



PJM Winter Operations and Market Performance

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FERC Winter Operations Panel

October 19, 2017



- Winter 2017/18 System Projections
- Winter Preparedness
- Gas Electric Coordination
- Resilience – Gas Pipeline Initiatives
- Market Performance



50/50 Non-diversified Peak Load Base Case

LAS Load Forecast	135,526 MW
RTO Net Interchange	3,950 MW** (Importing)
PJM RTO Installed Capacity	184,926 MW (preliminary as of 8/02/2017)
Discrete Generator Outages	16,586 MW

** 3,950 MW of net interchange is modeled in the OATF base case and accounted for in the total RTO installed capacity

PEAK LOAD ANALYSIS

- No reliability issues identified.
- Re-dispatch and switching required to control local thermal or voltage violations in some areas.
- All networked transmission voltage violations were controlled by capacitors. All other voltage violations were caused by radial load.

IN PROGRESS

- Sensitivity Studies - Results expected early October



PJM Winter Preparations

PJM Studies, Data Requests & Drills

PJM Operating Analysis Task Force (OATF) Winter Operations Study (November 2017)

Resource Winter Testing Exercise (December 2017)

PJM Emergency Procedures Drill (November 7, 2017)

Fuel Inventory Survey (October 13, 2017)

Generation owner Cold Weather Resource Preparedness Checklist (Nov. 1 - Dec. 15, 2017)

Reliability Coordinator Winter Preparation Meetings

PJM / DEP / VACAR (November/December, 2017)

SERC Operating Committee / SERC RCS / VACAR (October 3-4, 2017)

Reliability First (September 20, 2017)

Joint NPCC/PJM/MISO (November 9, 2017)

NYISO / PJM (October 24, 2017)

TVA / PJM (November, 2017)

Gas / Electric Coordination

Joint INGAA – Inter-RTO Council Meeting (October 19, 2017)

Daily, Weekly, Monthly, and Seasonal Communications with Pipelines in PJM footprint

Data Sharing Agreements and Communication Protocols with key Local Distribution Companies

Resilience efforts to:

- Operationalize Gas Infrastructure Contingencies
- Develop gas pipeline model in conjunction with Argonne Labs

Increase transparency through enhancements to tools/visualization

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

The screenshot displays the PJM Gas Pipeline dashboard. At the top, there is a search bar and navigation options. Below this is a map of the PJM region showing various gas pipelines in different colors. A sidebar on the left contains a 'Lines & Outages' panel with a tree view of pipeline categories and a 'Gas Pipelines' panel with a list of specific pipelines. Below the map is a data table with columns for Pipeline ID, ID, Type ID, Subject ID, Posted UTC, Effective UTC, and End UTC. The table lists various pipeline conditions and alerts, such as 'Current Pipeline Conditions', 'Capacity Constraints', and 'Operational Alert'. A 'Disclaimer' section is visible at the bottom of the dashboard.

Pipeline ID	ID	Type ID	Subject ID	Posted UTC	Effective UTC	End UTC
2562	7861	Pipeline Conditions	Current Pipeline Conditions	12/09/2014 22:21	12/09/2014 22:21	06/09/2015 21:21
2562	40740	Capacity Constraint	To Pipeline Conditions For 12/10/2014	12/09/2014 21:04	12/10/2014 18:00	12/11/2014 18:00
4730	40740	Capacity Constraint	From Pipeline Conditions For 12/10/2014	12/09/2014 20:58	12/10/2014 14:00	12/11/2014 14:00
352626	34826	Pipeline Conditions	Current Pipeline Conditions	12/09/2014 20:58	12/09/2014 20:58	12/31/2048 14:00
402	47737	Capacity Constraint	Act Pipeline Conditions For 12/10/2014			
502	2381027	Operational Alert	Flow Alert - Market Area 24 Lowest Available Flow Limitation			
2562	254797	Current Pipeline Conditions	Restrictions For 12/9/14 01			
2562	254795	Ops	Ops Balance Alert Pro Specifics 423070			
2562	254794	Maintenance	Conservation Repair Six 455a Effective 12/9			
2562	254793	Ops	Ops Balance Alert Pro Specifics Lifted			
2562	4179188	Constraint	Market And Production Constraints			
502	2381026	Capacity Constraint	Capacity Limits - Toledo For December 10, 2014			
2562	1977	Pipeline Conditions	Current Pipeline Conditions			
502	18076	Capacity Constraint	IS.1 Restrictions Effective December 9, 2014			
502	18075	Capacity Constraint	IS.1 Restrictions Effective December 8, 2014			





Risks / Dependencies:
 Extreme Weather | Physical/Cyber Attacks | Fuel Source/Security

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Prepare

- Assess Risks**
Targeted risk management
- Strengthen Infrastructure**
Make critical assets less vulnerable
- Increase Coordination**
Cross-sector & public/private partnerships

Operate

- Strengthen Operations**
Expand coordination and communications
- Enhance Continuity**
Planned response exercises
- Apply Innovative Approaches**
Microgrids & distributed energy resources

Recover

- Stabilize the System**
Prioritize interdependent infrastructures for system survivability
- Regain Critical Functions**
Balance industry and societal priorities
- Make Enhancements Based on Lessons Learned**

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Establish
Normal &
Conservative
Operations
Triggers

Assess
Redundancy

Evaluate
Contingency

Revise EMS
Contingency &
30 Minute
Reserve
Requirement

A green target graphic with three concentric circles and a central bullseye. A large grey arrow points from the left towards the center of the target.

