Gas Electric Coordination

National Academy of Science, Engineering and Medicine
May 13, 2019
Brian Fitzpatrick – Sr. Lead Fuel Supply Analyst
### Key Statistics

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Member companies</td>
<td>1,010+</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>180,086</td>
</tr>
<tr>
<td>Miles of transmission lines</td>
<td>84,042</td>
</tr>
<tr>
<td>2018 GWh of annual energy</td>
<td>806,546</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>
</tr>
</tbody>
</table>

- 26% of load in Eastern Interconnection
- 20% of transmission assets in Eastern Interconnection

21% of U.S. GDP produced in PJM

As of 1/2019
Cleared Installed Capacity

**MW**

- **Coal**
- **Gas**
- **Nuclear**
- **Renewables**
- **Demand Response**

*Includes solar & wind at nameplate, hydro and wood.*
Queued Generation Fuel Mix
(December 31, 2018)

- **Solar**, 18,751 MW (Nameplate Capacity, 33,281 MW)
- **Methane**, 8 MW
- **Other**, 240 MW
- **Storage**, 515 MW
- **Oil**, 14 MW
- **Diesel**, 4 MW
- **Biomass**, 4 MW
- **Coal**, 146 MW
- **Wind**, 4,845 MW (Nameplate Capacity, 25,793 MW)
- **Wood**, 66 MW
- **Hydro**, 580 MW (Nameplate Capacity, 1,077 MW)

**Natural Gas**, 50,602 MW

**NOTE:** Nameplate Capacity represents a generator’s rated full power output capability.
### PJM Natural Gas Generation Supply Sources

![Bar chart](chart.png)

<table>
<thead>
<tr>
<th>Source</th>
<th>GW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interstate</td>
<td>64.0</td>
</tr>
<tr>
<td>LDC</td>
<td>16.0</td>
</tr>
<tr>
<td>Gathering</td>
<td>0.2</td>
</tr>
</tbody>
</table>
Key PJM Natural Gas Generator Stats

Total MWs of Gas-fired Generation (81,270 MWs)

- **Firm vs. Interruptible Transport**
  - Firm Transport: 43,369 MW (53.4%)
  - Interruptible Transport: 37,901 MW (46.6%)

- **Dual Fuel Capability**
  - Single Fuel: 54,323 MW (66.9%)
  - Dual Fuel: 26,937 MW (33.1%)

- **Pipeline Connection**
  - Single Pipeline: 65,430 MW (80.9%)
  - Multiple Pipelines: 15,840 MW (19.1%)
Dispatch Interactive Mapping Application
Gas-Electric Coordination

• FERC Orders
  – Order 787 (2013)
    • Allows for the voluntary sharing of non-public operating information between interstate pipelines, public utilities and electric transmission operators
  – Order 809 (2016)
    • Adjustment of interstate gas pipeline nomination cycles to improve gas-electric coordination
      – Timely nomination deadline moved from 12:30pm Eastern time to 2:00pm Eastern time
      – Addition of 3rd intraday nomination cycle
Focused on understanding and evaluation of interstate pipeline and local distribution company conditions
Gas Electric Coordination Team Focus

- Weekly calls with interstate pipeline gas operations personnel (Primarily November through March)
- Daily analysis of natural gas scheduled deliveries to generators (Is the gas nomination sufficient to meet electric obligation?)
- Daily assessment of pipeline operating conditions (OFO’s, Critical Days, Ratable Take Requirements, Force Majeure)
- Coordination of pipeline, generator and transmission maintenance outages (Primarily April through October)
- Daily report(s) to PJM Dispatch on gas delivery risks which could impact generation
# Summary of Pipeline Critical Notifications

### Critical Notifications

Critical notifications from the following pipelines are currently unavailable:
- Dominion Gas Transmission - last update
- Equitrans, L.P. - last update
- Guardian Pipeline, L.L.C. - last update
- Midwestern Gas Transmission - last update

