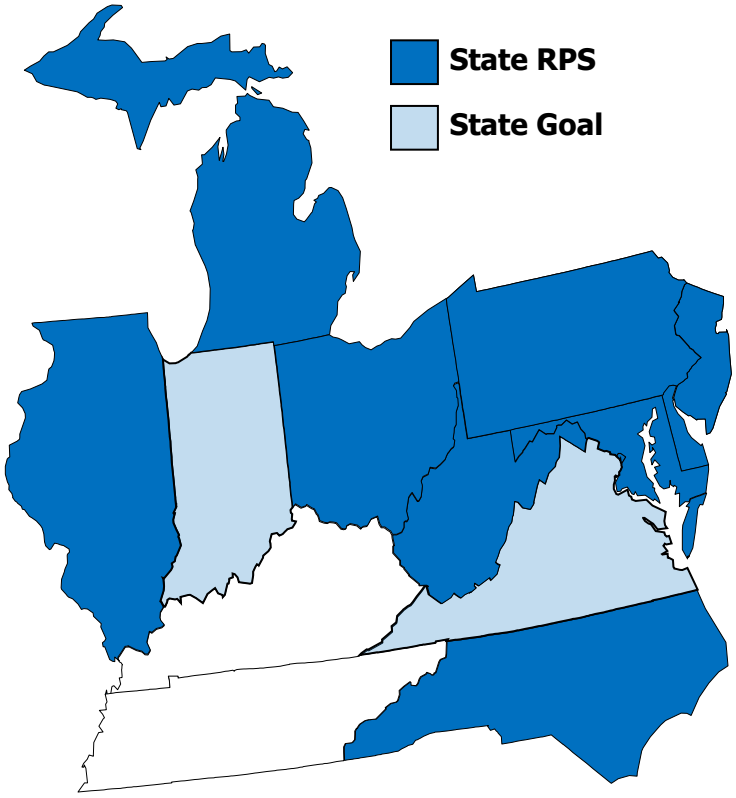
PJM member companies	750+
millions of people served	60
peak load in megawatts	163,848
MWs of generating capacity	185,600
miles of transmission lines	65,441
GWh of annual energy	832,331
generation sources	1,365
square miles of territory	214,000
area served	13 states + DC
Internal/external tie lines	142

21% of U.S. GDP produced in PJM

As of 1/4/2012

PJM States with RPS

State Renewable Portfolio Standards (RPS) require suppliers to utilize wind and other renewable resources to serve an increasing percentage of total demand.



DSIRE: www.dsireusa.org December 2011

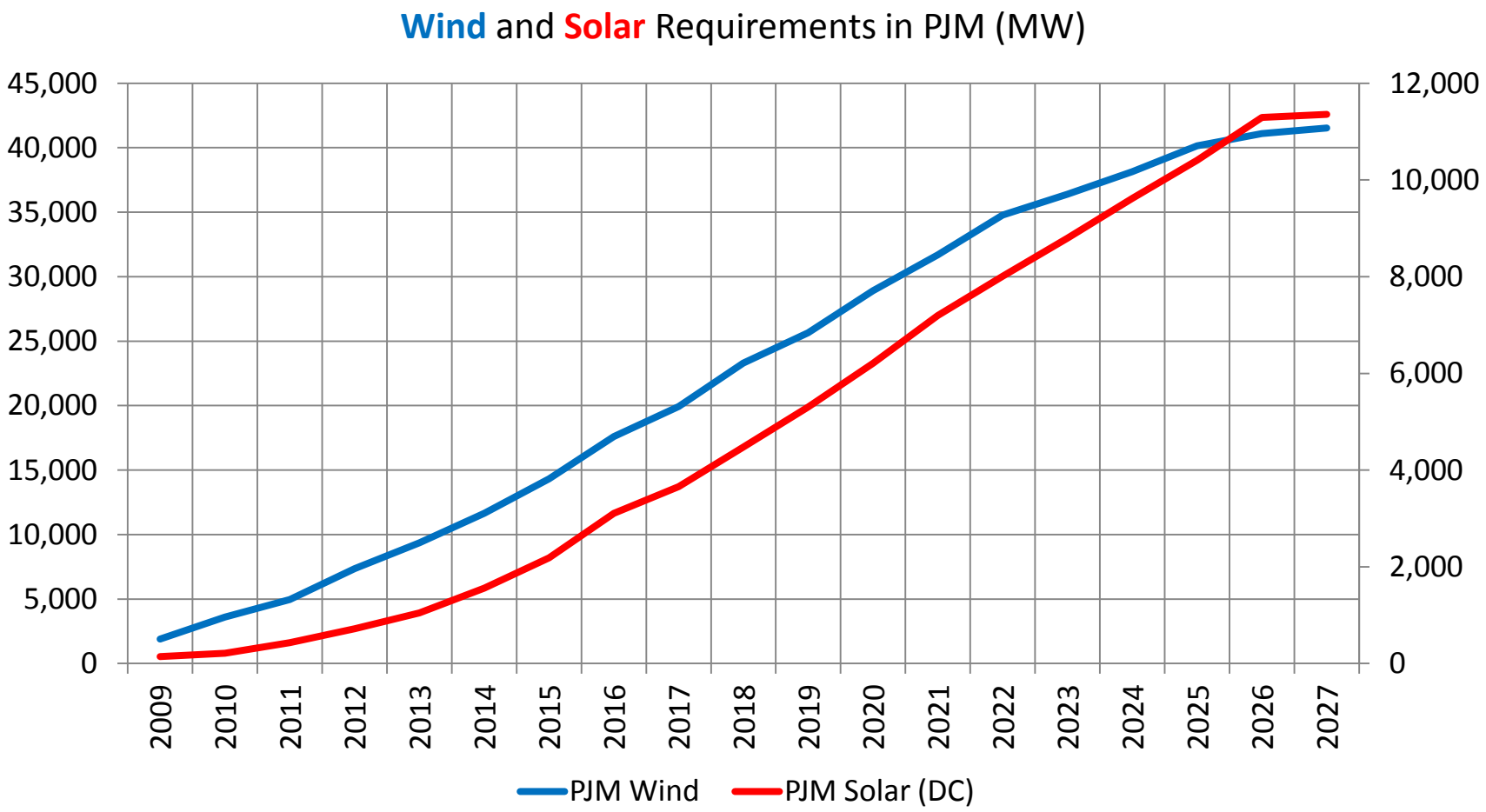
State RPS Targets:

- ☼ NJ: 22.5% by 2021
- ☼ MD: 20% by 2022
- ☼ DE: 25% by 2026
- ☼ DC: 20% by 2020
- ☼ PA: 18%** by 2020
- ☼ IL: 25% by 2025
- ☼ OH: 25%** by 2025
- ☼ NC: 12.5% by 2021 (IOUs)
- WV: 25%** by 2025
- MI: 10% + 1,100 MW by 2015
- VA: 15% by 2025
- IN: 10% by 2025

