



Natural Gas Reliability: Understanding Fact from Fiction

David W. Souder Sr. Director, Operations Planning NARUC 2018 Winter Policy Summit February 13, 2018



- Winter preparations
- Winter Performance
- Fuel Security Paper findings
- Effort to Operationalize Gas Pipeline contingencies
- Resilience Takeaways



PJM Winter Preparations

PJM Studies, Data Requests & Drills	Reliability Coordinator Winter Preparation Meetings	Gas / Electric Coordination	
PJM Operating Analysis Task Force (OATF) Winter Operations Study	PJM / DEP / VACAR (November/December, 2017)	Joint INGAA – Inter-RTO Council Meeting (October 19, 2017)	
(November 2017) Resource Winter Testing Exercise (December 2017)	SERC Operating Committee / SERC RCS / VACAR (October 3-4, 2017)	Daily, Weekly, Monthly, and Seasonal Communications with Pipelines in PJM footprint	
PJM Emergency Procedures Drill (November 7, 2017)	Reliability First (September 20, 2017)	Data Sharing Agreements and Communication Protocols with key Local Distribution Companies	
Fuel Inventory Survey (October 13, 2017)	Joint NPCC/PJM/MISO (November 9, 2017)	Resilience efforts to: • Operationalize Gas Infrastructure	
Generation owner Cold Weather Resource Preparedness Checklist (Nov. 1 - Dec. 15, 2017)	NYISO / PJM (October 24, 2017) TVA / PJM (November, 2017)	 Contingencies Develop gas pipeline model in conjunction with Argonne Labs 	

Increase transparency though





PJM Evolving Resource Mix and System Reliability



Define fuel diversity and fuel security with a primary focus on reliability

Analyze fuel diversity trajectory and identify avoidance areas which will negatively impact reliability

Reflect on current makeup of PJM / U.S. fuel diversity

Explore fuel security and impact on reliability and fuel diversity



reliability





Establish Baseline near-term PJM portfolio

Establish Potential Portfolios

Leveraged NERC Essential

Reliability Services to measure



Operational Reliability Risk Assessment

Diversity & Reliability Indices



Portfolios composed of up to 86 percent natural gas showed no decreases in reliability but increase risk in fuel security.

Portfolios with moderate wind/ solar are reliable if accompanied by large shares of coal and natural gas.

As the resource mix moves in the direction of less coal and nuclear generation, frequency response, reactive capability and fuel assurance attributes decrease.

http://www.pjm.com/~/media/library/reports-notices/special-reports/20170330-pjms-evolving-resource-mix-and-system-reliability.ashx

Gas Pineline Redundancy



bim



Resilience - Gas Pipeline Contingencies



Resilience Takeaways

- Order 787 Reforms
- Separate Gas Generation Tariff Section
 - Tailored Gas Pipelines Services for Generation to address unique operating characteristics.
- Planning and Operations Reforms
 - Interconnection Coordination
 - Gas Pipeline Contingency Identification and Real-time Analysis
 - Coordinated Gas-Electric Operating Procedures
- Cyber and Physical Security



NARUC Winter Policy Summit

PRESENTED TO

The Committee on Gas Panel on "Natural Gas Reliability: Understanding Fact from Fiction"

PRESENTED BY

Sam Newell with Anul Thapa, Matthew Witkin, and Ray Wong

February 13, 2018



Introduction

- Natural gas-fired capacity has displaced coal and made electric systems highly dependent on gas, leading to concerns about reliability, particularly during cold snaps when gas pipeline capacity is less available for generation
- Systems were tested by the 2014 Polar Vortex, the 2015 cold snap, and the recent "Bomb Cyclone"
 - No load was shed
 - RTOs and market participants learned and became better prepared
- Concerns remain about future reliability as gas dependence grows
- The key questions are how vulnerable are we and what to do about it?
 - Varies by region: ISO-NE study shows vulnerabilities; PJM's does not
 - Getting price formation right (reflect fuel costs in offers, energy shortage pricing, CP/PFP) should incent investment and performance when needed

Regional Differences in Reliability Concerns

Region	Risk / Mitigating Factors	Future Outlook	
ISO-NE	 Limited gas pipelines and no storage 45% of capacity has gas as primary fuel¹ Dual-fuel w/limited oil storage and emissions LNG, but deliveries not guaranteed Growth in wind and possibly imports Scarcity pricing & performance incentives 	ISO-NE study projected power shortages due to inadequate fuel in 19 of 23 scenarios by winter 2024/2025 ²	
PJM	 Extensive pipeline, storage, and production infrastructure⁴ Only 36% of capacity has gas as primary fuel³ Scarcity pricing & performance incentives 	PJM study concluded it could maintain reliability with 66% natural gas capacity even under Polar Vortex conditions ⁴	

Sources and Notes:

1 36% of which is dual fuel and 11% LNG. See <u>www.iso-ne.com/system-planning/system-plans-studies/celt</u>

2 www.iso-ne.com/static-assets/documents/2018/01/20180117_operational_fuel-security_analysis.pdf

3 42% of which is dual fuel. See www.pjm.com/-/media/markets-ops/ops-analysis/capacity-by-fuel-type-2017.ashx?la=en

4 <u>www.pjm.com/~/media/library/reports-notices/special-reports/20170330-appendix-to-pjms-evolving-resource-mix-and-system-reliability.ashx</u>, p. 41.

Strong Price Signals When Needed

"[High wholesale energy prices] send important signals to drive performance and investment... Prices that accurately reflect fuel costs and system conditions also send signals that drive operational and investment decisions for both resources and consumers."

