Integrating Renewables

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PJM as Part of the Eastern Interconnection

KEY STATISTICS
- PJM member companies: 600
- Millions of people served: 51
- Peak load in megawatts: 144,644
- MWs of generating capacity: 164,905
- Miles of transmission lines: 56,250
- GWh of annual energy: 729,000
- Generation sources: 1,310
- Square miles of territory: 164,260
- Area served: 13 states + DC
- Internal/external tie lines: 250

- 26% of generation in Eastern Interconnection
- 23% of load in Eastern Interconnection
- 19% of transmission assets in Eastern Interconnection

19% of U.S. GDP produced in PJM
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)
- **MI**: 10% + 1,100 MW by 2015
- **VA**: 15% by 2025
- **WV**: 25%* by 2025

- **Minimum solar requirement**
- **^ Extra credit for solar or customer-sited renewables**
- **** Includes separate tier of “alternative” energy resources

DSIRE: [www.dsireusa.org](http://www.dsireusa.org)  
September 2009
Projected Renewable Project Requirements in PJM

**By 2020:** Estimated **34,000 MW** of wind and **6,000 MW** of solar will be required in PJM

Wind and Solar Requirements in PJM (MW)
Projected Renewable Energy Requirements in PJM

**By 2020:** Estimated **100,000 GWh** of renewable energy, 10.7% of PJM annual net energy

Renewable Energy Required in PJM (GWh)
• MWh of renewable energy produced in 2009;
• Cumulative MWh since tracking began in 2005;
• Percent change between 2009 and 2008.
Proposed Generation (MW)

As of July 13, 2010

- Wind, 39,302
- Non-Renewable, 30,188
  - Storage, 62
  - Wood, 108
  - Captured Methane, 179
- Solar Photovoltaic, 2,218
- Hydro, 524
- Other Renewable, 369
- Biomass, 291
Proposed Renewable Generation in PJM

As of March 31, 2010
Transmission Drivers

- Proposed Nuclear Generation
- Proposed Wind Generation
- Higher Reserve Levels
- Exports
- Generation Retirements

Note: This map does not represent the actual transmission routes.
• If you like nuclear …
• If you like clean coal …
• If you like wind…
• If you like PHEVs…

Bottom line…. You have to love Transmission.
The RTEP process identifies upgrades to meet customers’ requirements:

- operational
- economic
- reliability requirements

Broad system view that looks out 15 year over the entire geographic area
**Eastern Interconnection Planning Collaborative**

- Rolls-up regional plans
- Coordinates with Canada, Western Interconnect and Texas
- Receives stakeholder input and holds public meetings
- Performs studies of various transmission alternatives against national, regional and state energy/economic/environmental objectives
- Identifies gaps for further study

**ISE / RTOs & Order 890 Entities**

- Produce Regional Plan through regional stakeholder process, including state regulatory authorities

**States**

- Regional Policy recommendations
- State energy policies

**DOE/FERC**

- Provides policy direction, assumptions & criteria

**States**

- Policy recommendations
- State energy plans

**FERC**

- Review/direction
- Order adjustments
- Cost recovery

**Annual Interconnection Analysis**

- Publishes Annual Interconnection Analysis

**Regional Plans**

- Regional/state compliant plans provided as input
- Study gaps relative to national, regional and state policy
PJM Initiatives to Address Operational and Reliability Impacts

- Formed the Intermittent Resource Working Group (IRWG) to address market, operational, and reliability issues specific to variable resources.
- Implemented a centralized wind power forecasting service in April 2009 for use in PJM reliability assessments:
  - Day Ahead (Medium-Term Wind Power Forecast)
    1. predict day-ahead congestion and mitigating strategies
    2. ensure sufficient generation resources are scheduled to meet reserve requirements
  - Real-Time (Short-Term Wind Power Forecast)
    1. evaluate current day congestion
    2. ensure that sufficient generation resources are available to respond to real-time or projected fluctuations in Wind Power Output.
- Implemented changes to improve wind resource management in June 2009.
  - Generating resources are now able to submit negative price offers, enabling wind resources to submit flexible offers that better reflect the price at which they will reduce output.
In November 2009 the IRWG started work on new assignments:

1. Assessing operational impacts
2. Examining interconnection standards
3. Reviewing interconnection study methodologies for intermittent resources
4. Implementing changes for Energy Storage Resources

PJM Operations Planning is proposing changes to:

- Improve communication/coordination when a wind farm has multiple owners/operators
- Improve dispatch and control by ensuring that economic minimums are not set too high.

PJM is participating in NERC Integration of Variable Generation Task Force (IVGTF)
ISOs and RTOs reduce intermittent resource integration costs:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Impact to Wind Integration Cost</th>
</tr>
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<tbody>
<tr>
<td>Larger balancing areas</td>
<td>• Reduces overall increase in variability&lt;br&gt;• Less regulation and ramping service required</td>
</tr>
<tr>
<td>Faster markets, i.e., shorter scheduling intervals (5-15 minutes)</td>
<td>• Less regulation required to accommodate intra-hour variations</td>
</tr>
<tr>
<td>Larger geographic area</td>
<td>• Increases wind diversity and reduces overall variability</td>
</tr>
<tr>
<td>Centralized wind power forecasting</td>
<td>• Cost-effective approach to reduce scheduling impacts</td>
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</tbody>
</table>
• 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)
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