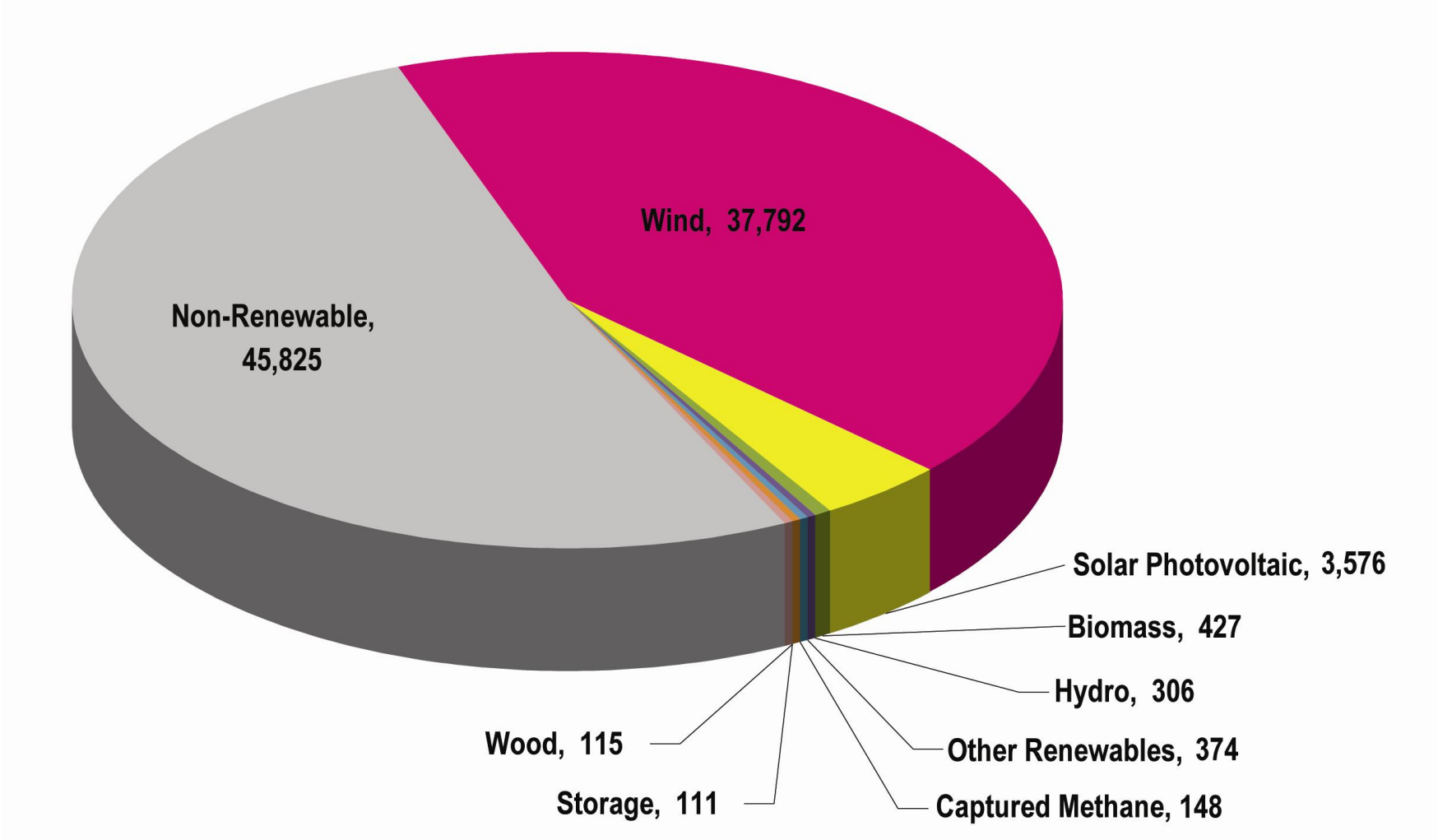
☼ Minimum solar requirement
** Includes separate tier of "alternative" energy resources

Projected Renewable Energy Requirements in PJM

By 2026: **133,000 GWh** of renewable energy, 13.5% of PJM annual net energy (**41 GW** of wind and **11 GW** of solar)