-- Chairman McIntyre, U.S. Senate Hearing, Jan. 23, 2018



Daily ICE prices from Velocity Suite, ABB Inc., averaged for each month

Sources and Notes:

Shortage Pricing and Performance Incentives

Market	Offer Cap ¹ (\$/MWh)	Max Shortage Adder ² (\$/MWh)	Capacity Performance Incentive (\$/MWh)	Max Signal in Severe Shortage (\$/MWh)
ISO-NE	\$2,000	\$3,050	\$3,500 ³	\$8,500
PJM	\$2,000	\$1,700	\$3,500 ⁴	\$8,200
MISO	\$2,000	\$1,500	N/A	\$3,500
NYISO	\$2,000	\$3,250	N/A	\$5,250
ERCOT	\$1,000	\$9,000	N/A	\$10,000

Notes:

1 Offers up \$1,000/MWh normally, or \$2,000/MWh w/case-specific review, except ERCOT.

2 Sum of Reserve Constraint Penalty Factors in ISO-NE, PJM, MISO, and NYISO.

3 In effect for 6/2021-5/2025.

4 In effect for the RTO in 2020-21; range is \$2,200 to \$4,000 across the LDAs.

High Response when Forward Prices Reflect Tightness (but no guarantees)



LNG —Algonquin Natural Gas Futures Prices as of Previous October 1

Source and Notes:

www.iso-ne.com/about/regional-electricity-outlook/grid-in-transition-opportunities-and-challenges/natural-gasinfrastructure-constraints#imported-liquefied.

The chart shows LNG deliveries to interstate pipelines and excludes LNG for Mystic 8 and 9.

* Preliminary total through mid-Jan 2018 was ~15.1 Bcf; more deliveries expected before winter's end.

Market Participants Do Respond to Incentives

- ISO-NE: added dual fuel on 1,774 MW existing gen¹ + 2,027 MW new.²
- PJM: \$250m investment in winterization, infrastructure, staffing, and firm fuel at existing plants.³
- PJM: 25 GW entry, much w/dual fuel, firm gas, or in producing regions.⁴
- Calpine (for example): continued investment in dual fuel⁵ after record earnings in Polar Vortex w/dual fuel.⁶

Incentives and responses should increase if conditions tighten.

Sources

¹ www.isonewswire.com/updates/2017/10/27/update-on-the-20172018-winter-reliability-program.html

² www.iso-ne.com/static-assets/documents/2015/02/fca9_initialresults_final_02042015.pdf; www.iso-ne.com/staticassets/documents/2016/02/20160211_fca10_initialresults_final.pdf

³ www.platts.com/latest-news/electric-power/houston/pjm-capacity-auction-reform-spurs-250-million-21872908

⁴ Brattle review of recent/cleared new generation, including environmental permits and websites.

⁵ s2.q4cdn.com/871785789/files/doc presentations/2014/CPN-2Q14-Earnings-Presentation.pdf

⁶ s2.q4cdn.com/871785789/files/doc_presentations/2014/CPN-1Q14-Earnings-Presentation.pdf

Presenter Information



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Dr. Samuel Newell, a Principal of The Brattle Group, is an economist and engineer with 20 years of experience consulting to the electricity industry. His expertise is in the design and analysis of wholesale electricity markets and in the evaluation of energy/environmental policies and investments, including in systems with high penetration of variable energy resources. He supports clients in regulatory, litigation, and business strategy matters involving wholesale market design, contract disputes, generation asset valuation, benefit-cost analysis of transmission enhancements, the development of wholesale demand response programs, and integrated resource planning. He frequently provides testimony and expert reports to RTOs, state regulatory commissions, and the FERC and has testified before the American Arbitration Association.

Dr. Newell earned a Ph.D. in Technology Management and Policy from MIT, and a M.S. in Materials Science and Engineering from Stanford University. Prior to joining Brattle, Dr. Newell was Director of the Transmission Service at Cambridge Energy Research Associates.

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Michael Moses Director, Gas Control & Planning West

TransCanada U.S. Natural Gas Pipelines

Based in Houston, Texas, Michael is responsible for the Facility Planning, Operations Planning and Gas Control teams, which design, maintain and operate TransCanada's U.S.-based, West natural gas pipelines and storage facilities.

Pipelines

() TransCanada

ANR Pipeline, Great Lakes Gas Transmission, Northern Border Pipeline, Bison Pipeline, Gas Transmission Northwest, Tuscarora Gas Transmission, North Baja Pipeline

Storage

ANR Pipeline, ANR Storage Co, Blue Lake Gas Storage, Eaton Rapids Gas Storage System



TransCanada U.S. Natural Gas Pipelines



* GTN, Tuscarora, North Baja, Bison, Northern Border and Portland interests, together with 46% of Great Lakes and 49% of Iroquois, held within TC PipeLines, LP

Increased demand for Firm Transient Services

- Flexibility is interruptible
- Reliability is designed for firm

Firm Storage MDWQ remains important

- Storage continues to sell out of MDWQ
- MDWQ is not just for winter peaks

System Reliability

 Continued commitment with growing maintenance and integrity programs



Cautions About Gas

NERC Special Assessment, "Operational Risk Assessment with High Penetration of Natural Gas-Fired Generation" (May 2016)

National Academy of Sciences, "Enhancing the Resilience of the Nation's Electricity System" (July 2017)

DOE Staff Report, Secretary Perry's letter, NOPR (August and September 2017)

NERC, "Single Point of Disruption" (November 2017)

NERC, "2017 Long-Term Reliability Assessment" (December 2017)

ISO New England, "Operational Fuel-Security Analysis" (January 2018)

A Few of These Concerns

Interruptible contracts

Lack of dual-fuel capability

"Single point of disruption"

Difficulty building new gas pipelines

Gas and electricity have different regulatory models

FORCED OUTAGES DUE TO FUEL SUPPLY PROBLEMS