### Critical Notifications Table

<table>
<thead>
<tr>
<th>Pipeline</th>
<th>ID</th>
<th>Type</th>
<th>Subject</th>
<th>Posted UTC</th>
<th>Effective UTC</th>
<th>End UTC</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGT</td>
<td>82017</td>
<td>Capacity Constraint</td>
<td>Agt Pipeline Conditions For 2/25/2019</td>
<td>2/24/2019 20:35</td>
<td>2/25/2019 14:00</td>
<td>2/26/2019 14:00</td>
</tr>
<tr>
<td>TGP</td>
<td>370570</td>
<td>Current Pipeline Conditions</td>
<td>Restrictions For 2-23-19 Id3</td>
<td>2/24/2019 00:32</td>
<td>2/24/2019 00:32</td>
<td>2/24/2019 00:32</td>
</tr>
<tr>
<td>TGP</td>
<td>370569</td>
<td>Current Pipeline Conditions</td>
<td>Restrictions For 02-23-19 Ec</td>
<td>2/24/2019 00:16</td>
<td>2/24/2019 00:16</td>
<td>2/24/2019 00:16</td>
</tr>
<tr>
<td>ETNG</td>
<td>81990</td>
<td>Capacity Constraint</td>
<td>Etng Pipeline Conditions For 2/24/2019</td>
<td>2/23/2019 20:17</td>
<td>2/24/2019 14:00</td>
<td>2/25/2019 14:00</td>
</tr>
</tbody>
</table>
Gas Generator Risk Assessment Tool Process

- Pipeline Critical Notices
- Pipeline Nominations
- Day Ahead Awards

Generator Risk Assessment Report
## Gas Electric Coordination Initiatives

### Gas Electric Coordination Team 2014
- Assembled after 2013/2014 Polar Vortex
- Focused on coordination and collaboration with interstate pipelines and local distribution companies and fuel delivery risk assessment

### Capacity Performance 2016-2021
- 5 year phase in
- Generators must perform when called on during Performance Assessment Interval
- Significant penalties can be assessed for non-performance

### Market Timing Change April 2016
- PJM moved Day Ahead Award notification from 4:00pm to 1:30pm
- NAESB timely gas nomination deadline moved from 12:30pm to 2:00pm

### Hourly Offers November 2017
- Allows generators to updated their offers on an hourly basis if they choose to reflect changing market conditions
2019 Gas Electric Coordination Initiatives

- **PJM/Interstate Pipeline Tabletop Exercise – Spring 2019**
  - Pilot exercise
  - Testing operational and communication protocols between PJM and Interstate Pipeline personnel under various system disruption scenarios

- **GridEx V – November 2019**
  - Including representatives from an Interstate Pipeline in this year’s exercise

- **NPCC Tabletop Exercise November 2019**
  - Focus on New York/New England but with some impact on eastern PJM

- **Gas Electric Coordination Database**
  - Central repository for all gas generation related data
  - Single tool to consolidate and enhance existing daily team processes

- **Contingency Planning**
  - Continue to identify/refine gas contingencies
  - System restoration coordination with pipelines/Black Start Fuel Assurance

www.pjm.com
Threats to Fuel Sources

Transportation
Physical Attacks
Regulation
Storms
Cyber Attacks
Droughts
Hurricanes
Temperature Extremes
1. Define fuel security considering 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 in 2019 and target solution filed with FERC early 2020
Fuel Security looks at the whole system

Capacity Performance looks at each unit individually
### Scenarios Analyzed

<table>
<thead>
<tr>
<th>Dispatch</th>
<th>Retirement</th>
<th>Winter Load</th>
<th>Non-Firm Gas</th>
<th>Refueling</th>
<th>Pipeline Disruption (med. impact)</th>
<th>Pipeline Disruption (high impact)</th>
<th>Forced Outages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic</td>
<td>Announced</td>
<td>Typical 50/50 134,976 MW</td>
<td>62.5% Avail.</td>
<td>Moderate</td>
<td>Looped 1</td>
<td>Looped 1</td>
<td>Five Year Avg.</td>
</tr>
<tr>
<td>Max. Emergency</td>
<td>Escalated 1</td>
<td>Extreme 95/5 147,721 MW</td>
<td>0% Avail.</td>
<td>Limited</td>
<td>Looped 1</td>
<td>Looped 2</td>
<td>Modeled Outages</td>
</tr>
<tr>
<td></td>
<td>Escalated 2</td>
<td></td>
<td></td>
<td></td>
<td>Single 1</td>
<td>Single 2</td>
<td></td>
</tr>
</tbody>
</table>

300+ combinations

www.pjm.com
Is The Sky Falling?
There is NO immediate threat to the reliability of the PJM RTO.