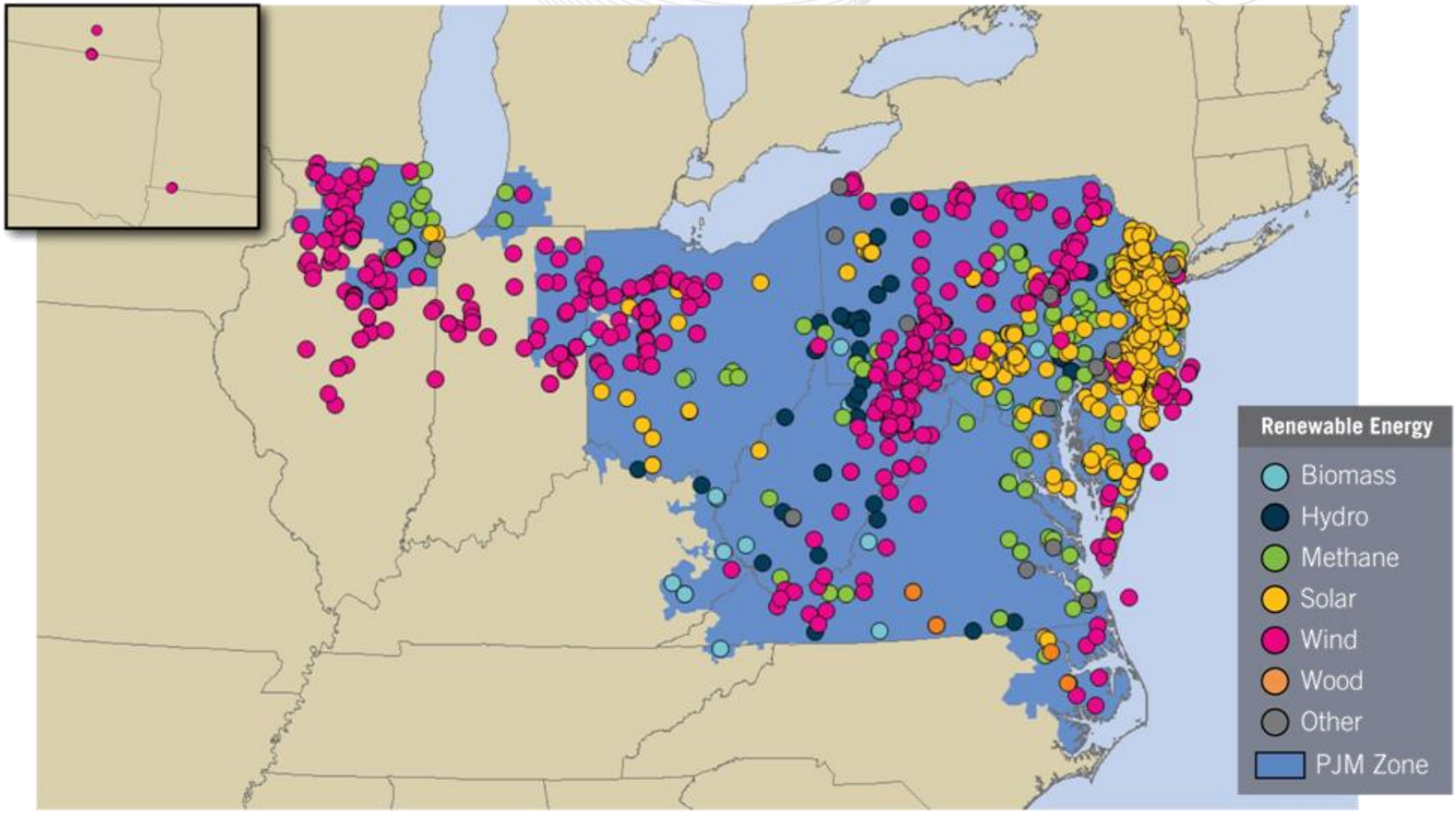


Proposed Generation (MW) in PJM



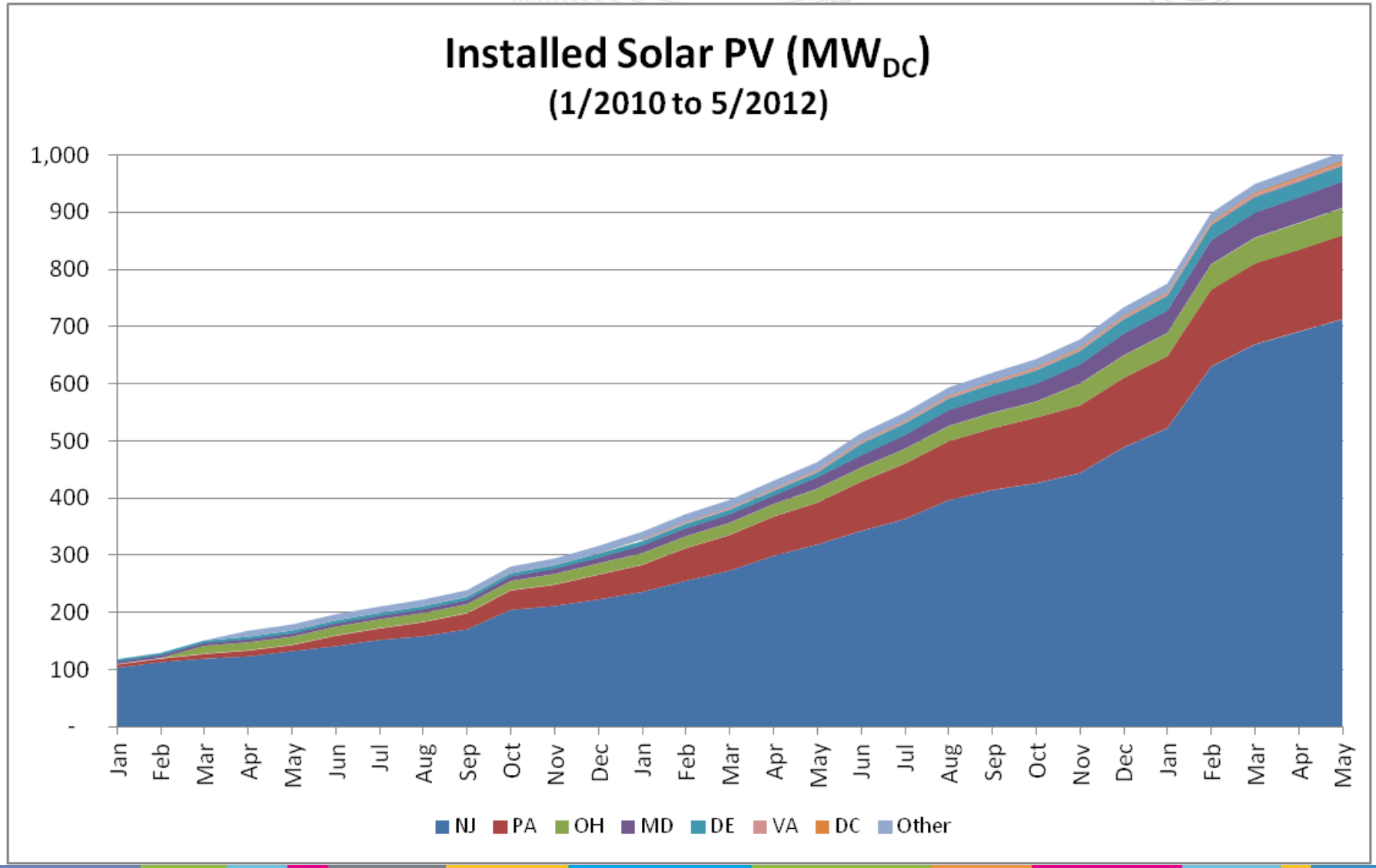
As of January 4, 2012

Proposed Renewable Generation in PJM

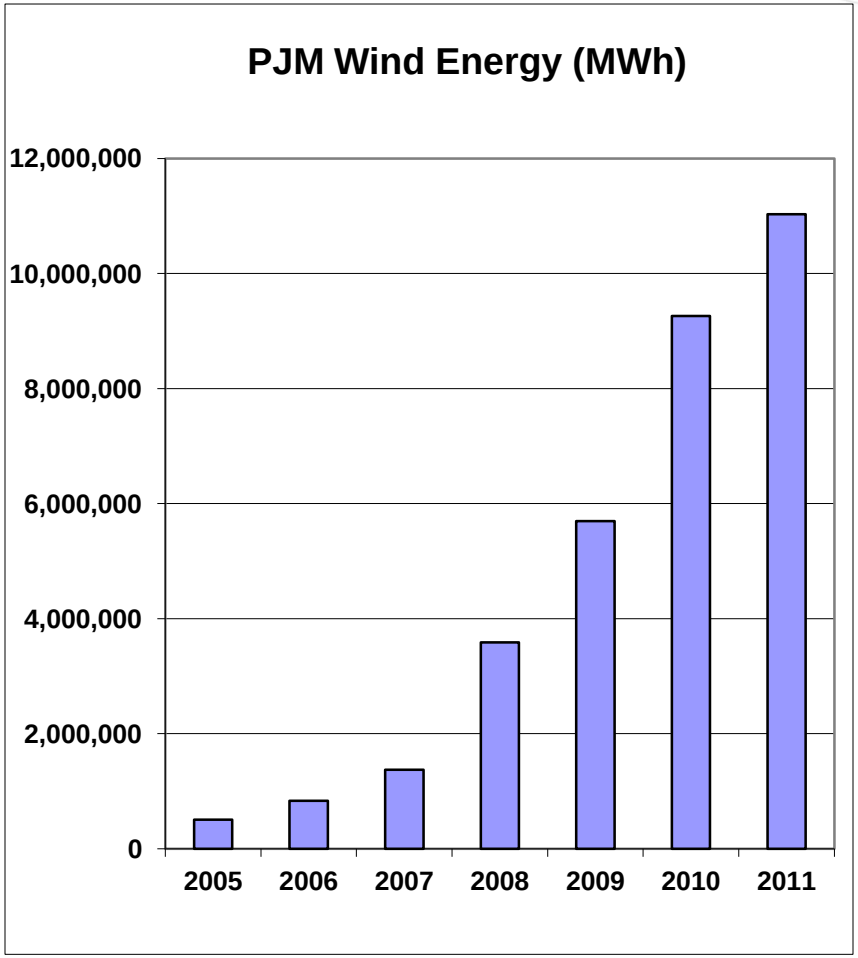


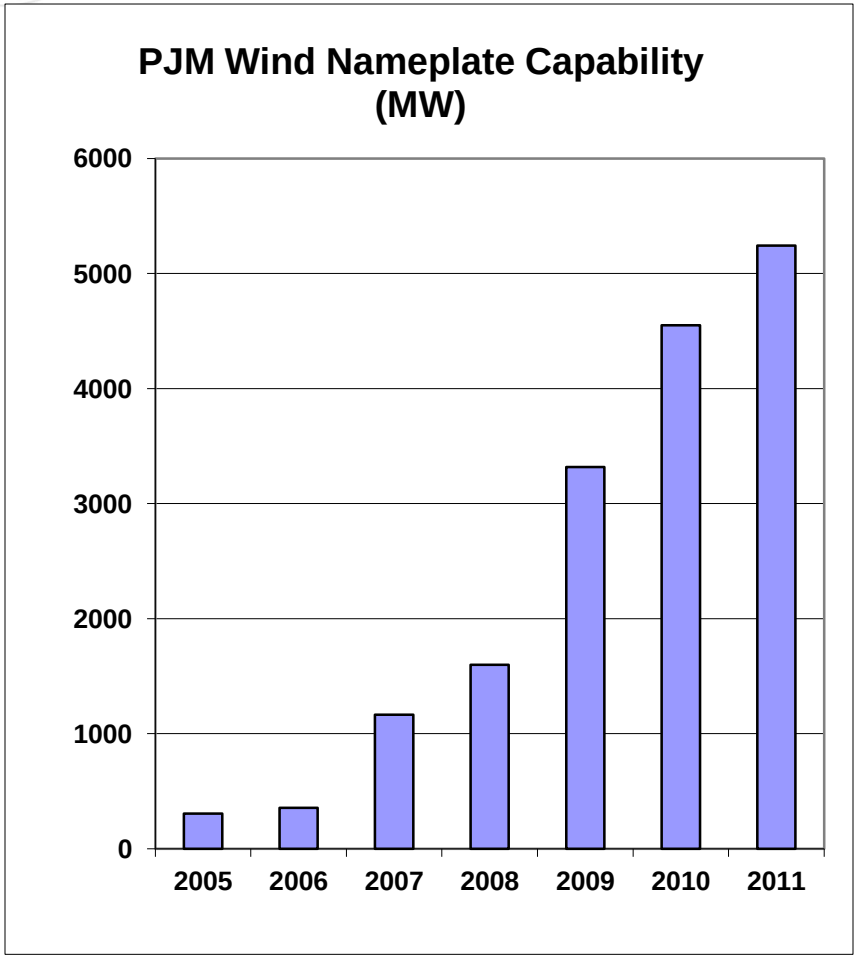
As of January 4, 2012

Installed Solar in PJM Surpasses 1,000 MW



Increasing Wind Penetration in PJM





