The Role of Electricity Markets in Regional Planning and Achieving Climate Goals

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Managing Partner, State Government Policy
PJM Interconnection
August 3, 2021
## Key Statistics

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Member companies</td>
<td>1,040+</td>
</tr>
<tr>
<td>Millions of people served</td>
<td>65</td>
</tr>
<tr>
<td>Peak load in megawatts</td>
<td>165,563</td>
</tr>
<tr>
<td>Megawatts of generating capacity</td>
<td>185,378</td>
</tr>
<tr>
<td>Miles of transmission lines</td>
<td>85,103</td>
</tr>
<tr>
<td>2020 gigawatt hours of annual energy</td>
<td>757,284</td>
</tr>
<tr>
<td>Generation sources</td>
<td>1,424</td>
</tr>
<tr>
<td>Square miles of territory</td>
<td>369,089</td>
</tr>
<tr>
<td>States served</td>
<td>13 + DC</td>
</tr>
</tbody>
</table>

21% of U.S. GDP produced in PJM

As of 2/2021
PJM Backbone Transmission

Legend
Substation
765 kV
500 kV
345 kV

Transmission Lines
345 kV
500 kV
765 kV
HVDC
Value Proposition

Total Annual PJM Value

$3.2-4 B

$1.2-1.8 B
SAVINGS

$600 M
SAVINGS

$300 M
SAVINGS

$1.1-1.3 B
SAVINGS

10+ M
fewer tons of emissions
(annual avg.)

— All numbers are estimates. —

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PJM’s Role as a Regional Transmission Organization

**PLANNING**
Planning for the future like...

**OPERATIONS**
Matches supply with demand like...

**MARKETS**
Energy Market Pricing like...

Urban Planning

Air Traffic Control

Stock Market
Industry Paradigm Shift

- Changing market participant profiles
- Changing fuel mix
- Regulatory uncertainty
- Energy efficiency
- Renewable and distributed energy resource integration
- Cybersecurity and system resiliency
- Customer behavior and choice

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2005–2020 Annual Fuel Mix

- Nuclear
- Renewables
- Oil
- Gas
- Coal

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2020 Renewable Energy in PJM

MWh (millions)

- Solar
- Wind
- Biomass
- Wood
- Methane
- Solid Waste
- Water

PJM System Average Emission Rates

**CO₂ lbs/MWh**

- Carbon Dioxide
- Sulfur Dioxide
- Nitrogen Oxides

**SO₂ and NOₓ lbs/MWh**

- 2005: 1,300 lbs/MWh
- 2020: 150 lbs/MWh
What Is Resilience?

Pre-Event
Mitigating and preventing activities

During an Event
The ability to manage a disruption as it unfolds

Post-Event
The ability to get back to normal as soon as possible

Incident
Focused Learning

Readiness

Resourcefulness

Rapid Recovery

Adaptability/Lessons Learned
The ability to absorb new lessons after a disaster
Capacity Performance Features

- Obligation to deliver energy when PJM calls for it
- Over-performers rewarded; under-performers pay
- Small net cost for improved reliability/price stability
System Enhancement Drivers

- Delivering Generation
- Improving Market Efficiency
- Replacing Aging Facilities
- Enhancing Operational Performance
- Evaluating Demand-Side Trends

Reliability & Resilience

State & Federal Public Policy
State Renewable Portfolio Standards (RPS) require suppliers to utilize renewable resources to serve an increasing percentage of total demand.