Reliability / Resilience

MODEL FRAMEWORK AND PLATFORM

- Model framework based on “node-link” representation:

- Nodes → compressor stations, receipt/delivery points, etc.
- Links → pipeline segments

- Gas networks will be modeled using Argonne’s PLASMO (Platform for Scalable Modeling and Optimization)

Natural Gas Networks



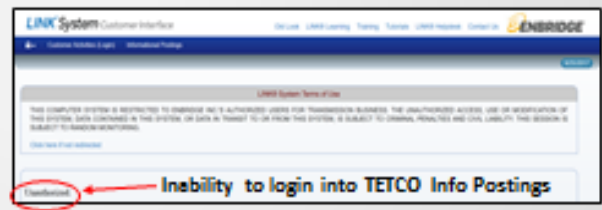
We can easily model a network of pipelines by defining sets of nodes (junctions) and links (pipelines).

- \mathcal{N} : Set of nodes (junctions)
- \mathcal{L} : Set of links (pipelines)
- \mathcal{S} : Set of gas supply flows
- \mathcal{D} : Set of gas demand flows
- $\mathcal{L}_a \subseteq \mathcal{L}$: Set of active links (pipelines with compressors)
- $\mathcal{L}_p \subseteq \mathcal{L}$: Set of passive links (pipelines without compressors)

- Pilot model with Texas Eastern pipeline under development
 - December 2017 target completion
- Run model on pre-identified critical areas on all other pipelines
 - Q2, 2018 target completion
- Continue seeking cooperation from interstate pipelines for model result review/ validation

GAS-ELECTRIC SCENARIO – CYBER EVENT

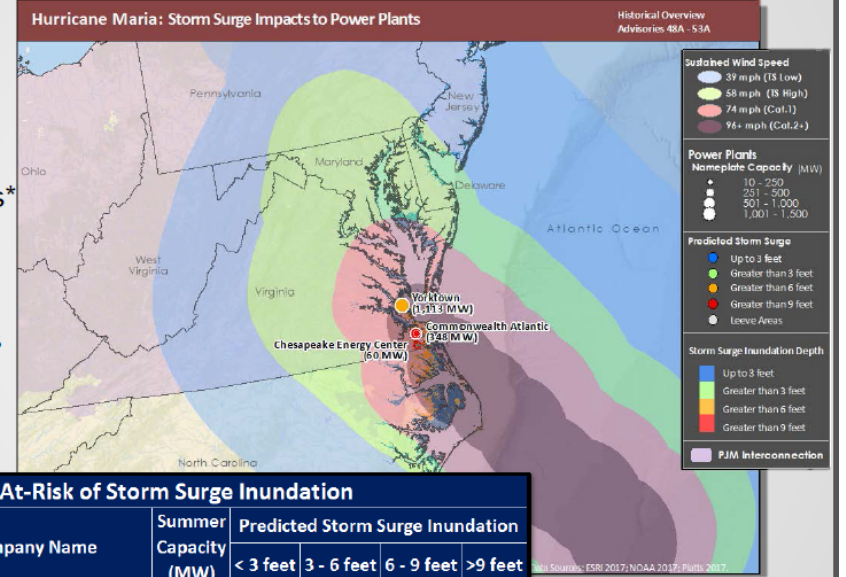
- Major news organizations reporting delivery problems for multiple natural gas interstate pipelines in the U.S.:
 - Issues with natural gas deliveries to customers.
 - Unconfirmed reports of natural gas being released to the atmosphere via relief valves.
- News report indicate that Texas Eastern Gas Transmission (TETCO) may be affected:
 - Company Informational Posting web site down.
 - Natural gas supply to interruptible electric power plants abruptly halted over multi-state region.
- Source of the disruptions is unknown; unsubstantiated reports indicate disruptions were intentional.



- Conjecture that the incidents could be cyber-related (but not certain).
- U.S. government investigating to determine whether incidents are intentional.

STORM SURGE IMPACTS ON ELECTRIC SECTOR: POWER PLANTS

- NOAA projects that the storm surge from Hurricane Maria could extend into Virginia and North Carolina:
 - Three power plants* projected to be completely inundated.
 - Other power plants may be subject to localized flooding (not determined).



Power Plants At-Risk of Storm Surge Inundation						
Plant Name	Company Name	Summer Capacity (MW)	Predicted Storm Surge Inundation			
			< 3 feet	3 - 6 feet	6 - 9 feet	>9 feet
Yorktown	Virginia Electric & Power Co.	1,113			X	
Commonwealth Atlantic	Virginia Electric & Power Co.	348				X
Chesapeake Energy Center	Virginia Electric & Power Co.	60				X

* Summer capacity > 50 MW

Recently Implemented

Hourly Offers

Shortage Pricing

Initiatives

Energy Price Formation

Load Following