



WEATHER RESILIENCE IN THE NATURAL GAS INDUSTRY

THE 2017-18 TEST AND RESULTS

Prepared for
The Natural Gas Council
August 2018

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Introduction—Proof of Resilience

- » In July 2017, the Natural Gas Council¹ released “Natural Gas Systems: Reliable and Resilient” (NGC Report) (attached as Appendix A), a report detailing the characteristics of the U.S. natural gas industry that contribute to its reliability, resistance to weather-related interruption of service, including the ability to compensate for any operational issue and to recover rapidly.
- » Beginning one month after the release of the NGC Report, a series of significant weather events—two hurricanes and the combination of the Northeast freeze and the Bomb Cyclone—tested the natural gas industry. The industry’s performance through the stress test of those three widely varied and tumultuous events fully reinforced the conclusions of the NGC Report.
- » This study examines that industry performance in detail. It has been compiled from a review of press accounts, government reports, and detailed interviews with affected companies.



Why These Three Storms?

The 2017-2018 storms spanned the full range of potential weather impacts on the natural gas industry.

From Gulf Storms and Flooding: Hurricane Harvey

- » A traditional Gulf hurricane affecting offshore production, but then flooding and immobilizing the fourth largest U.S. city and the headquarters of much of the natural gas pipeline industry.

To Extreme Wind and Flooding in Populated Areas: Hurricane Irma

- » A fierce South Atlantic and Gulf storm moving the length of the heavily populated state of Florida, which relies on natural gas for power generation more than any other state in the U.S., with some extended impact north into Georgia and the Southeast.

To a Deep Freeze and Extreme Winter Conditions: The Bomb Cyclone

- » An historic Northeast deep freeze, exacerbated by the “Bomb Cyclone,” a snow and ice hurricane affecting Northeast production areas and the most densely populated region in the U.S., the East coast.



Definition of “Resilient”

- » The Merriam-Webster Dictionary defines “resilient” as follows:
 - a: capable of withstanding shock without permanent deformation or rupture.
 - b: tending to recover from or adjust easily to misfortune or change.²
- » For the natural gas industry, in the context of the last year’s weather events and incorporating the Department of Energy’s definition of resilience,³ the working definition may be translated to:
 - **Able to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions.**
 - **Able to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents.**
- » Ultimately the test is whether commitments to customers can be met regardless of the degree of stress that is caused by a weather event. As this study demonstrates, the natural gas industry passes this test with flying colors.



Overall Conclusion: Industry Resilience in a Wide Variety of Storms

- » This study concludes that the industry proved remarkably resilient in all three weather events for reasons directly traceable to the characteristics described in the NGC Report
 - Planning and preparation, combined with the physical characteristics of the industry, resulted in very few operational issues that impaired supply or capacity, in any of the three storms.
 - In all cases where any such issues could have impaired firm pipeline service, the industry was able to “work around” the issues, through rerouting of gas, operation of storage, or cooperation among interconnected pipelines, resulting in no impact on firm customers’ service.
 - There was no meaningful curtailment of local distribution companies’ delivery of natural gas to end-users reported in any of the three storms—the limited curtailments caused by facility damage were not meaningful, since repairs were complete by the time evacuations were lifted and consumers were back on site and requiring service.
- » Though some constraints in the Northeast resulted in elevated prices and the use of alternate fuels for generation, these were not due to a shortfall in physical capacity necessary to satisfy firm contracts. **Northeast constraints were the result of market participants exhausting their contractual entitlements to pipeline capacity. Market participants facing constraints either had no such contractual entitlements, or had used them up.**



Some Notable Specific Observations Bear Out the Resilience Finding

- » In the two major hurricanes, the real news about the natural gas industry was that there was no news.
 - The industry performed normally throughout both storms.
 - In the face of large transmission-driven power outages in Florida, steady gas industry performance enabled backup generation, distributed generation and combined heat and power installations to continue to operate, protecting high-priority needs.
- » In the Northeast, impacts of the exhaustion of committed firm capacity in New York and New England resulted in spot-price-driven impacts in power markets, but did not result in a loss of reliability for gas or for power, and gas consumers shielded from spot prices by firm contracts were protected from local price spikes.
- » In the Mid-Atlantic market, PJM indicated that no gas-fired generation outages were the result of a failure of firm transportation.
 - A decision by PJM to operate some coal facilities briefly in lieu of gas-fired generation was misinterpreted by the Department of Energy's National Energy Technology Laboratory (NETL) as a failure of gas-fired generation.
 - PJM directly corrected the NETL assertion, clarifying that the decision was strictly economic, as coal became briefly less expensive than natural gas—gas supply to generators remained fully available.



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Summary Conclusion: Three Varied Tests, Three Successes for Industry Resilience

Hurricane Harvey

August 2017

- » Traditional Gulf of Mexico hurricane & flooding seriously affected the Texas region including Houston.
 - 51 inches of rain
 - \$125 billion in damage (costliest in history)
- » Customers: No end-use curtailment.
- » Pipelines: Minor, short-term restriction of firm service on pipelines with damaged compressor stations briefly affecting exports but no end-users.
- » Spot prices: a "non-event"; stayed in \$2.80-\$3.00 range.

Hurricane Irma

September 2017

- » Fierce Atlantic/Gulf of Mexico storm swept the most natural gas-generation intensive state.
- » Power was out; natural gas was not.
 - Power lines were down.
 - Gas distributed generation still worked.
- » Customers: Very minor short-term end-use curtailment to evacuated areas; (did not affect customers—they weren't there).
- » Pipelines: No restrictions on firm pipeline service
- » Spot prices: a "non-event"; stayed in \$2.80-\$3.00 range

"Bomb Cyclone"

Dec./Jan. 2018

- » Historic Northeast deep freeze/snow & ice hurricane
- » Customers: LDC customers fully served.
- » Pipelines:
 - Firm customers fully served between their contractual points.
 - Interruptible and secondary-firm service limited as firm customers used the space they had paid for.
- » Producers: Some freeze-offs, but storage and cooperative relationships among pipelines covered shortfalls.
- » Spot prices: Spiked in the Northeast, at the outlet of the pipelines, but Henry Hub and Marcellus saw only minor effects.



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I. NGC RELIABILITY REPORT AND INDUSTRY BACKGROUND: *A HISTORY AND CULTURE OF RELIABILITY*

The July 2017 NGC Report explained in detail the factors that make the natural gas industry reliable and resilient, resulting in a 99.79 percent success rate in meeting its customers' firm-service requirements.



The NGC Reliability Report

- » The 2017 NGC Report addressed five main aspects of the natural gas industry:
 - History of reliability and the reasons for it;
 - System security, both physical and cyber;
 - The role of firm pipeline contracts in ensuring service;
 - The role of regulation in dealing with reliability at both federal and state levels; and
 - The role of storage in supporting reliability.
- » The NGC Report explained why the natural gas industry is inherently reliable and resilient, with the most important variable for pipeline customers being the level of contractual assurance to which they commit and the most important variable for end-users served by LDCs being how the LDC is regulated.
- » The NGC Report found that the pipeline industry exhibited a 99.79 percent reliability in fulfilling its firm contract obligations (primary service between contractual points) over the ten years through 2016.



