
February 23, 2016

Todd Olinsky-Paul
Project Director
Clean Energy Group
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Submit your questions at any time by typing in the Question Box and hitting Send.

This webinar is being recorded.

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Who We Are

www.cleanegroup.org
www.resilient-power.org
Resilient Power Project

- Increase public/private investment in clean, resilient power systems
- Engage city officials to develop resilient power policies/programs
- Protect low-income and vulnerable communities
- Focus on affordable housing and critical public facilities
- Advocate for state and federal supportive policies and programs
- Technical assistance for pre-development costs to help agencies/project developers get deals done
- See [www.resilient-power.org](http://www.resilient-power.org) for reports, newsletters, webinar recordings
Today’s Speaker

• Scott Baker, Business Solutions Analyst, PJM Interconnection
Energy Storage in PJM: Overview of Rules and Requirements

Scott Baker
Sr. Business Solutions Analyst

Clean Energy States Alliance Webinar
February 23, 2016
<table>
<thead>
<tr>
<th>Key Statistics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Member companies</td>
<td>960+</td>
</tr>
<tr>
<td>Millions of people served</td>
<td>61</td>
</tr>
<tr>
<td>Peak load in megawatts</td>
<td>165,492</td>
</tr>
<tr>
<td>MW of generating capacity</td>
<td>171,648</td>
</tr>
<tr>
<td>Miles of transmission lines</td>
<td>72,075</td>
</tr>
<tr>
<td>2014 GWh of annual energy</td>
<td>792,580</td>
</tr>
<tr>
<td>Generation sources</td>
<td>1,304</td>
</tr>
<tr>
<td>Square miles of territory</td>
<td>243,417</td>
</tr>
<tr>
<td>States served</td>
<td>13 + DC</td>
</tr>
</tbody>
</table>

21% of U.S. GDP produced in PJM
PJM Grid Operations | PJM Markets

Long-Term

Day-Ahead

Real-Time

Growth in Services

Capacity Market

Financial Transmission Rights

Gas

Day-Ahead Scheduling Reserve Market

Regulation

Shortage Pricing

Locational Marginal Pricing

Ancillary Services

Synchronized Reserves

www.pjm.com
Grid Connected Energy Storage ("Generation")
Grid-Scale Energy Storage – 250+ MW in Operation

Total Advanced Storage
Grid Connected – 263 MW
Under Construction – 53 MW
Under Study – 674 MW*

*historically, only a small percentage are actually delivered in-service
Grid-Scale Energy Storage – 250+ MW in Operation

Total Advanced Storage

Grid Connected – 263 MW
Under Construction – 53 MW
Under Study – 674 MW*

*historically, only a small percentage are actually delivered in-service
Following ISA/WMPA execution, 16,083 MW of capacity with ISAs and 277 MW of capacity with WMPAs withdrew from PJM’s interconnection process. Another 2,783 MW have executed agreements but were not in service as of January 7, 2015. Overall, 11% of requested capacity MW reaches commercial operation.

Activity in Queue A through Queue AA1 (as of January 7, 2015)

- Applications Received by PJM
- Feasibility Studies Issued
- Impact Studies Issued
- Facilities Studies Issued
- Executed ISA/WMPA
- In Service

11% of requested capacity reaches commercial operation
Queue Process

New Service Requests (queue open) → Studies → ISA/CSA/UCSA/WMPA Execution → ISA/CSA/UCSA Implementation → Commercial Operation

**OATT Attachment N, Y, BB, S, EE**
- N – Generation (>2 MW)
- Y – Generation (<= 2 MW)
- BB – Generation (< 10kW, inverter based)
- S – Merchant Transmission
- EE – Upgrade Request

**Required Information**
- Location
- Project Size
- Ownership (site control for generation requests)
- Equipment Configuration
- Planned In-Service Date
- Deposit
- Data

*NOTE: Transmission service requests are received through OASIS, communicated to System Planning and added to New Services Queue.*
Queue Process

Service Agreement Execution
- Based on FERC jurisdictional determination
- **Interconnection Services Agreement** (ISA) used if project is FERC jurisdictional
- **Wholesale Market Participant Agreement** (WMPA) used if not FERC jurisdictional; requires additional two-party Interconnection Agreement between Developer and TO
- **Interconnection Construction Service Agreement** (CSA) identifies terms, conditions, and coordinates construction activities for Attachment Facilities and Network Upgrades
- **Upgrade Construction Service Agreement** (UCSA) identifies terms, conditions, and coordinates construction activities for Network Upgrades
## Storage in the Queue

### Fuel Type: Storage  Status: In-Service  State: All

<table>
<thead>
<tr>
<th>Queue</th>
<th>AQ</th>
<th>Queue Date</th>
<th>PJM Substation</th>
<th>MW</th>
<th>MW In Srvc</th>
<th>MWC</th>
<th>MWE</th>
<th>Stat</th>
<th>Feas</th>
<th>Imp</th>
<th>Fac</th>
<th>ISA/ WMPA</th>
<th>CSA</th>
<th>St</th>
<th>Projected In Service</th>
<th>Fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>U3-001</td>
<td></td>
<td>08/11/2008</td>
<td>Barbadoes 34kV</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<td></td>
<td></td>
<td>PA</td>
<td>2008 Q3</td>
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<tr>
<td>W1-111</td>
<td></td>
<td>04/30/2010</td>
<td>Harwood-Berwick 69kV</td>
<td>20</td>
<td>20</td>
<td>0</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
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<td>PA</td>
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<td></td>
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<tr>
<td>W2-057</td>
<td></td>
<td>07/28/2010</td>
<td>Laurel Mountain</td>
<td>32</td>
<td>32</td>
<td>0</td>
<td>32</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td>WV</td>
<td>2011 Q3</td>
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<tr>
<td>X2-013</td>
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<td>05/19/2011</td>
<td>Thorofare 13kV</td>
<td>2</td>
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<td></td>
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<td>NJ</td>
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<td>Y2-111</td>
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<td>11/02/2012</td>
<td>Tait 69kV</td>
<td>12</td>
<td>12</td>
<td>0</td>
<td>12</td>
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<td></td>
<td></td>
<td>OH</td>
<td>2013 Q3</td>
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<tr>
<td>Y3-080</td>
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<td>04/19/2013</td>
<td>Tait 69kV</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>OH</td>
<td>2013 Q3</td>
<td></td>
</tr>
</tbody>
</table>