Impact of wind power **variability** and **uncertainty**:

- **Minute-to-Minute**
  - Additional generation needed to provide regulation
- **Intra-Hour**
  - Conventional generators must adjust output
- **Day Ahead**
  - Forecast errors cause over- or under-scheduling

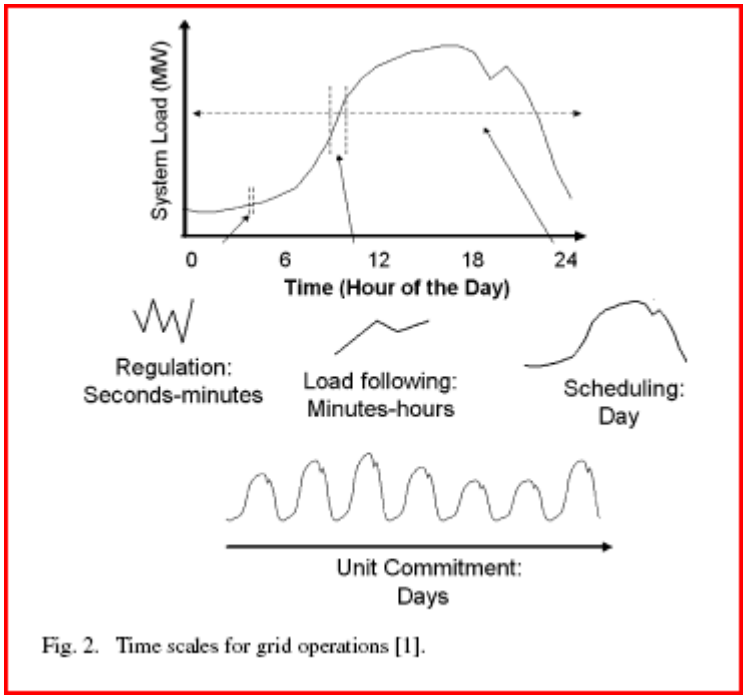
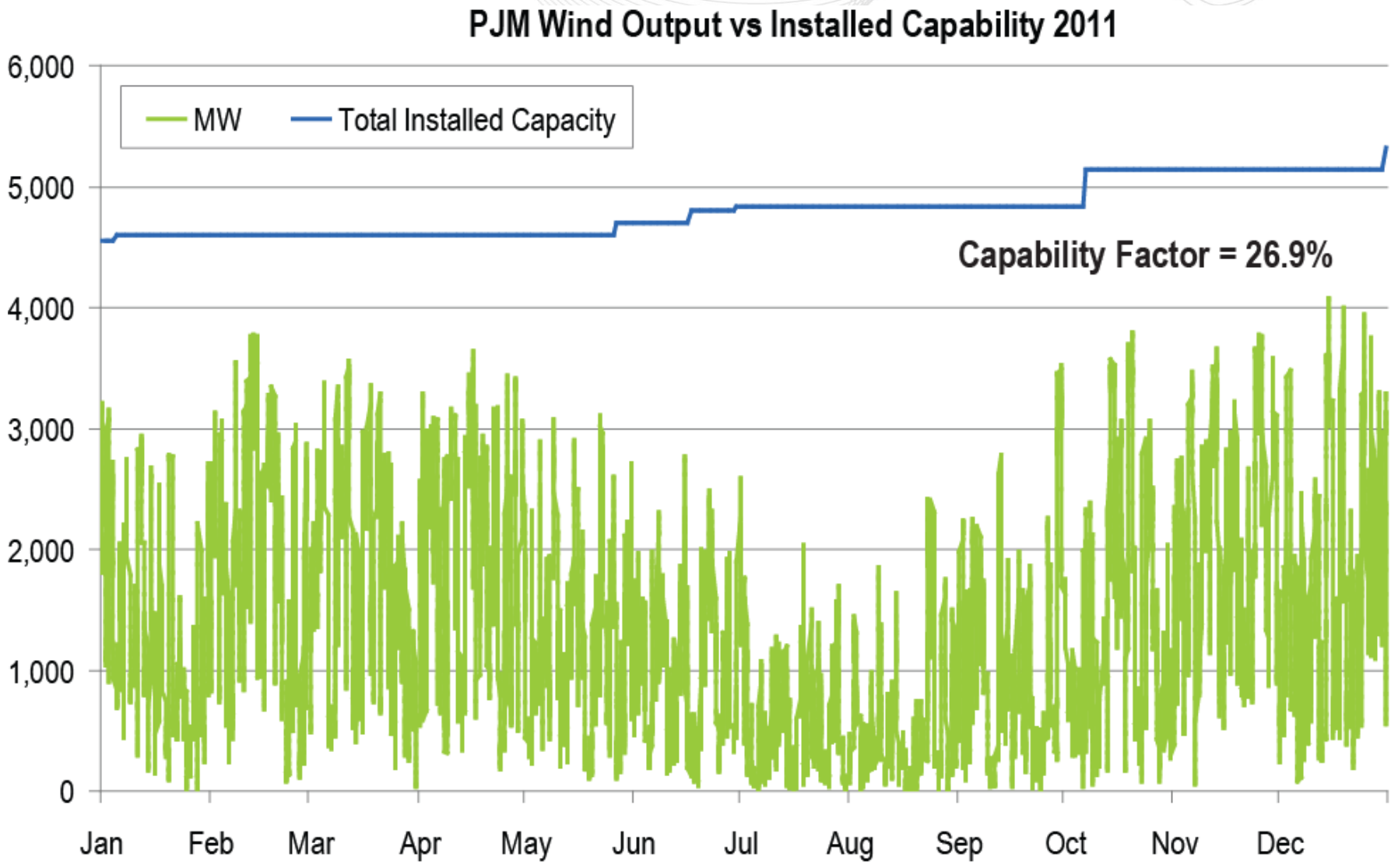