### State RPS Targets*

<table>
<thead>
<tr>
<th>State</th>
<th>Target</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>NJ</td>
<td>50% by 2030**</td>
<td>Includes an additional 2.5% of Class II resources each year</td>
</tr>
<tr>
<td>VA</td>
<td>100% by 2045/2050 (IOUs)</td>
<td></td>
</tr>
<tr>
<td>MD</td>
<td>50% by 2030</td>
<td></td>
</tr>
<tr>
<td>NC</td>
<td>12.5% by 2021 (IOUs)</td>
<td></td>
</tr>
<tr>
<td>DE</td>
<td>40% by 2035</td>
<td></td>
</tr>
<tr>
<td>OH</td>
<td>8.5% by 2026</td>
<td></td>
</tr>
<tr>
<td>DC</td>
<td>100% by 2032</td>
<td></td>
</tr>
<tr>
<td>MI</td>
<td>15% by 2021</td>
<td></td>
</tr>
<tr>
<td>PA</td>
<td>18% by 2021***</td>
<td>Includes non-renewable “alternative” energy resources</td>
</tr>
<tr>
<td>IN</td>
<td>10% by 2025***</td>
<td></td>
</tr>
<tr>
<td>IL</td>
<td>25% by 2025-26</td>
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</tbody>
</table>

* Minimum solar requirement

** Targets may change over time, these are recent representative snapshot values

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Feb. 2021
### Snapshot of DER in PJM Today

#### Wholesale DER

<table>
<thead>
<tr>
<th>1 GW</th>
<th>Demand Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Customer-sited generation:</strong></td>
<td>Offers into capacity, energy and/or ancillary services markets</td>
</tr>
<tr>
<td>~8 GW</td>
<td>Remaining ~8 GW of DR is load modification without any generation (e.g., industrial process management)</td>
</tr>
</tbody>
</table>

#### Non-Wholesale DER

<table>
<thead>
<tr>
<th>~2 GW</th>
<th>Generator</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Front-of-the-meter generation:</strong></td>
<td>Offers into capacity, energy and/or ancillary services markets</td>
</tr>
<tr>
<td>Can be sited at customers</td>
<td></td>
</tr>
<tr>
<td>Mostly solar but also other fuels</td>
<td></td>
</tr>
</tbody>
</table>

#### ~10 GW DER

- **Solar PV DER:** Retail/rooftop solar
- **Municipal DER:** Municipal electric company distribution-level generators
- **Process DER:** Industrial generators, combined heat and power
- **Resilience DER:** Emergency backup
- **Qualified Facilities:** Direct sales to distribution utilities
Reliability is Job One

Reliability
Rationale for Refreshing PJM’s Strategy

There is a broad set of trends reshaping the energy ecosystem, e.g.,

- States & stakeholders adopting decarbonization goals
- Intermittent resource penetration increasing rapidly, with changing mix
- DER proliferating rapidly, with limited visibility to us
- High investment in grid modernization
- Innovation in technology, business models, etc.

Across our footprint, we see these trends progressing at varied pace and impacting some stakeholders sooner than others.

These trends are impacting our ability to fulfill our fundamental functions.

- Operations
- Markets
- Planning

This transition represents a significant change in our environment.

Continuing to deliver value to the region requires us to take a significant role in managing an efficient and reliable transition.

PJM needs to make sure our strategy reflects the factors driving our industry to continue to maximize our value to the region we serve.
Strategic Pillars

Facilitate Decarbonization

Grid of the Future

Innovation

THE ENABLING FOUNDATION

Maintain Reliability

Stakeholder Engagement and Governance

Risk Management

Workforce Development

Efficiencies of Scale

CULTURE

Monitor Developments
Appendix
Appendix – Wind Installed Capacity in PJM: Operational & Proposed

Cumulative Nameplate
Millions (GW)

Cumulative Total: 46,243 MW

- Proposed Offshore Wind: 17,582 MW
- Proposed Onshore Wind: 18,294 MW

RPS Requirement: 29,646 MW by 2029

As of December 31, 2020

As of December 31, 2020
Appendix – Managing Security Threats

IDENTIFY

SECURITY THREATS & INCIDENTS

Protect → Detect → Respond → Recover

MEASURE, EDUCATE AND PARTNER

METRICS
Appendix – Cyber Resilience With Eyes Wide Open

Prevention
- Build security into the design
- Implement traditional controls
- Improve security controls

Resilience
- Focus on incident response
- Enhance scenario planning
- Plan and drill restoration scenarios