The NGC Report--Characteristics

- » The NGC Report emphasized four key characteristics of natural gas support reliability and resilience:
 - **Underground:** The extensive underground location of facilities protects them from weather impacts;
 - **Line Pack:** Transmission pipelines incidentally store gas at pressure (called "Line Pack") which provides a buffer that can mitigate the effects of abnormal operating conditions; and
 - **Network Reliability:** The network configuration of the pipeline industry means that, in the event of an outage, there is usually a "work-around" that allows continued service to LDCs and directly-connected consumers.
 - **Confined Impact:** Physical configuration limits impact of a disruption; not susceptible to 'cascading events' such as those on electric transmission systems

- » The NGC Report also explained the benefit of the transition from offshore (mostly Gulf of Mexico) production to diverse resources onshore; the shale revolution has, in essence, "hurricane-proofed" the industry.

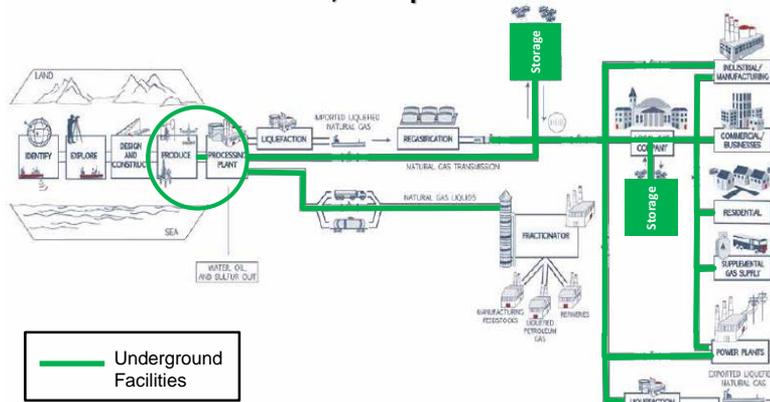


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From Producer to Consumer, the Pipe is Buried

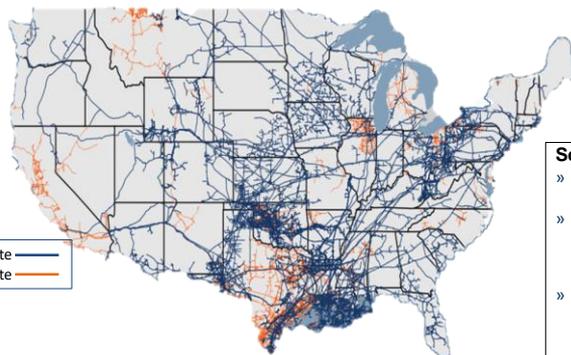
From Producer to Consumer, the Pipe is Buried



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The U.S. Natural Gas Industry Is Large and Very Resilient



Interstate —
Intrastate —

- » Over 300,000 Miles of transmission pipe
- » Over 200 Transmission Companies
- » Largest natural gas market in the world
- » Production dispersed across 30 states and 500,000 natural gas wells
- » Over 300 active storage fields

Security of Service:

- » Most pipeline facilities are buried, protected from weather.
- » Cyber exposures are managed through layered protection, isolation of operating systems, etc.
- » The size and configuration of the grid enables substantial redundancy to compensate for any physical pipeline outage.
- » During most pipeline events, service is maintained with a "work-around" and collaborative help from other pipelines, similar to mutual aid in the electric industry.



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Customer Choice of Firm vs. Interruptible Service Matters When Assessing Reliability

Transportation service is a *choice by the customer* that determines predictability of customer service and financial underpinning for pipeline. Choice of service must be factored in when assessing reliability.

Firm Pipeline Service

- » Customer pays a fixed monthly charge to reserve capacity between specific points on the pipeline, essentially leasing space whether gas flows or not.
- » This is the highest-priority service, provides underpinning for pipelines to invest capital.
- » Firm service is analogous to reserving and paying for a seat on an airline in advance.
- » High record of reliability: industry 99.79% reliable in fulfilling firm contracts 2007-2016.

Marketer Transportation Options

- » Marketers offer contract options too, such as rebundled packages to provide flexible service on the pipeline throughout 24-hour gas day, along with a range of other service options.

Interruptible Pipeline Service

- » Customer pays per unit, only as gas actually flows, incurring no cost if gas does not flow.
- » Interruptible is a lower priority service than firm, subject to availability of pipeline capacity with no guarantee of service.
- » Pipelines generally do not invest capital to support interruptible service.
- » On high-demand days, if customer has only interruptible transportation and is seeking natural gas on the day-ahead market, customer choice is limited to spot markets that are higher-priced.
- » Interruptible service is analogous to flying stand-by.
- » Customer accepts risk of unpredictability on peak demand days in exchange for lower costs.
- » [SEE APPENDIX B FOR MORE DETAIL ON SERVICES]



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II. THE 2017 HURRICANES HARVEY AUGUST 24- SEPTEMBER 2 IRMA SEPTEMBER 7-13

FIERCE, BUT “NON-EVENTS” FOR THE INDUSTRY

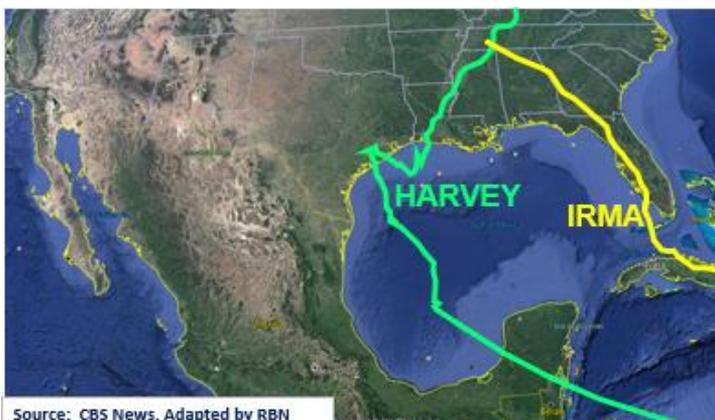
The 2017 hurricanes, caused a great deal of damage, but essentially became inconsequential events for the natural gas industry, thanks to the characteristics and preparation of the industry.



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The Gulf Storms—A Busy Year



Source: CBS News, Adapted by RBN

- » Harvey (Aug-Sept) profoundly affected Houston, and had barely passed when Irma hit Florida.
- » Irma (Sept) tracked the length of the state resulting in 64% of power being lost (per EIA).
- » Then Maria (Sept) hit in the islands in the Caribbean, creating an additional logistics crisis.