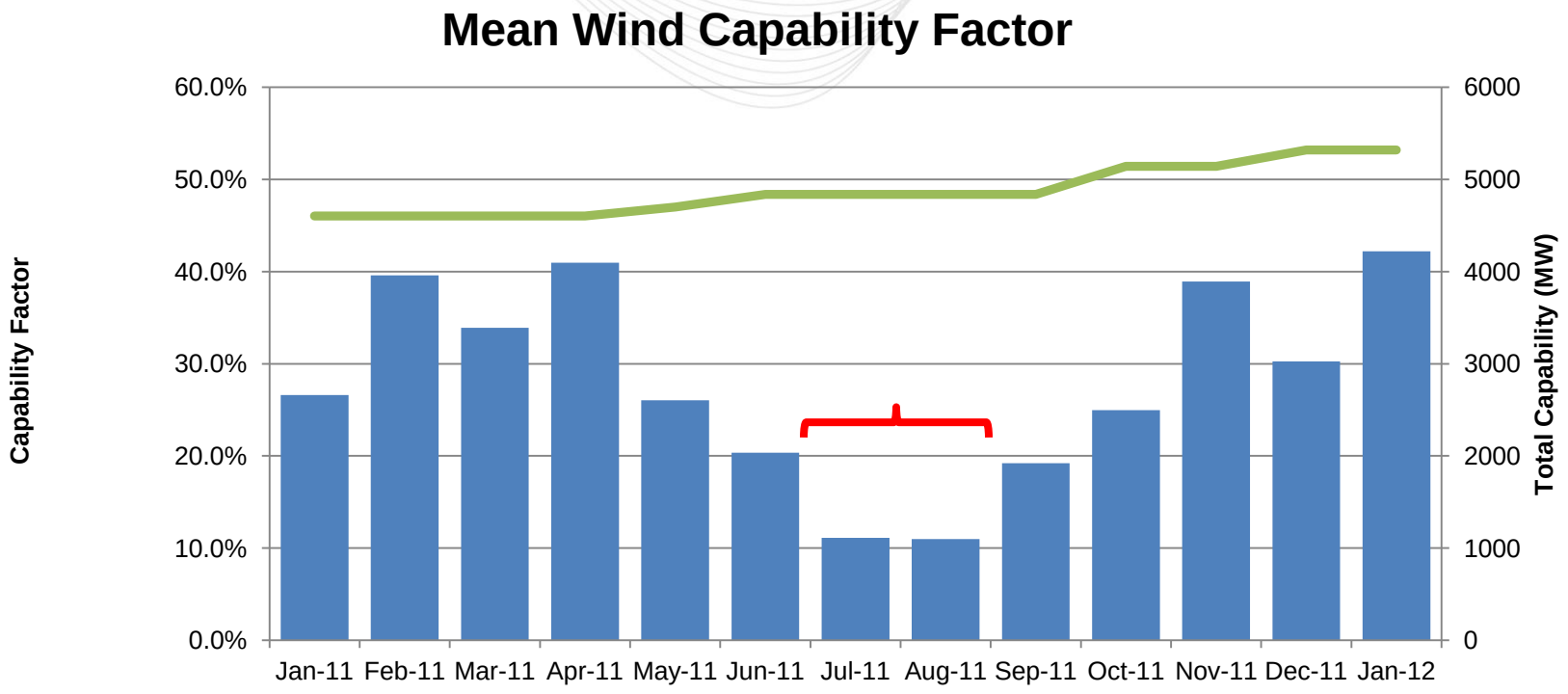
Fig. 2. Time scales for grid operations [1].