• PJM is reliable in the announced retirements and escalated retirements cases under all typical winter load scenarios.

• PJM is reliable in the announced retirements cases under all extreme winter load scenarios.

• Scenarios to identify points at which an assumption or combination of assumptions begin to impact the ability to reliably serve customers.

• The stressed scenarios resulted in a loss of load under extreme but plausible conditions.

Contributing factors:

• The level of retirements and replacements

• The level of non-firm gas availability

• The ability to replenish oil supplies

• The location, magnitude and duration of pipeline disruption

• Pipeline configuration
## Emergency Procedures Summary

**Announced Retirement Summary**

<table>
<thead>
<tr>
<th>Winter Load</th>
<th>Non-Firm Gas Avail.</th>
<th>Dispatch</th>
<th>Pipeline Disruption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical 50/50</td>
<td>62.5% Economic</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>0% Economic</td>
<td>Med.</td>
<td>Med.</td>
</tr>
<tr>
<td>Extreme 95/5</td>
<td>62.5% Max Emer. Economic</td>
<td>Med.</td>
<td>Med.</td>
</tr>
<tr>
<td></td>
<td>0% Max Emer. Economic</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Single 1</th>
<th>Single 2</th>
<th>Looped 1</th>
<th>Looped 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Med.</td>
<td>Med.</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>

**Legend**
- **Normal Operations**
- **Demand Response Deployed**
- **Reserve Shortage**
- **Voltage Reduction**
- **Load Shed**

**Table Key**
- Moderate Refueling
- Limited Refueling
# Emergency Procedures Summary

## Escalated Retirement Models

<table>
<thead>
<tr>
<th>Winter Load</th>
<th>Retirement</th>
<th>Non-Firm Gas Avail.</th>
<th>Dispatch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pipeline Disruption</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td><strong>Typical 50/50</strong></td>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>Escalated 1</td>
<td>62.5%</td>
<td>Economic</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>0%</td>
<td>Economic</td>
<td>None</td>
</tr>
<tr>
<td>Escalated 2</td>
<td>62.5%</td>
<td>Economic</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>0%</td>
<td>Economic</td>
<td>None</td>
</tr>
</tbody>
</table>

| Extreme 95/5 |            |                     | Pipeline Disruption |
|             |            |                     | None | Single 1 | Single 2 | Looped 1 | Looped 2 |
| **Escalated 1** |            |                     | None | Single 1 | Single 2 | Looped 1 | Looped 2 |
| Max Emer. | 62.5%      | Economic            | None | Single 1 | Single 2 | Looped 1 | Looped 2 |
| Economic | 0%          | Economic            | None | Single 1 | Single 2 | Looped 1 | Looped 2 |
| Max Emer. | 62.5%      | Economic            | None | Single 1 | Single 2 | Looped 1 | Looped 2 |
| Economic | 0%          | Economic            | None | Single 1 | Single 2 | Looped 1 | Looped 2 |

Legend:
- Normal Operations
- Demand Response Deployed
- Reserve Shortage
- Voltage Reduction
- Load Shed

The table shows the pipeline disruption levels for different scenarios and the corresponding dispatch methods for both typical and extreme load conditions.
Fuel Security Study Documentation

- **Fuel Security Analysis PDF** 12.18.2018
- **Fuel Security Analysis - Technical Appendix PDF** 1.2.2019
- **Fuel Security Analysis – Scenario Summaries PDF** (133MB) 1.16.2019
- **Fuel Security Study - Presentation PDF** 11.1.2018
- **Fuel Security: Analyzing Fuel Supply Resilience in the PJM Region PDF** 11.1.2018
- **Fuel Security FAQs XLS** 11.21.2018
- **Valuing Fuel Security PDF** 4.30.2018
Challenges and Opportunities

• Staying ahead of cyber and physical threats
  – Collaboration with federal agencies
  – Exercises and drills between gas and electric industries
• Fuel assurance during a system restoration event
  – Black start and critical generation
    • How much gas would be available?
    • Emergency order to raise priority of gas deliveries?
    • On-site fuel requirements
• Continuing to enhance coordination with pipelines
  – Control room to control room communications during emergencies