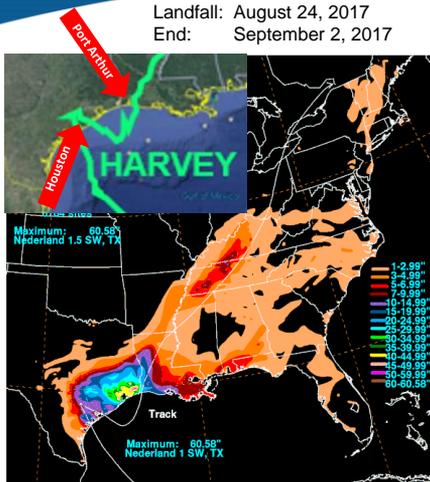


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Harvey Had a Record Impact, but the Natural Gas Industry Performed Normally

Landfall: August 24, 2017
End: September 2, 2017



Source: National Oceanic and Atmospheric Administration

- » Hurricane Harvey made landfall south of Houston, turned back out to sea, came back, stayed in place, then made landfall again at Port Arthur.
- » The resulting rain totaled 51 inches in Houston, and Port Arthur sustained both flooding and wind damage.
- » Harvey was the costliest storm in U.S. history, inflicting damages estimated at \$125 billion.
- » Yet the natural gas industry continued to perform normally before, during, and after the storm.

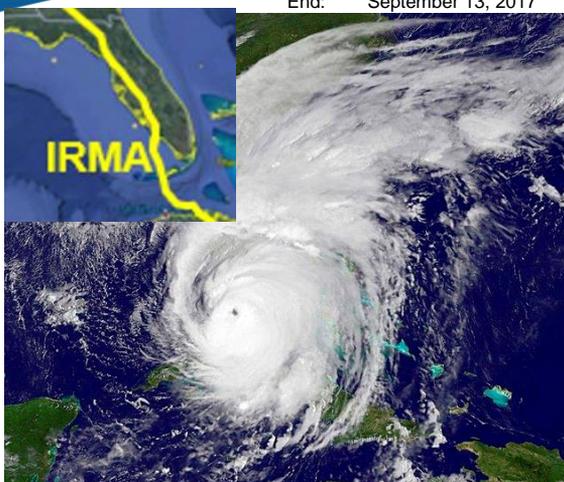


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Irma Took Out Power Region-Wide, but Gas Stayed on and Performed Normally

Landfall: September 7, 2017
End: September 13, 2017



Source: National Oceanic and Atmospheric Administration/NASA

- » Hurricane Irma ultimately threatened, but was not centered over the Gulf.
- » It went straight up the West Coast of Florida, causing widespread damage throughout the state that relies on natural gas for electricity more any other.
 - Power was out.
 - Natural gas supply was unimpaired to all users, including distributed generation.
 - While power outages also happened in Georgia, Alabama, and the Carolinas, none were related to unavailability of natural gas supply.
- » Throughout, gas performed normally, allowing alternative generation to operate.



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Service During Harvey Continued Normally, Due to Resilience and Preparation

- » Harvey's impact spanned the Houston metropolitan area, smaller cities south (Port O'Connor, etc.) and smaller cities to the Northeast (Port Arthur, etc.).
- » Utility and pipeline emergency protocols, well-established from experience with hurricanes, were implemented and were effective.
- » There was no failure of service to end users. At the LDC level, it was necessary in many instances, for safety reasons, to turn off gas service to end-use residences and businesses that had been flooded, in the same way that power was intentionally disconnected at such locations. Neither was a failure of service, merely a normal safety precaution in the face of severe flooding.
- » Several compressor stations in South Texas and Louisiana were closed for safety reasons, with some actual damage. Minor compressor station damage resulted in limited restriction of firm service on the affected pipelines, but restrictions were short-term and minor. End-use customers did not experience any failure of natural gas service as pipelines successfully worked around any issues.



Reliability of Natural Gas was Unaffected by Harvey

- » The most widespread problem caused by Harvey was severe flooding. Fortunately, high-wind damage was limited, thus avoiding widespread power outages from damage to transmission and distribution lines. Gas-fired generation performed normally, with no impairment of natural gas supply.
- » The most pronounced impacts of Harvey involved mobility.
 - For pipelines headquartered in the Houston area, this meant operating systems and managing customer nominations using remote locations and distributed networks.
 - For the gas distribution system, this meant needing to reach areas of severe flooding to turn off gas for safety reasons, in flooded residences and businesses.
 - Impassable roads meant that large fleets of boats and large trucks were necessary to locate crews where they were needed.
- » The Texas Railroad Commission reported no significant problems for natural gas facilities or operations.
- » Thanks to natural gas resilience, Harvey—the most costly storm in U.S. history—was a fully manageable event for natural gas service.



Pipelines and LDCs Delivered During Irma

- » Irma did not cause any restrictions to firm pipeline service.
- » Very limited end-use curtailment took place, due to damage to LDC lines from uprooted trees.
 - The duration was only 24 hours until repairs were accomplished.
 - Meanwhile, since residents had been evacuated for safety reasons, the limited service interruptions were insignificant.
- » Storm damage incurred by the gas industry primarily involved above-ground LDC facilities such as buildings. Damages did not affect reliability of service.

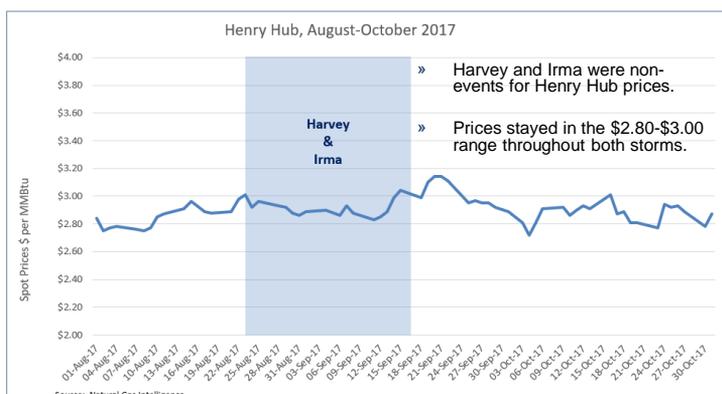


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Henry Hub Spot Prices Through Harvey and Irma

Spot market price behavior can be a good indicator of whether any pipeline constraints exist that may eventually cause pressure on service. Through both Harvey and Irma, *no constraint-driven price behavior was observed.*



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Irma: Widespread Power Outages, No Meaningful Gas Outages

- » Irma's impact spanned the entire Florida peninsula, plus areas of states such as Georgia (although at lower intensity than in Florida). Utility and pipeline emergency protocols, well-established from experience with hurricanes, were implemented and were effective.
- » The most widespread energy problem caused by Irma was damage to power transmission and distribution systems, causing the loss of 64 percent of Florida's electric load (EIA "Today in Energy," December 21, 2017). Two nuclear units went offline, but there are no reports of gas-fired generation failing to run when needed. Primarily, the loss of load caused all generation to operate at low levels or not at all.
- » But natural gas service continued *normally*, with pipelines and LDCs both avoiding major impairment—gas flowed even when power could not.
- » **Thus, those customers with distributed gas generation, combined heat and power, and gas-fired emergency generation were able to maintain power service.**



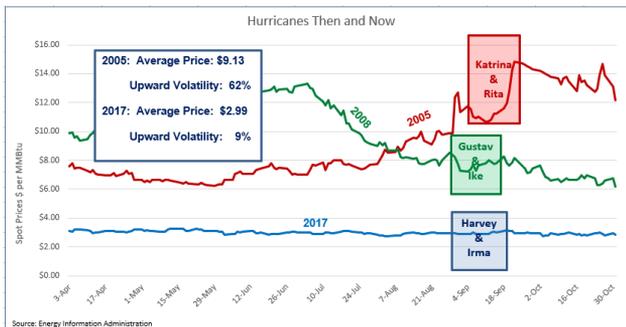
Shale Gas Has Hurricane-Proofed the Industry for a Decade

