Integrating DER in PJM Transmission Operations and Planning

NRRI Webinar: Case Studies in Utility Integrated Distributed Resources Planning and Doing
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PJM
PJM Markets: Serving Innovation Since 1927

- 65 million people served
- 21% of US GDP
- 165 GW peak load

Among the largest and oldest power pools in the world
## Snapshot of DER in PJM Today

<table>
<thead>
<tr>
<th>Wholesale DER</th>
<th>Non-Wholesale DER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.1 GW</strong> (Demand Response)</td>
<td>~6.6 GW DER</td>
</tr>
<tr>
<td>Generation reducing customer load: Mostly emergency back-up. Offers into capacity, energy and/or ancillary services markets</td>
<td>Solar PV DER: Retail / rooftop solar</td>
</tr>
<tr>
<td>74% Diesel</td>
<td>74% Diesel</td>
</tr>
<tr>
<td>24% Natural Gas</td>
<td>24% Natural Gas</td>
</tr>
<tr>
<td>2% Other</td>
<td>2% Other</td>
</tr>
<tr>
<td>Remaining ~6,900 MW DR is load modification without any generation (e.g., Industrial process management)</td>
<td>Municipal DER: Municipal electric company distribution-level generators</td>
</tr>
<tr>
<td></td>
<td>Process DER: Industrial generators, combined heat and power</td>
</tr>
<tr>
<td></td>
<td>Resilience DER: Emergency back-up</td>
</tr>
<tr>
<td></td>
<td>Qualified Facilities: Direct sales to distribution utilities</td>
</tr>
<tr>
<td><strong>0.8 GW</strong> (Generator)</td>
<td></td>
</tr>
<tr>
<td>Front-of-the-meter generation on distribution: Offers into capacity, energy and/or ancillary services markets</td>
<td>.6 Solar</td>
</tr>
<tr>
<td>.6 Solar</td>
<td></td>
</tr>
<tr>
<td>.2 Other</td>
<td></td>
</tr>
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<td></td>
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</tbody>
</table>
Significant Solar Growth Projected

Forecasted Cumulative Nameplate MW Non-Wholesale Solar

- Dominion
- PPL
- Pepco
- PSEG
- ComEd
- AEP
- APS
- Peco
- ATSI
- BGE
- Other zones

Megawatts

Local Concentration of Installed Solar Capacity
(Non-Wholesale and Wholesale)

The size of the PJM RTO provides a significant advantage to DER integration.

In the near- to mid-term, DER impacts will be local, not regional.

Unknowns
- Natural gas DER
- Batteries, EVs
- State policy

Source: Generator Attribute Tracking System, PJM Environmental Information Systems, 2016
www.pjm.com
Pop Quiz: What is this?

The diagram shows a graph with the x-axis representing time from 6:00 to 20:00 and the y-axis representing MW (megawatts). The graph includes several lines:

- Low: More Conservative
- Low: Less Conservative
- High: More Conservative
- High: Less Conservative
- Estimated Actual

The graph illustrates the variation in MW over the course of the day.
DER Integration Topic: “Shall Trip” and “Ride Through”

“Shall Trip”
• Immediately following a grid problem, DER must physically disconnect from the grid.
• **Purpose**: facilitate and simplify effective distribution system response to grid problems. Also simplifies controls for certain legacy and other non-inverter DER.

“Shall Ride Through”
• Immediately following a grid problem, DER must continue to supply the grid. DER must NOT disconnect from the grid.
• **Purpose**: avoid regional stability problems due to loss of large numbers of DER.

Under high DER deployment, both “Shall Trip” and “Shall Ride Through” are important!
Blue, teal, and green are abnormally low voltage, which puts load at risk.

<table>
<thead>
<tr>
<th>LOAD AT RISK FROM GRID EVENT</th>
<th>Many DER Ride Through:</th>
<th>No DER</th>
<th>Many DER Ride Through:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td></td>
<td>2,600 MW</td>
<td>1,600 MW</td>
<td>750 MW</td>
</tr>
</tbody>
</table>

Grid event worsened: Red
Grid event improved: Green
Problem/opportunity: no “ride through” requirement in the national standard “IEEE 1547”.

Solution: change the national standard to require both “Shall trip” and “Ride through”.

How do you do require both tripping and ride through? It’s a little complicated, that’s why it took engineers at IEEE Working Group 2 years to make the new standard!

What next? Incorporate the new IEEE 1547 standard into rules and laws.

New IEEE 1547 revision with ride through expected early next year!*

*Mass-market DER hardware that meets the revised standard expected in the 2019-2020 timeframe.
PJM Approach to DER Integration

Visibility

Forecast

Incent

Distribution Coordination

Resilience
Dispatch Interactive Map Application (DIMA)

- Multi-search
- Advanced Substation Panel
- Gas Layer
- Generation Layer
- Behind the Meter Generation
## Wind and Solar Forecasts

### Processes and Benefits

<table>
<thead>
<tr>
<th>Aggregate input data for each farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW Output</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Receive forecasts from vendor</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-min. forecasts for next 6 hours</td>
</tr>
<tr>
<td>Hourly forecasts, for next 7 days</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calculate Lost Opportunity Cost*</th>
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</thead>
<tbody>
<tr>
<td>Calculate for curtailed farms using back-cast</td>
</tr>
<tr>
<td>Use actual meteorological data instead of forecast</td>
</tr>
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</table>

### Dispatchability Requirements*

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<th>Communications</th>
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<td>Must send MW &amp; meteorological data to PJM</td>
</tr>
<tr>
<td>Must electronically receive signals from PJM</td>
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<th>Controls</th>
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<td>Must be capable of following electronic control signals, i.e. reduce farm output</td>
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<th>Markets</th>
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<td>When dispatched, must follow Economic Basepoint</td>
</tr>
<tr>
<td>Must update Economic Min &amp; Max once an hour</td>
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</table>

*Currently only for wind power
How is PJM responding to solar growth?

• **Increasing visibility and situational awareness**
  – Gathering static and real-time data for behind-the-meter facilities
  – Modeling utility-scale behind-the-meter solar facilities in EMS

• **Implementing forecasting tools**
  – Obtaining short-term and long-term solar power forecasts

• **Working with stakeholders**
  – Enhancing inverter requirements for grid-connected solar
  – Reporting negative values at load buses
PJM Approach to DER Integration

Visibility

Forecast

Incent

Distribution Coordination

Resilience
Hopewell Valley Central High School Solar/Storage

- Owned by Public Service Electric and Gas Company (PSE&G) as part of Solar 4 All program
- 876 kWdc solar + 580 kWh batteries
- PJM wholesale power plant
- Also: backup during grid outage
PJM Approach to DER Integration

- Visibility
- Forecast
- Incent
- Distribution Coordination
- Resilience
Great reference from CA:
“Coordination of Transmission and Distribution Operations in a High Distributed Energy Resource Electric Grid”