Variability of Wind Generation



Wind Generation is Lower During Summer Months

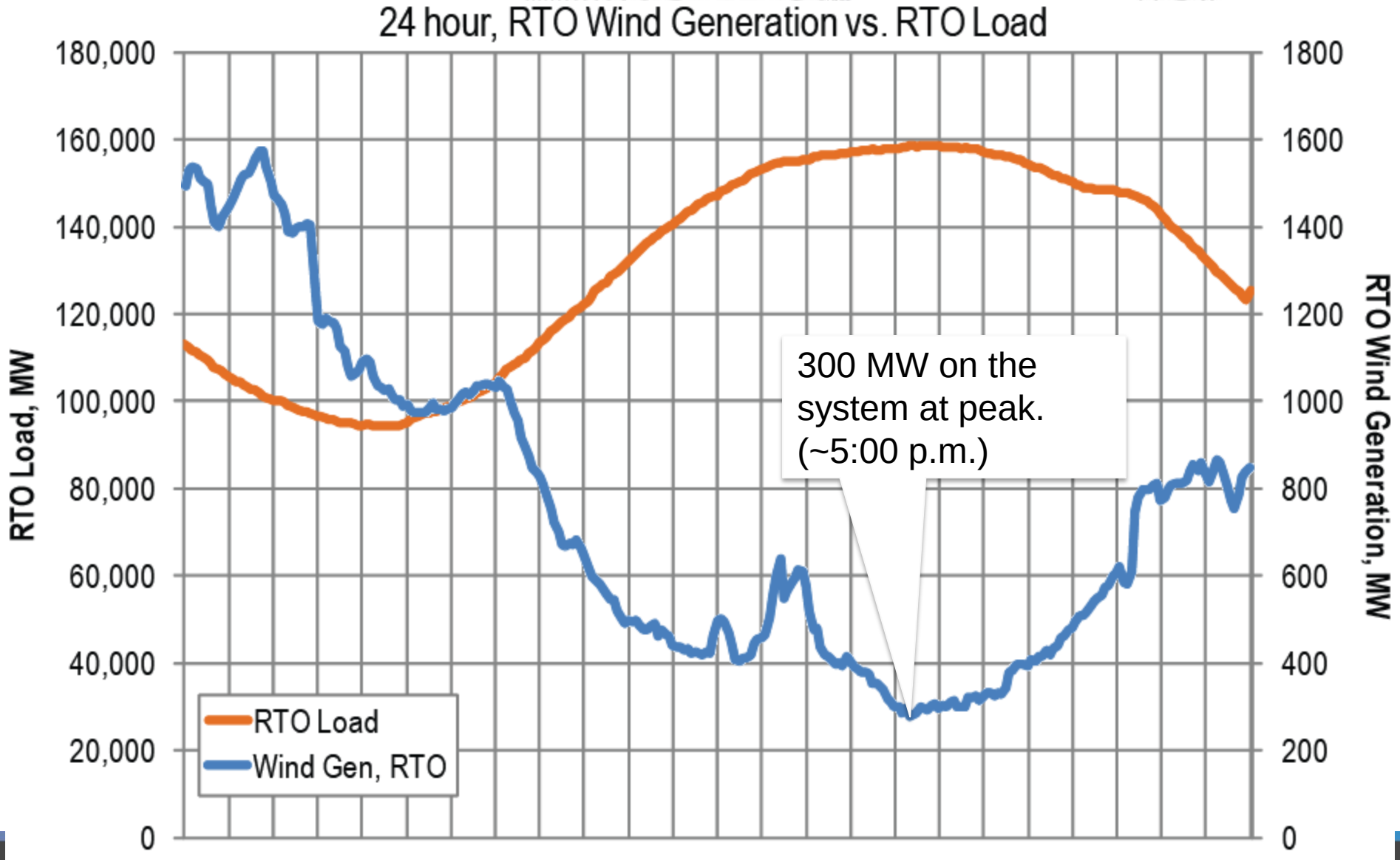
Therefore a Lower PJM Capacity Value



	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12
Capability Factor	26.6%	39.6%	33.9%	41.0%	26.0%	20.3%	11.1%	11.0%	19.2%	25.0%	38.9%	30.2%	42.2%
Total Capability (MW)	4603.7	4603.7	4603.7	4604	4701	4838.3	4838.3	4838.3	4838.3	5142.3	5142.3	5318.5	5318.5
RTO Load (MW)	89778	83586	77251	70537	73194	93227	107081	97088	84736	77067	80011	86792	94447

$$Capability\ Wind\ Factor = \frac{Average\ Wind\ Generation}{Total\ Wind\ Capability^{*}}$$

July 21, 2011 – PJM New All-Time Peak



Impact of Increasing Wind Penetration

ISOs and RTOs reduce intermittent resource integration costs:

Characteristic	Impact to Wind Integration Cost
Larger balancing areas	• Reduces overall increase in variability • Less regulation and ramping service required
Faster markets, i.e., shorter scheduling intervals (5-15 minutes)	• Less regulation required to accommodate intra-hour variations
Larger geographic area	• Increases wind diversity and reduces overall variability
Centralized wind power forecasting	• Cost-effective approach to reduce scheduling impacts
Regional / Interregional Transmission Planning	• Cost-effective upgrades to ensure grid reliability and mitigate congestion

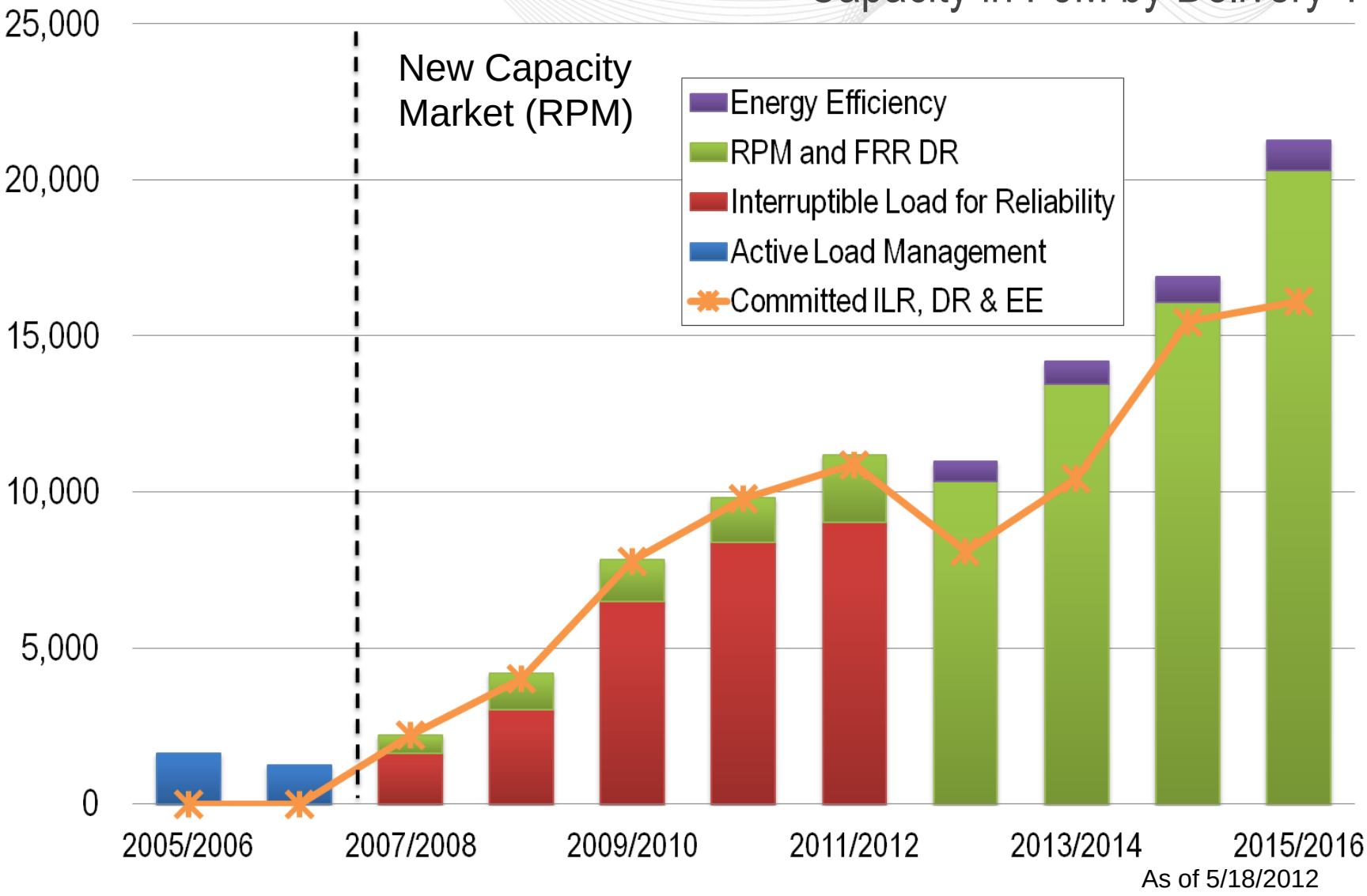
PJM Initiatives to Address Operational and Reliability Impacts

- **Intermittent Resource Task Force (IRTF)**
  - Stakeholder group to address market, operational, and reliability issues specific to variable resources.
- **Energy Markets / Operations**
  - Implemented a centralized wind power forecast service.
  - Implemented changes to improve wind resource dispatch / control.
  - Demand Response / Price Responsive Demand improves operational flexibility
- **Ancillary Service Markets**
  - Implemented tariff changes to allow Energy Storage Resources to participate in PJM ancillary services markets
  - Frequency Regulation - new methodology to compensate better performing resources (like storage), per FERC Order No. 755
  - Reduced minimum size for participating resources from 1MW to 100kW.

