Grid of the Future: PJM RTEP Perspective

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PJM Interconnection
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PJM as Part of the Eastern Interconnection

Key Statistics

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
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<tbody>
<tr>
<td>Member companies</td>
<td>1,060+</td>
</tr>
<tr>
<td>Millions of people served</td>
<td>65</td>
</tr>
<tr>
<td>Peak load in megawatts</td>
<td>165,563</td>
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<tr>
<td>Megawatts of generating capacity</td>
<td>185,442</td>
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<tr>
<td>Miles of transmission lines</td>
<td>85,103</td>
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<tr>
<td>2020 gigawatt hours of annual energy</td>
<td>782,683</td>
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<tr>
<td>Generation sources</td>
<td>1,436</td>
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<tr>
<td>Square miles of territory</td>
<td>368,906</td>
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<tr>
<td>States served</td>
<td>13 + DC</td>
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21% of U.S. GDP produced in PJM

As of 2/2021
### Objectives
Outline a vision for the grid of the future and identify factors to consider when planning for that future

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<td><strong>Identify anticipated impacts of current trends on generation, transmission and load</strong></td>
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<td><strong>Provide a vision of what the generation and transmission system will look like</strong></td>
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<td><strong>Outline the policy, planning process and technical factors to be considered</strong></td>
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<td><strong>Develop a grid of the future road map for planning the PJM system</strong></td>
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## Grid of the Future Report

### Reviewed:
- Prior renewable integration studies and ongoing efforts
- Neighboring RTO grid of the future/future vision initiatives
- Industry reports related to renewable integration

### Assessed:
- PJM data on generation trends and drivers
- PJM data on load electrification trends and drivers
- Relevant emerging transmission technologies

### Developed a road map of future initiatives to prepare Planning for PJM’s vision of the future grid
Renewable Generation

**Wind**
- Development continues in western PJM and along Allegheny Mountains.

**Offshore Wind**
- PJM states are collectively targeting 17 GW of wind by 2035.

**Solar**
- Dominant resource in the PJM queue, with projects in all PJM zones

**Storage**
- Recent growth seen in PJM, often following the solar development.
Conventional Generation – Deactivations

Coal – Over 30,000 MW retired between 2012 and 2021.

Natural Gas – Once driven by shale gas; growth slowed in wake of renewables expansion.

Nuclear – Future is uncertain, impacted by economics, policy, licensing.
Electrification of Transportation

• White House EV target of 50% of light-duty vehicle sales by 2030 may drive accelerated growth. PEV charging could account for ~10% of total RTO energy over next 15 years.

• Energy demand will be impacted by policies that could incentivize charging behavior that shifts charging to off-peak periods, minimizing the impact on the PJM peak load. Otherwise, the demand impact could be more significant.
Electrification of Load

Load

Electrification of Transportation
Growth of plug-in electric vehicles (PEV) will impact peak-day load shapes and drive increased energy consumption.

Electrification of Building Heating
Growth in electric building heating is less certain due to economics compared to gas/oil heat for PJM; potential load impact could be bigger but likely further in horizon.

Potential Future PJM Winter and Summer Peak Day Under PEV Scenario

Net Load:
- Before PEV
- Inflexible With PEVs
- Flexible With PEVs

Winter Peak Day

Summer Peak Day

Load:

Electrification of Transportation
Growth of plug-in electric vehicles (PEV) will impact peak-day load shapes and drive increased energy consumption.

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## Impacts to Transmission Planning

### DER
- FERC Order 2222 may accelerate development of DER.
- Need for greater visibility of DER will drive changes in modeling of DER; greater coordination with utilities/state commissions.

### Emerging Grid Technologies
- Grid forming inverters
- Dynamic line rating
- Special conductors
  - Tower configuration
  - Storage as transmission
  - Microgrids

### Resilience
- Fuel assurance
- Extreme event planning

### Planning Enhancements
- Target studies for reliability attributes – inertia, voltage control, stability, ramping and short-circuit current
- Increased probabilistic planning
- 15-year scenario planning
- Scenario planning for future generation
- Interregional planning criteria
- Resilience planning criteria
To achieve the public policy goals of the PJM states, estimates are that more than 100,000 MW of renewable generation will need to be interconnected:

<table>
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<th>Wind (18–35 GW)</th>
<th>Solar (25–55 GW)</th>
<th>Storage (2–7 GW)</th>
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Initial studies performed for offshore wind, which also included all other RPS goals, indicate transmission grid enhancements will be needed to accommodate the interconnection of renewable resources.

- **Near term**: ~$627 million
- **Long term**: ~$2.2–3.2 billion
Transmission Build-Out Scenario Studies – Develop scenarios to identify transmission for policy case and accelerated scenario

Regulatory Policy Impacts
- Federal and state policies – renewables, electrification
- Long-term transmission planning (ANOPR) and Interconnection Process Reform
- State Agreement Approach (SAA)

Targeted Reliability Studies – Additional studies that will focus on reliability attributes and build on prior scenario studies

DOE/NREL Studies – Partner with/engage with DOE, national labs and neighbors on interregional studies – National Transmission Study and Atlantic Shore OSW Transmission Study

RTEP Process Enhancements
- Modeling wind and solar in generator deliverability analysis
- DER modeling
- ELCC development
- Resilience
- Improve load forecast
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