- » This experience was very different from past experience with Gulf hurricanes.
 - Historically, Gulf hurricanes had a serious impact on supply availability from offshore, creating sudden supply-demand imbalances that drove prices up.
 - Physical supply was maintained, primarily by pulling very hard from other areas such as Texas.
 - While service remained resilient, there were significant economic consequences in the form of higher natural gas prices caused by the supply-demand balance and pipeline bottlenecks moving gas from Texas.
- » Due to the shift from largely Gulf of Mexico supplies to regionally diverse onshore shale production, this phenomenon has vanished. Shale gas has "hurricane-proofed" the industry for over a decade.
- » Appendix C is an American Petroleum Institute discussion of storm impacts on the oil and gas industries. The discussion identifies no natural gas issues. Shale-driven abundance has caused natural gas supply to be a solution, not a problem.



Hurricane Proofing Shows By Comparing 2005, 2008, and 2017

- » The surge in abundant onshore production has made hurricanes a non-event with respect to price volatility, as compared with 2005.
- » Aside from the obvious impact of shale-driven abundance in lowering the overall non-hurricane levels from \$7.00 to \$3.00, there was simply no spike in prices like that experienced in 2005.



The first full demonstration of this hurricane-proofing was in 2008:

- » Gustav and Ike affected the same level of offshore production as Katrina and Rita.
- » But prices were flat despite the storms, actually declining afterward.



FERC Saw Hurricanes as Very Important in 2005. . .

- » The impact of the 2005 storms was apparent in FERC's State of the Markets report covering 2005.⁴ "Hurricanes Katrina and Rita" were the first words of the report.



But a Non-Issue in 2017

- » But the words “hurricane,” “Harvey,” and “Irma” do not appear anywhere in the FERC State of the Markets Report covering 2017.⁵
- » The FERC market analysis clearly did not consider the hurricanes to be market “events.”



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In Addition to Insulation from Offshore Losses, Industry Resilience Showed Onshore

- » Harvey's onshore impact went from approximately Port O'Connor to Port Arthur, with Houston's massive population and industrial concentration in the center a primary target.
- » That arc defines the Houston Ship Channel (HSC) market area.
- » Service continuity for the HSC during the storm is strongly indicated by HSC prices that were actually more stable than during other portions of the summer, as shown below.



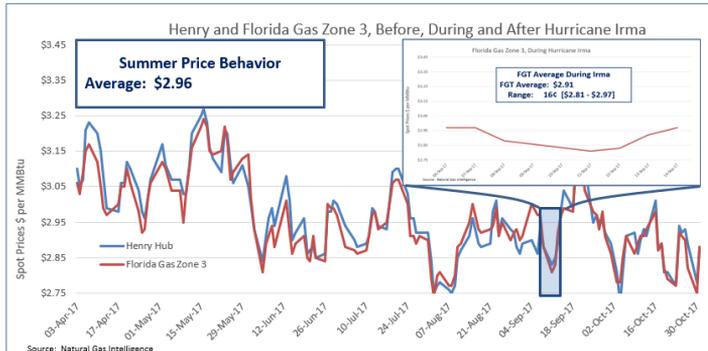
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Service/Price Continuity Also Prevailed for Irma and Pipeline Service to Florida

- » Irma tracked up the west side of the Florida peninsula. Price activity indicated no real Irma-related impact on pipeline service
- » The primary price index for the entry point into Florida, FGT Zone 3 shown below, tracked Henry Hub prices throughout the summer.
- » During Irma itself, both level and volatility were below the results for the full summer. (Florida city gate prices were only sporadically reported during the storm, but no major pipeline outages were reported, so FGT Zone 3 is representative of wholesale spot prices).



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III. THE BOMB CYCLONE AND NORTHEAST FREEZE

RELIABILITY AND PRICE STABILITY FOR FIRM CUSTOMERS

The Northeast Bomb Cyclone provided a winter test of the natural gas network, in terms of both temperatures and wind. The industry passed with flying colors. Firm customers received full service, allowing access to reasonably priced supplies



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And then Winter—The Bomb Cyclone

Cold and Blizzard: December 27, 2017
End of Bomb Cyclone: January 7, 2018



Source: National Oceanic and Atmospheric Administration/NASA

- » In the midst of a severe cold wave and blizzard beginning in December, the Bomb Cyclone descended on the East Coast in early January.
- » A bomb cyclone, or explosive cyclogenesis, is a non-tropical hurricane-type disturbance that can happen at any time, but this winter's was coupled with severely low temperatures and substantial snowfall. It was technically labeled Winter Storm Grayson, but consistent with press reports, "bomb cyclone" has been used as shorthand for the combination of conditions that existed in the storm.⁶
- » Regional spot gas prices were high, and national spot prices were temporarily elevated somewhat, but service was maintained.



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Firm Service Was Unaffected During the Cold Snap

- » Overall, there was no curtailment of service to firm end users served by LDCs.
- » Firm pipeline customers received service between their stated contractual receipt and delivery points (Primary Firm service) with **100 percent reliability**.
- » Since primary firm customers were fully utilizing their capacity, pipelines had little or no capacity left for lower-priority customers for whom that capacity had not been built.
- » Firm end-users were unaffected by the limited instances (in both size and duration) of producer freeze-offs and pipeline outages. Gas storage and cooperative relationships among pipelines maintained supply and deliveries to the market.



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Physical Reliability Was Very High

- » In the Northeast, physical reliability was high throughout the winter event—retail gas consumers and wholesale gas customers with firm contracts received their supply to the full extent of their contractual rights.
- » The primary observable impacts were in spot-market prices. The national and regional situations contrasted sharply.
- » Nationally, Henry Hub prices increased briefly, averaging \$3.76 for January as compared with a full-winter average of \$2.99.
- » Marcellus shale gas, in close proximity to East Coast markets, averaged 68 cents below the Henry Hub average for the winter, at \$2.31 and was available at that price to East Coast customers holding firm pipeline capacity from the Marcellus.
- » However, East Coast *spot market* customers, having not locked in firm pipeline access to these low-cost supplies during peak periods, were subject to high sellers' market prices at pipeline outlets.