PJM Initiatives to Address Operational and Reliability Impacts

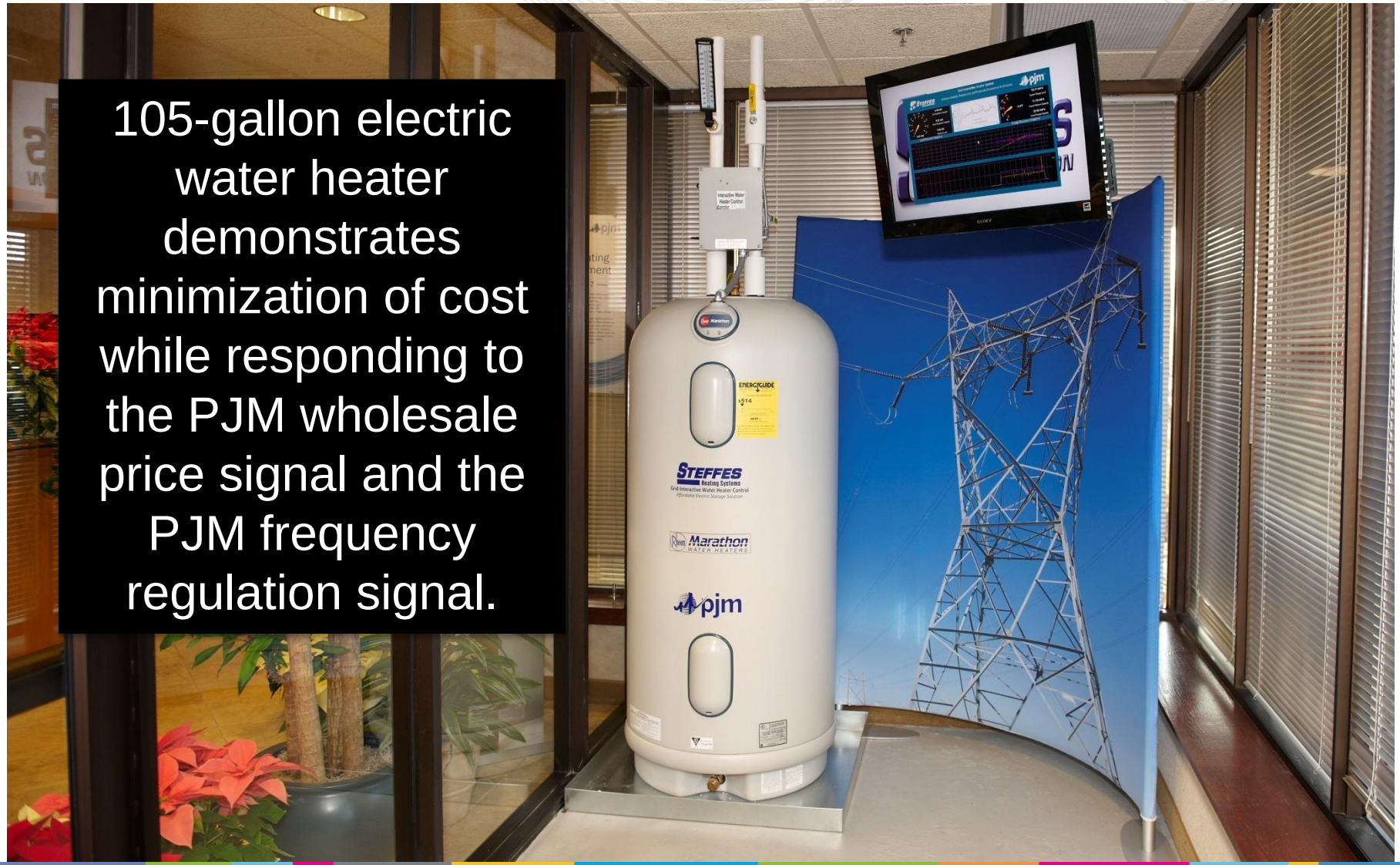
- **Transmission Planning**
  - Light load criteria implemented to improve grid reliability
  - Expansion planning considers public policy impacts (i.e., RPS)
  - Grid interconnection requirements for wind and solar being evaluated
- **Evaluating Potential Grid Impacts**
  - Initiated a PJM Renewable Integration Study (PRIS) to assess impacts to planning, markets, and operations
- **Advanced Technology Research Program**
  - Pilot programs are underway across the PJM footprint to evaluate new technologies and remove barriers to participation in PJM markets and operations.