Collaboration
- Coordinate response plans
- Develop and maintain government relationships
- Leverage industry relationships
- Share best practices
## Appendix – Facilitating the Reliable and Cost-Effective Decarbonization Transition

<table>
<thead>
<tr>
<th>Major trends</th>
<th>Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>We currently manage one of the most diverse groups of states in the country with regard to decarbonization policy. Absent federal policy, we will continue to face this divergence over the next decade. PJM is not a policymaker, but can play a key role in informing and facilitating policy choices.</td>
<td>Growth in ambition and differences in state decarbonization policies pose risk for our ability to administer efficient markets and effective planning. Recognizing the magnitude of the climate change issue and the unique position PJM holds and the role we fulfill, PJM will enable decarbonization efforts by policymakers and consumers in a reliable, cost-efficient manner utilizing at-scale, market-based solutions whenever possible.</td>
</tr>
</tbody>
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### Our strategic intent and initial associated initiatives

We will facilitate pursuit of policy-maker and consumer decarbonization objectives by establishing ourselves as a trusted, unbiased policy adviser & driving consensus for at-scale, market-based solutions where possible.

- Convene stakeholders to develop a resource adequacy construct that better supports state and federal decarbonization goals
- Support states' decarbonization objectives using competitive, market-based solutions wherever possible
- Utilize State Agreement Approach to enable state decarbonization goals where appropriate
- Explore solutions to operating challenges associated with intermittent resource penetration

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**Growth in ambition and differences in state decarbonization policies pose risk for our ability to administer efficient markets and effective planning.**

Recognizing the magnitude of the climate change issue and the unique position PJM holds and the role we fulfill, PJM will enable decarbonization efforts by policymakers and consumers in a reliable, cost-efficient manner utilizing at-scale, market-based solutions whenever possible.
Appendix – PJM’s Unique Position to Drive an Efficient Transition to the Grid of the Future

Major trends

- Utility-scale wind and solar generation is increasing in our territory (from 3% today to as high as 100% under a Biden plan)
- DER penetration is increasing in our territory (distributed PV projected to grow at 13% CAGR ’19-'25)
- Aggressive offshore wind agenda by certain PJM states
- Aging transmission infrastructure and associated replacement spend

Implications

We need to:
- Ensure operational reliability and long-term resource adequacy with a higher share of intermittent resources
- Develop markets and planning criteria to incorporate DER
- Incorporate OSW into planning processes
- Continue to help drive transparency into supplemental project spend and encourage regional approaches while respecting CTOA limits

Our strategic intent and initial associated initiatives

We will be successful in facilitating an efficient transition to the grid of the future given our unique regional role and position operating and administering one of the largest grids in the U.S.

- Establish a clear vision of the future grid
- Develop Order 2222 compliance framework
- Evolve planning criteria to ensure reliability given increasing intermittent resources
- Ensure reliable and efficient integration of offshore wind
- Evolve interconnection process to better meet changing stakeholder needs
- Ensure resource adequacy construct accurately accounts for reliability value of resources
- Explore products to value grid reliability services
- Ensure system reliability given DER proliferation
- Define model of coordination with distribution utilities
Appendix – Fostering Innovation Will Be Essential to Responding to Major Trends Driving Change in the Power System

Major trends

Major trends like DER/intermittent resource growth and state decarbonization policies are driving changes across the power sector and will require us to adapt.

Increasing volume of data and advanced analytical tools are creating new opportunities to drive value for the region.

Implications

Increasingly complex power systems will require testing and implementing new technologies, market structures and operational practices.

Opportunity to leverage technology and innovation to create value for stakeholders.

New skillsets and mindsets are needed to drive required changes.

Our strategic intent and initial associated initiatives

We will create an environment to become a center for grid innovation in the U.S. by fostering innovative approaches to addressing challenges both internally and with our external stakeholder community.

- Build high-value data and analytics use cases
- Build a robust data & analytics foundation
- Enhance innovation process, frameworks & organization
- Foster innovative talent & culture