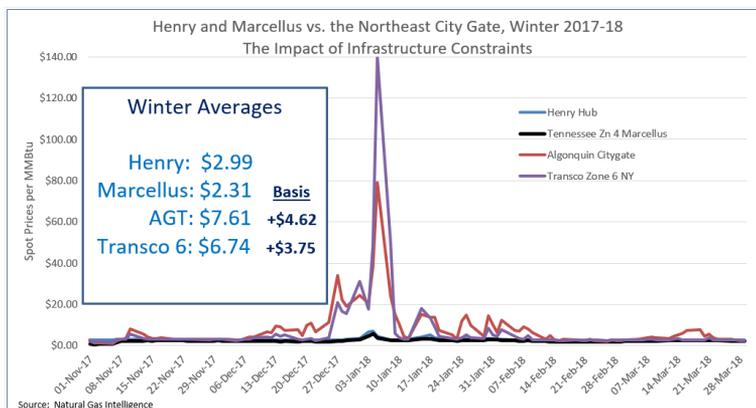
Firm Customers Avoided any Run-Up in Local Spot Prices

- » Spot market customers paid a price:
 - Over the course of the entire winter, customers relying on the spot market paid average regional spot prices of \$6.74 to \$7.61 for the winter, including the impact of a sharp temporary run-up during the Bomb Cyclone.
 - However, particularly during that sharp run-up, the actual volumes traded at the very high prices averaged at most 1 to 2 percent of the market.
 - In other words, the extremely high prices did not affect a great deal of natural gas (see Slide 36).
- » Customers with firm transportation were shielded from the elevated spot prices:
 - Customers who bought gas in the production areas and transported it through firm capacity or through arrangements with marketers were able to benefit from lower supply-area prices plus the actual cost of transportation.
 - These customers paid approximately \$3.30 to \$4.00 per MMBtu average for the winter (assuming \$1.00 for pipeline transportation cost and rounding).
- » In New England, rather than buy natural gas at the high spot prices, many generators turned to their dual-fuel capability to use oil, usually for economic reasons rather than because of an unavailability of natural gas supply.



Northeast Infrastructure Constraints Led to Large Cold-Driven Spot Price Spikes

- » The premium of as much as \$4.31 (Algonquin minus the Marcellus price plus transport) is the price paid by customers without firm transportation.
- » Only small volumes, 1 to 2 percent of the market, reported paying the extremely high prices reported at some Northeast city gates during the Bomb Cyclone.⁷



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LDCs Avoided the Bulk of the Winter Spot Price Spikes by Using Firm Service

- » Gas LDCs used committed firm transportation to reach low-price supply areas (\$3.30 to \$4.00 delivered, as opposed to the regional spot prices of \$6.74 to \$7.61 for the winter).
 - These base purchases constituted the bulk of each LDC's portfolio, but each LDC planned its business to optimize cost-effectiveness.
 - LDCs apportion their supply sources over "load duration curves," to select the most cost-effective mix of firm transportation, storage, peak shaving such as propane-air or LNG, and high-price spot purchases, based upon the expected frequency or infrequency of severe weather spikes.
- » Meanwhile, very little gas appears to have actually been traded at the very high prices. Based on data from S&P Global Market Intelligence (SNL),⁸ less than 1 percent in New England and less than 2 percent in New York City was traded at those high prices.

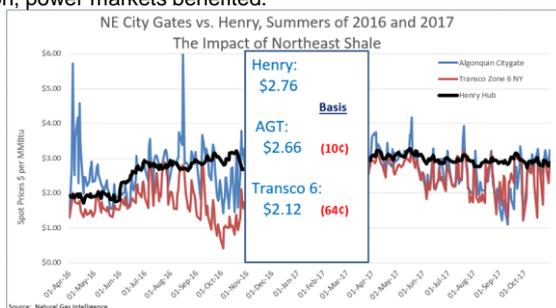
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The Summer Experience Demonstrates What Adequate Pipeline Capacity Could Mean

- » Despite the high prices experienced during a harsh winter, the Northeast summer experience (when electric load peaks for cooling demand) indicates how the region could perform with adequate pipeline capacity.
- » In the summer (as demonstrated here by the actual history for the summers of 2016 and 2017), flexible pipeline capacity and nearby low-cost Marcellus shale gas yielded spot prices well below Henry Hub. New York and New England had some of the lowest natural gas prices in the United States, and since that was during the electric peak season, power markets benefited.



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IV. GAS-FIRED POWER IN THE BOMB CYCLONE

EXPOSING THE COST OF INADEQUATE PIPELINE COMMITMENT

Gas-fired generation with firm pipeline transportation performed normally during the Bomb Cyclone, while generation without firm pipeline transportation was exposed to high spot prices. All necessary power generation received service.



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How Gas-Fired Generation Fits In

- » Power generators are particularly affected by the firm-interruptible distinction, because a large number of generators rely on interruptible transportation despite their generation commitments to power markets.
- » Debates around resilience at the Federal level are focused on electric service.
 - In those debates, gas-fired generation tends to be singled out as endangering electric reliability and resilience—but far too often without any real inquiry into generators' contracting decisions.
 - The resilience shown by the natural gas industry, as recounted in this study, translates to resilience of gas-fired generation, but only to the extent that generation commits to pipeline capacity through firm contracts. Generators choose the level of reliability and resilience they desire from pipeline service.
- » Thus, it is valuable to review the experience of generation during the Bomb Cyclone, primarily through reports of the RTO/ISO operators of organized markets and the observations of the EIA and FERC.



Overall Conclusion as to Generation

- » The regions heavy in gas-fired generation performed well during the Bomb Cyclone. As noted, firm gas customers received their fuel as needed, without interruption.
- » On a broader scale, when spot-price-dependent generation became very expensive, markets such as New England caused generators to move to alternate fuels, primarily oil.
- » In PJM, a market where generators make extensive use of firm transportation, the escalation in Henry Hub prices caused coal to be temporarily more economic, so the generation mix was adjusted to run existing coal plants. Gas plants could have run at a higher level, but were held in reserve as "out of the money," a statistic that was misinterpreted by DOE's National Energy Technology Laboratory (NETL), and corrected by PJM as demonstrated in Slides 41-44.
- » Overall, no threats to reliability were reported.
- » **Outcomes were based on a series of economic choices.**



NETL's Claim and PJM's Response

- » As noted, DOE's NETL issued a report on the role played by coal and nuclear units⁹ claiming that PJM's dispatch of coal units during the Bomb Cyclone meant that there would have been a major reliability crisis without coal.
- » PJM strongly contradicted that conclusion.¹⁰ PJM stated in no uncertain terms that its dispatch decision was purely economic, and that no resource shortage drove its choice to run coal plants. Below are the NETL statement and PJM response:

NETL Report, Executive Summary at p. 1

"In PJM, the largest of the ISOs, coal provided the most resilient form of generation, due to available reserve capacity and on-site fuel availability, far exceeding all other sources (providing three times the incremental generation from natural gas and twelve times that from nuclear units); without available capacity from partially utilized coal units, PJM would have experienced shortfalls leading to interconnect-wide blackouts."