Search the Active Queue on [PJM.com](http://www.pjm.com)
• “Energy Storage Resource” shall mean flywheel or battery storage facility **solely** used for short term storage and injection of energy at a later time to participate in the PJM energy and/or Ancillary Services markets as a Market Seller. (emphasis added)

• “Station Power” does not include any energy … (iii) used for storage and injection of such energy at a later time to participate in the PJM wholesale energy, capacity, and/or ancillary services markets.
Behind-the-Meter Energy Storage (DR)
<table>
<thead>
<tr>
<th>Regulation</th>
<th>Zone</th>
<th>January 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locations</td>
<td>RTO</td>
<td>293</td>
</tr>
<tr>
<td>MW</td>
<td>RTO</td>
<td>22</td>
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</tbody>
</table>

Note: Percent of CSP Reported Load Reduction MWs
## DR Market Participation: Synchronized Reserves

<table>
<thead>
<tr>
<th>Synch Reserves</th>
<th>Zone</th>
<th>January 2016</th>
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</thead>
<tbody>
<tr>
<td>Locations</td>
<td>MAD</td>
<td>135</td>
</tr>
<tr>
<td></td>
<td>Non-MAD</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>RTO</td>
<td>145</td>
</tr>
<tr>
<td>MW</td>
<td>MAD</td>
<td>377</td>
</tr>
<tr>
<td></td>
<td>Non-MAD</td>
<td>198</td>
</tr>
<tr>
<td></td>
<td>RTO</td>
<td>575</td>
</tr>
</tbody>
</table>

Note: Percent of CSP Reported Load Reduction MWs
Participation, General Requirements

- Ability to receive and react to a dynamic regulation control signal from PJM
- Real time telemetry
- Minimum 0.1 MW market offer (single resource or aggregated resources)
- Resource certification and testing requirements
- Current limitations on amount of DR eligible to clear (subject to change)
  - 25%, Regulation Market
  - 33%, Synchronized Reserve Market
Fundamental: Injections not considered DR

• This is not a "new rule", only clarification
• There must be load to be considered "demand" response
  – No load at the customer site typically means there are injections
    • Net metering agreement with EDC does not allow DR to provide injections in wholesale market
• Specific to the Regulation Market:
  • Injections measured at same scan rate as Regulation signal (2 seconds)
  • Frequent injectors will not be eligible to participate in Regulation as DR
    – Are eligible to participate in Regulation Market as generation
    – Are eligible to participate as DR if action taken to prevent future injections
• 2 second interval (Regulation); 1 minute interval (Synch Reserves)
• Must be certified* – ANSI 12.1 (Meter), ANSI 57.13 (CT/PT)
  – Non-ANSI certified meters
    • by exception only
    • must be tested by third party to verify accuracy
    • Must be approved by PJM
    • End to end accuracy must be +/- 2%
• Inverters: metering must always be placed on the AC side

• Placed at EDC account level (default)
• Sub-metering
  – By exception only with PJM approval
    • Load being regulated can only be a small portion of site-load
    • Requires submittal of one-line diagram to PJM by CSP
      – One-line should include all electric devices beneath EDC account meter
  – EDC account level meter (or other metering setup) additionally required where potential exists for grid injections
• If a site injected during an hour, it was not eligible to participate as DR for that hour
  – CSP should not offer into market that hour
  – If CSP inadvertently offers and clears, should self report to PJM. That hour will not be eligible for payment as DR.
  – If PJM discovers injection during audit, hour will be resettled and not eligible for payment
Practical Considerations

• BtM Solar PV injections nullify DR participation
  • Unless participation is only at night
• The Regulation Market is *small* and *increasingly competitive*
  • 525 MW off-peak, 700 MW on-peak
  • Many view the existing RegD (fast-response) service as “saturated”
  • Currently, only the very high performers are clearing in this market segment (~90-95% performance score)

• Regulation Market Evolution
  • [Evaluating Distributed Energy Resources in PJM](#)
  • [Regulation Market changes are coming](#)
Demand-side Resources in Ancillary Services Market, Training
http://www.pjm.com/~media/training/core-curriculum/ip-dsr/dsr-in-the-ancillary-service-markets.ashx

http://www.pjm.com/~media/documents/manuals/m11.ashx

Scott.Baker@pjm.com
Thank you for attending our webinar

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Upcoming Webinars

- Optimizing Energy Storage Sizing, Location and Operation: Current R&D Efforts at Sandia National Laboratories, February 25
- Resilient San Francisco: How to Develop a Citywide Solar+Storage Disaster Plan, March 7
- Fuel Cells for Telecommunication, March 17
- Flow Batteries, March 23

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