Offers of Demand-Side Resources as Capacity in PJM by Delivery Year

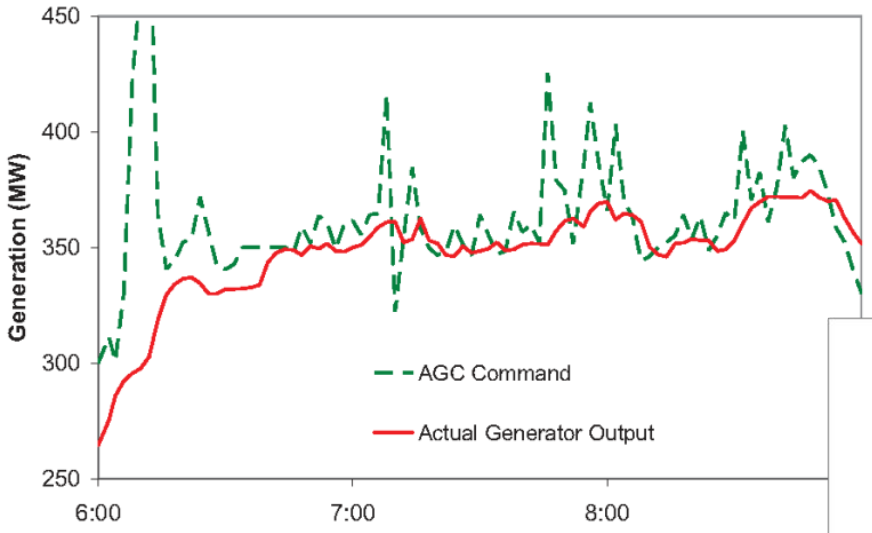


As of 5/18/2012

Water Heater

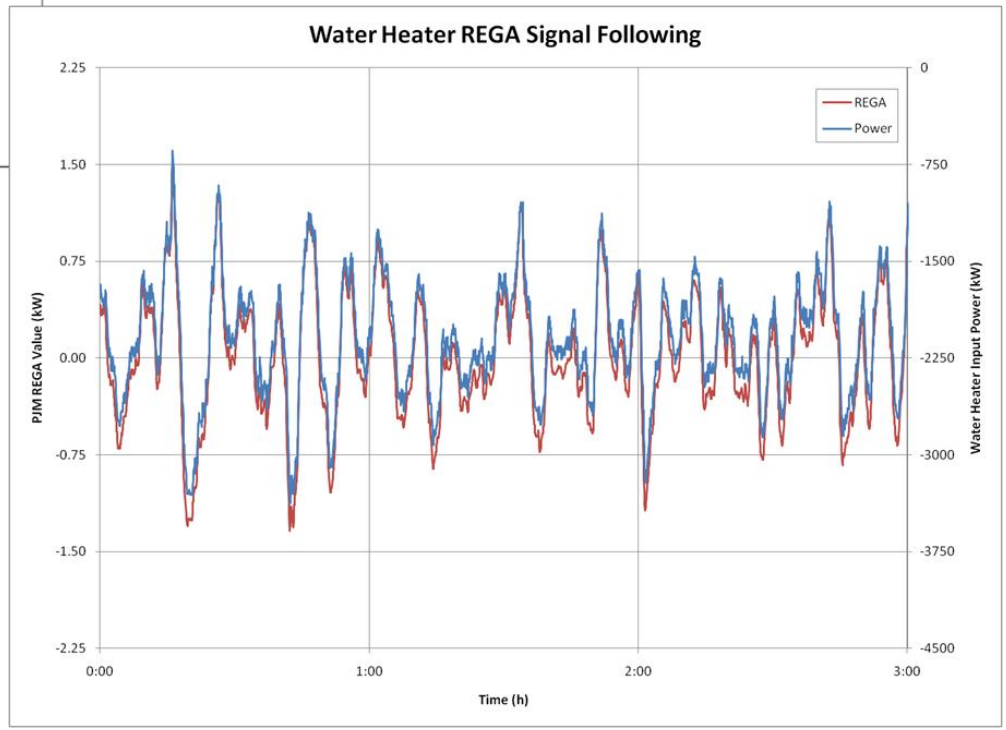


Fast Regulation: Speed Matters…

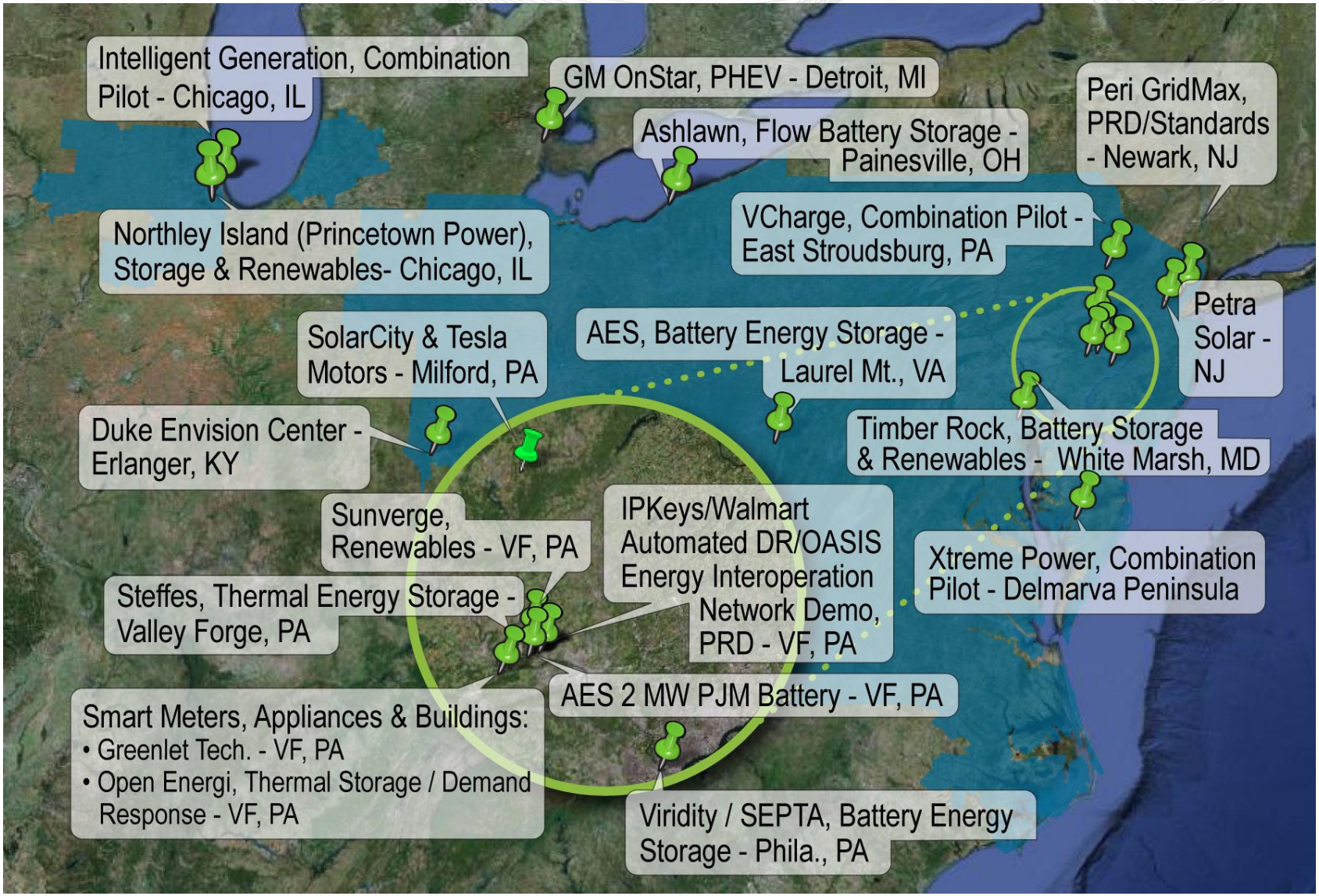


A fossil power plant following a regulation command signal

Energy Storage (water heater) accurately following a regulation command signal



PJM ATRP Program



- Flexible resources will be needed to offset the impacts of variable generating resources
- New market players:
  - Price Responsive Demand
  - Smart Grid Technologies
  - Energy Storage Resources
    - battery arrays
    - flywheels
    - compressed air energy storage
    - plug-in hybrid electric vehicles (PHEVs)
- Potential market changes:
  - New tools to co-optimize energy and ancillary service markets, and improve forecasting and scheduling capabilities
  - New market mechanisms to incent flexible resources

Summary

- The Western Governors Association Report includes recommendations to reduce renewable integration costs through increased grid flexibility:
  - ✓ Improved institutional flexibility
  - ✓ A more flexible generating fleet
  - ✓ Demand response
  - ✓ Adequate transmission
- PJM initiatives are in alignment with the report recommendations
- PJM Renewable Integration Study (PRIS) final report (expected Q1 2013) will include recommendations of additional measures that PJM should consider.