PJM Response to NETL, March 13, 2018 (emphasis added)

"PJM agrees that the report underscores the importance of a fuel-secure generation fleet to serve future demands. But in PJM's view, the report erroneously concludes that the relative economics of coal and nuclear vs. natural gas during the cold snap, which drove the dispatch of coal units (i.e., that the cost of coal was lower), indicates that the system would have faced "shortfalls leading to interconnect-wide blackouts" during this period. As PJM demonstrated in its own report on system performance during the cold snap, **PJM had adequate amounts of resources to supply power—the price of natural gas relative to coal and nuclear during the cold snap drove dispatch decisions.**

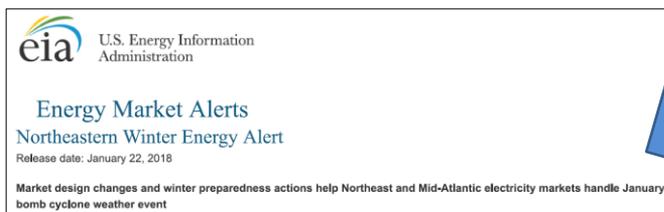
During the cold snap, the region experienced an increase in the price of natural gas, which made coal resources (which often did not run under periods of lower natural gas prices) the more economic choice during times of high gas prices. **But one cannot extrapolate from these economic facts a conclusion as to future reliability within PJM.**



EIA and RTO/ISO Reports on the Winter

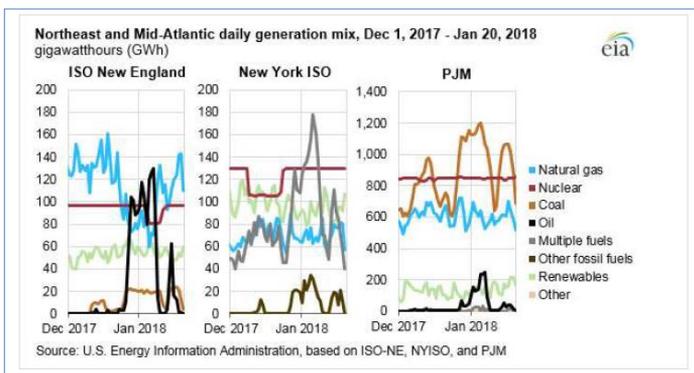
- » While PJM, ISO-NE, and NYISO all published post-mortem reports examining performance during the Bomb Cyclone,¹¹ the Energy Information Administration (EIA) published a single overall report on all three.
- » The EIA report is included with this study as Appendix D. Its comprehensive view is best summarized by the main headline of the report:

"Market design changes and winter preparedness actions help Northeast and Mid-Atlantic electricity markets handle January's bomb cyclone weather event."



EIA's Overall Summary of Northeast Generation

- » Of the three markets, only New England saw a sharp drop in gas-fired generation (the blue line) and a corresponding increase in alternate fuel during the Bomb Cyclone, representing the use of oil (black) to avoid high spot prices for generators that did not have firm transportation available.
- » PJM (whose electric load was six times as large as either New England or New York) saw a significant increase in coal use (brown), rather than a turn-up of gas facilities. As PJM has explained, this was strictly an economic decision, not a lack of availability of gas.



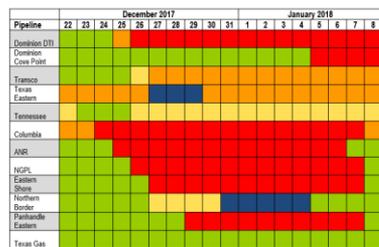
Prepared by RBN Energy LLC for the Natural Gas Council

PJM's Tabulation Shows High Pipeline Reliability



PJM Cold Snap Performance
Dec. 28, 2017 to Jan. 7, 2018

Figure 16. Active Interstate Pipeline Restrictions, Dec. 22, 2017–Jan. 8, 2018



LEGEND

Color Code for Restriction Severity

- No Restrictions
- Scheduling Operational Flow Order
- Non-Firm Restriction
- Rateable Take
- Force Majeure

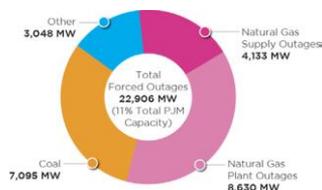
- » PJM's report on the cold snap included a tabulation of the situation on 11 pipelines spanning its extensive footprint, from December 22 to January 8.¹²
- » The tabulation itemized, by pipeline and by day, periods of no restriction (green), days covered by operational flow orders (OFOs, yellow), the restriction of "non-firm" service (orange), the restriction of flows to ratable takes (red), and the occurrence of *force majeure* outages (blue).
- » Out of 198 pipeline/day combinations, there were only eight days that experienced any *force majeure* events, and PJM clarified that all such events **affected only non-firm service**:
 - "There were no reported firm capacity restrictions during this period, and all force majeure events were related to generators with interruptible capacity."¹³



Prepared by RBN Energy LLC for the Natural Gas Council

Other Power Issues: More Clarity as to Forced Outages

- » Within the RTO/ISO community, natural gas contracting decisions are often included in the overall forced outage.
 - For example, as noted above, PJM indicated that there were no firm restrictions on pipeline service during the Bomb Cyclone. However, the same report showed substantial gas-related forced outages:



- **PJM's language cited earlier made it clear that gas outages were the result of contract choices, not any failure on the part of the gas industry.**
- » It could be very helpful to provide more detail as to the reasons for forced outages in all situations.

V. COMPANY CASE STUDIES RELIABLE SERVICE FROM EVERY SECTOR THROUGHOUT THE WEATHER EVENTS

A summary examination of individual company experience demonstrates both the techniques and the success of company preparation and response.

Overall Structure of Outreach

- » Ultimately, this study effort reached out to 25 companies in the pipeline, production, and local distribution business, spanning areas affected by all three storms.
- » Detailed responses or interviews were completed by two thirds of the survey population.
- » The conclusions throughout this study incorporate the consensus observation of those companies, additionally informed by public information from various regulators and by reviews of both mainstream media and industry trade press sources.
- » However, a few anecdotal or consolidated examples stand out as worth exploring here.



Representative Pipeline Assessment of Generic Storm Impact (1)

This is an individual company's summary, from a system that spans both the Gulf Coast and the Northeast. The response epitomizes what was received from the major pipeline systems as their overall reaction to weather events, so is included here as generic guidance:

- » Pipelines have very detailed and extensive Integrated Preparedness Procedures on how to handle various events that may impact the pipelines systems that cover operations, physical interruptions, weather events, and cyber events, to name just a few, that allow for a very quick response and recovery.
- » Weather events such as hurricanes and or cold weather periods impact very specific areas of the pipelines and do not impact overall system operations or deliveries.
 - Typically there is minimal to no impact to compressor stations along the Gulf Coast as they are built to sustain high winds and flooding.
 - Stations shut in and personnel evacuated for safety are re-manned as early as possible.
 - Pipeline to pipeline interconnectivity and other compression not impacted by the storms were sufficient to meet all firm obligations.
 - Biggest impact to pipes during the hurricanes was the overall load decrease due to the electric infrastructure failure along the Gulf Coast—without power lines, there is nowhere for generated power to go, so gas-fired generation runs less, despite having access to fuel.



Representative Pipeline Assessment of Generic Storm Impact (2)

- » Bomb Cyclones (cold weather events) and hurricanes typically have very little impact to the pipeline systems.
- » Very little generation load in New England is contracted for firm service;
 - Generation load desiring to obtain gas supply and deliver under interruptible services would most likely not flow during the Bomb Cyclone, leaving the generator to buy gas in a "seller's market" at the outlet of the pipeline.
 - Generation committed to firm transportation had reliable service.



