Resilience in Grid Operations

The Coal Institute
Fall Education & Engineering Seminar
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Manager – Generation
Reliability
- Grid Operations
- Supply/Demand Balance
- Transmission monitoring

Market Operation
- Energy
- Capacity
- Ancillary Services

Regional Planning
- 15-Year Outlook
PJM as Part of the Eastern Interconnection

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>165,492</td>
</tr>
<tr>
<td>MW of generating capacity</td>
<td>178,563</td>
</tr>
<tr>
<td>Miles of transmission lines</td>
<td>84,042</td>
</tr>
<tr>
<td>2017 GWh of annual energy</td>
<td>773,522</td>
</tr>
<tr>
<td>Generation sources</td>
<td>1,379</td>
</tr>
<tr>
<td>Square miles of territory</td>
<td>243,417</td>
</tr>
<tr>
<td>States served</td>
<td>13 + DC</td>
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</tbody>
</table>

- 28% of load in Eastern Interconnection
- 20% of transmission assets in Eastern Interconnection

21% of U.S. GDP produced in PJM

As of 2/2018
Cleared Installed Capacity

**MW**

- **Coal**
- **Gas**
- **Nuclear**
- **Renewables**

**Demand Response**

*Includes solar & wind at nameplate, hydro and wood

Since 2007 to 2020/2021
Queued Generation Fuel Mix – Requested Capacity Injection Rights (December 31, 2017)

Natural Gas, 57,778 MW
Nuclear, 162 MW
Solar, 10,882 MW
Storage, 69 MW
Wind, 2,793 MW
Wood, 66 MW
Biomass, 4 MW
Coal, 198 MW
Diesel, 9 MW
Hydro, 77 MW
Methane, 48 MW

NOTE: Nameplate capacity represents a generator’s rated full power output capability.
Feb. 20, 2015 – All Time Winter Peak (DR Included) - 142,749

Aug. 2, 2006 – All Time Summer Peak (DR Included) - 166,860*

Jan. 5, 2018 (DR Included) - 137,127

* Includes coincident not-yet-integrated zones
### PJM Winter Preparations

#### PJM Studies, Data Requests & Drills
- **PJM Operating Analysis Task Force (OATF) Winter Operations Study**  
  *November 3, 2018*
- **Resource Winter Testing Exercise**  
  *December 2018*
- **PJM Emergency Procedures Drill**  
  *November 6, 2018*
- **Fuel Inventory Survey**  
  *October 8–November 16, 2018*
- **Generation Owner Cold Weather Resource Preparedness Checklist**  
  *November 1–December 15, 2018*

#### Reliability Coordinator Winter Preparation Meetings
- **PJM/DEP/VACAR**  
  *December, 2018*
- **SERC Operating Committee/SE RCWG/VACAR**  
  *October 2-3, 2018*
- **Reliability First**  
  *October 30, 2018*
- **Joint NPCC/PJM/MISO**  
  *November 8, 2018*
- **NYISO/PJM**  
  *October 10, 2018*
- **TVA/PJM**  
  *December, 2018*

#### Gas/Electric Coordination
- **Joint INGAA – Inter-RTO Council Meeting**  
  *November 20, 2018*
- **Winter Planning Meetings Serving PJM Generation**  
  *November 5–9, 2018*
- **Daily, Weekly, Monthly, and Seasonal Communications with Pipelines in PJM Footprint**
- **Data Sharing Agreements and Communication Protocols**
- **Enhanced Markets Gateway To Assist in Effort to Automate Gas Pipeline Contingency Analysis**  
  *December 2018*
PJM team

- Analyze data related to gas delivery to units.
- Provide operational info that allows operators to make better decisions.
- Improve coordination with pipelines and LDCs.
- Develop tools to support processes.
A Common Understanding of Resilience

**FERC’s Proposed Definition:** The ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the capability to anticipate, absorb, adapt to, and/or rapidly recover from such an event.

**PJM’s Working Definition:** The ability to withstand or quickly recover from events that pose operational risks.

Prepare + Operate + Recover

**Reliability:** Delivering electricity consistently and uninterrupted

**Resilience:** Grid survivability during extreme events, even if that means outages
PJM Resilience Program Objectives

1. Fully integrate the internal PJM work plans and initiatives across six focus areas: Operations, Planning, Markets, Security, Partnerships and System Restoration to measurably improve the resilience of the PJM system.

2. Serve as an industry leader to align the input, goals, and needs of PJM members and external stakeholders.

3. Design and implement a system capable of preparing for, operating through, and recovering from severe events.
1. Define fuel security as risks in fuel delivery to critical generators
2. Reaffirm the value of markets to achieving a cost-effective, fuel-secure fleet of resources
3. Identify fuel security risks with a primary focus on resilience
4. Establish criteria to value fuel security in PJM markets

**Phase 1: Analysis**
Identify potential system vulnerabilities and develop criteria to address them

**Phase 2: Modeling**
Model incorporation of vulnerabilities into PJM’s markets

**Phase 3: Ongoing Coordination**
Address specific security concerns identified by federal and state agencies

**TIMING**

- **May–November 2018**
  Analysis
- **May 2018 – December 2019**
  Phase 3 ongoing coordination
- **2019/2020**
  - Phase 2: Assess market design
  - January 2020: Target for FERC filing
Market Changes

Recent Activities

5 Minute Settlement

30 Minute Reserve Requirement Calculation Defined

Future Initiatives

Energy Price Formation

Day-Ahead Market Timing