Example of Preparation Leading to Reliability in the Bomb Cyclone

- » **Planning and Briefing:**
 - Gas Control Leaders collaborated with Field Operations Leaders to understand the potential impact of the looming weather. From that collaboration, a facility staffing plan was developed to ensure reliability and accessibility of the facility at risk.
 - Update calls were implemented to provide a field assessment and current weather conditions. These calls occurred as needed, once a day, twice a day, or more frequently – depending upon circumstance. Gas Control monitored forecasts and increased line pack anticipating strong market pull.
- » **Operation:**
 - Storage wells were in a ready state and strategically activated for optimized operational needs.
 - System health checks were conducted on real-time systems (SCADA) and members of the Technical Services team continued those health checks around the clock.
 - Field personnel stood ready around the clock to provide on-site support with compressor stations, measurement equipment and storage facilities across the system.
- » **Monitoring and Coordination:**
 - Members of the commercial operations team monitored electronic bulletin boards (EBB) of other 3rd party pipes to understand other pipes' risk for receipt, deliverability, and/or restrictions.
 - Members of the Mid- Atlantic Contingency Group (representing nearly 21 pipes – LDCs, Midstream, Producers, Pipelines, etc.) participated in meetings to share best practices and weather preparation activities.



Sample LDC Preparations— Harvey & Irma

- » A variety of responses were received from utilities in both Texas and Florida, both being areas well used to hurricane impacts. Thus, the types of preparations were very similar across the two areas. A composite of the responses follows:
- » Upon notice that a storm is likely, depending on the severity of the expected event, the utility implements various levels of the measures contained in its emergency operations plan (EOP). These include:
 - Updating and confirming contact lists for company personnel, regulatory agency, and pipelines;
 - Testing emergency generators;
 - Coordinating with first-response agencies to be ready to disable gas service if hazardous situations are present;
 - Communicating with public agencies to be aware of transportation issues;
 - Confirming availability of alternative transportation in the event of flooding;
 - Ensuring that alternative communication mechanisms work in case of communication interruption;
 - Briefing service and distribution crews for emergency response;
 - Mobilizing fallback locations for operations coordination, service support, etc.;
 - Arranging temporary housing for emergency-response and key operational employees.



Sample Northeast LDC Preparations—Bomb Cyclone (1)

- » Planning and Briefing:
 - Staff meteorologist monitored government and contract weather services for developing weather systems to identify those that could adversely impact utility operations and/or infrastructure. Advisories were issued regarding progress, timing, and expected severity and impact.
 - Conference calls were held to provide weather updates and to help ensure preemptive steps required in each organizations Emergency Response Plans were implemented.
- » Coordination:
 - Agreements were in place (including the associated Memorandums of Understanding) with local, city, county, and state emergency management organizations for parking and storage of equipment.
 - Participated in Mutual Assistance calls with Regional Mutual Assistance Groups (RMAGs) to discuss plans and impacts of coastal storm, resource needs, and availability.
 - Initiated communications with key external stakeholders focusing upon the potential of a coastal storm event.
 - Established communication with transportation agencies to get updates on transportation due to storm.
 - Contacted other utilities and contractors regarding availability for gas and electric support..



Sample Northeast LDC Preparations—Bomb Cyclone (2)

- » Procedures, Materials, Staffing:
 - Ensured Emergency Preparedness to coordinate augmented requirements with gas and electric operations.
 - Initiated the appropriate level Incident Command Structure (ICS)
 - Activated the necessary System Emergency Assignments for supplemental resources requirements
 - Reviewed and updated materials and equipment required before, during, and after a significant coastal storm;
 - Reviewed and updated staffing requirements
 - Reviewed past coastal storm performances and implementation/documentation of process improvements realized thereby.
 - Ensured protection of locally stored equipment and critical supplies, from potential flood damage.
 - Identified and updated staging/evacuation areas for the purpose of storing equipment and materials in response to a significant coastal storm.
 - Coordinated with Logistics and other supporting groups, as appropriate, to update this information.
 - Assigned employees to emergency storm positions.



VI. CONCLUSIONS AND OBSERVATIONS, RESILIENCE IN THE FACE OF WEATHER CHALLENGES



The Gas Industry Showed its Resilience through Major Challenges

- » Based on the public records, interviews, and observations of the three major weather events affecting the last year, the gas industry faced the full range of the challenges weather can pose, and prevailed convincingly.
- » Succeeding through these events without reportable issues fully demonstrates the first aspect of resilience -- resistance to shocks that can cause damage..
- » Rapid recovery from or mitigation of any issues that did occur demonstrates the second aspect of resilience.
- » The most significant effects that were observed were the economic consequences of the freeze and Bomb Cyclone, primarily involving gas prices for power generation where sufficient firm commitments were not in place.



The Northeast Experience Shows More about Choices than Resilience

- » In the areas hardest-hit by the freeze and Bomb Cyclone, price behavior reflected the contractual choices of pipeline users in the market, and otherwise generally tracked normal supply and demand.
- » In power markets, successful management of gas along with other resources maintained reliability, sometimes holding gas in reserve for economic reasons.
- » The extent to which some coal and nuclear facilities were temporarily relied upon could suggest that as those facilities phase out and gas becomes more of a dominant baseload fuel, the longstanding need for more firm transportation in some markets may be exacerbated and confirmed.
- » The need for market participants to firm up their contractual requirements as the generation mix evolves does not indicate a lack of resilience in natural gas supply and infrastructure—just a need for the market to evolve.



Footnotes

- 1_/ The Natural Gas Council (NGC) comprises the primary national trade associations for the natural gas industry: the American Gas Association; the American Petroleum Institute; the Independent Petroleum Association of America; the Interstate Natural Gas Association of America; and the Natural Gas Supply Association.
- 2_/ <https://www.merriam-webster.com/dictionary/resilient>
- 3_/ Presidential Directive PPD-21, "the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents."
- 4_/ <https://www.ferc.gov/market-oversight/reports-analyses/st-mkt-ovr/som-rpt-2006.pdf>
- 5_/ <https://www.ferc.gov/market-oversight/reports-analyses/st-mkt-ovr/2017-som-A-3.pdf>
- 6_/ "What the Heck is a Bomb Cyclone?" Rachel Feltman, Popular Science, January 3, 2018 <https://www.popsci.com/bomb-cyclone>
- 7_/ S&P Global Market Intelligence, Daily Gas Report, January 8, 2018 page 11, Electronic Bulletin Board Operationally Available Capacity reports for Algonquin Gas Transmission and Transcontinental Gas Pipeline, analysis by RBN.
- 8_/ *Ibid.*
- 9_/ https://www.netl.doe.gov/energy-analyses/temp/ReliabilityandtheOncomingWaveofRetiringBaseloadUnitsVolumeITheCriticalRoleofThermalUnits_031318.pdf
- 10_/ <http://www.pjm.com/~media/library/reports-notice/weather-related/20180413-pjm-response-to-netl-report.ashx>
- 11_/ www.pjm.com/~media/library/reports-notice/weather-related/20180226-january-2018-cold-weather-event-7_7_report.ashx
https://www.iso-ne.com/static-assets/documents/2018/02/02272018_pr_remarks_state-of-the-grid.pdf
http://www.nyiso.com/public/webdocs/markets_operations/committees/bic_miwg/meeting_materials/2018-04-02/Item%20C%20-%20NYISO%20Winter%20Operations.pdf
- 12_/ www.pjm.com/~media/library/reports-notice/weather-related/20180226-january-2018-cold-weather-event-report.ashx, p. 18
- 13_/ *Ibid.*, p. 17.



APPENDIX A JULY 2017 NGC RELIABILITY REPORT





Natural Gas Systems: Reliable & Resilient



July 2017

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Preamble

Our trade associations, who together comprise the Natural Gas Council and represent the natural gas delivery system from production to consumption, originally researched and developed this white paper to inform a North American Electric Reliability Corporation (NERC) special assessment on any potential risks to bulk power system reliability from a single point of disruption on major natural gas infrastructure facilities (e.g., storage facilities, key pipeline segments, LNG terminals). The facts and data we gathered in the process of preparing information for NERC underscored the exceptional reliability of the natural gas system. It also revealed the need for a comprehensive resource that explains the underpinnings of natural gas reliability, both physical and contractual. The white paper that follows is the result of our joint effort.

The Natural Gas Council

Members:

- American Gas Association
- American Petroleum Institute
- Interstate Natural Gas Association of America
- Independent Petroleum Association of America
- Natural Gas Supply Association

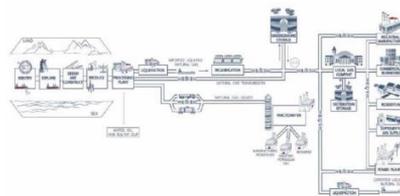
July 2017

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1. Introduction

The United States has abundant natural gas resources that enable our industry to satisfy customer demand fully. In only a few years’ time, the U.S. has become the largest producer of natural gas in the world. Estimates of the gas resource base have more than doubled in the past decade.¹ Since 2010, production has grown almost 30 percent, with government forecasts calling for production to once again reach the record of near 75 billion cubic feet per day this year.² The natural gas supply chain is extensive and spans from the production well-head to the consumer burner-tip (see illustration).

Critical Elements of the Natural Gas Supply Chain



Source: The American Petroleum Industry, Oil and Natural Gas Industry Progress Report, 2016.

¹ See Potential Gas Committee *Biennial Report of Potential Supply of Natural Gas in the United States*, (December 31, 2014), 2015, available [here](#).

² See EIA *Short-Term Energy Outlook, May 2017* available [here](#); and EIA *Natural Gas Summary | Custom Table Builder*, available [here](#).

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has control systems to help monitor, and in some cases operate the pipelines and its components to move the product in a reliable, efficient and effective manner. Operators manage the internal pressure of the delivery system by controlling the amount of natural gas entering and leaving the system. The process of increasing or decreasing pressure happens relatively slowly in a natural gas system because of the compressible nature of the gas. This compressibility lessens the immediacy of impact and increases the probability of detection. Layered onto this control system architecture are overpressure protection devices, which kick-in should the unlikely need arise to prevent the internal gas pressure from threatening the pipeline's integrity. This was demonstrated on January 7, 2014 during a "polar vortex" weather event that stretched across large parts of the United States and caused total delivered gas nationwide to reach an all-time record of 137.0 Bcf in a single day.¹⁴ Despite the unprecedented performance levels required, the industry honored all firm fuel supply and transportation contracts.¹⁵

The joint Federal Energy Regulatory Commission ("FERC")-NERC *Southwest Cold Weather Report* made similar findings about the reliability of the natural gas system during another weather-related event. In the first week of February 2011, the southwest region of the United States experienced historically cold weather that resulted in significant impacts on the electric system in Texas, New Mexico and Arizona, and natural gas service disruptions in those states as well. During the 2011 Southwest outages, 50,000 retail gas customers experienced curtailments when gas pressure declined on interstate and intrastate pipelines and local

¹⁴ EIA, Market Digest: Natural Gas (2013-2014), https://www.eia.gov/datalandgas/sec/sec%20interlockback2013/mhbs_Consumption-4
¹⁵ See <https://www.ferc.gov/media/news-releases/2014/14-10-16-14-A-4-presentation.pdf> and "During each of these cold events, customers who had firm transportation capacity on natural gas pipelines generally managed to secure natural gas deliveries." Also see <https://www.ferc.gov/legal/staff-reports/2014/04-01-14.pdf> at Slide 4.

segment. "Line pack"²¹ in the pipelines can be used, if necessary, to provide operational flexibility, as noted in the *Southwest Cold Weather Report*.²² As noted above, because of the inherent characteristics of natural gas and the interconnected pipeline system, operators can control and redirect the flow around an outage in one segment. The existence of geographically dispersed production and storage, and its location on different parts of the pipeline and distribution system, also provides flexibility for operators to maintain service in the event of a disruption on parts of the transportation and distribution system.

Similarly, producers use various methods to help ensure operational continuity. Because producers have an economic incentive to continue to flow gas out of the producing field at a constant rate, many techniques are in place to help ensure that operations continue or that any disruption is minimized when a problem arises. While not always possible, producers often rely on more than one processing plant or pipeline rerouting options in a production area, especially when handling a significant level of production. In the unlikely event of an unavoidable disruption of supply at a well or in a field, producers have many other options to balance their supply commitments, including increasing production in other areas or using natural gas they have in storage.

3. The Natural Gas Industry – Focused on Cyber & Physical Security Risks

²¹ Line pack is the volume of natural gas contained within the pipeline network at any given time. It allows gas received in one area of a pipeline system to be delivered simultaneously elsewhere on the system. It can facilitate non-ratable flows and support pipeline reliability as a temporary buffer for imbalances. However, line pack must be kept reasonably stable throughout the system to preserve delivery pressure and system capacity. Thus, line pack neither creates incremental capacity, nor is it a substitute for appropriate transportation contracts.

²² Southwest Cold Weather Report at 68-70.

distribution systems due to the loss of some production to well freezing at a time of increased gas system demand.¹⁶ In contrast, 4.4 million electric customers were affected over the course of the same event.¹⁷ Nonetheless, the *Southwest Cold Weather Report* found that only 10 percent of the electric generation failures were due to fuel supply problems,¹⁸ and that "[f]uel supply problems did not significantly contribute to the amount of unavailable generating capacity in ERCOT."¹⁹ Further, as noted in the *Southwest Cold Weather Report*, "[n]o evidence was found that interstate or intrastate pipeline design constraints, system limitations, or equipment failures contributed significantly to the gas outages. The pipeline network, both interstate and intrastate, showed good flexibility in adjusting flows to meet demand and compensate for supply shortfalls."²⁰

Other characteristics of the natural gas system contribute to its historical operational reliability and system resilience. The natural gas transportation network is composed of an extensive network of interconnected pipelines that offer multiple pathways for rerouting deliveries in the unlikely event of a physical disruption. In addition, pipeline capacity is often increased by installing two or more parallel pipelines in the same right-of-way (called pipeline loops), making it possible to shut off one loop while keeping the other in service. In the event of one or more compressor failures, natural gas pipelines can usually continue to operate at pressures necessary to maintain deliveries to pipeline customers, at least outside the affected

¹⁶ Southwest Cold Weather Report at 2.

¹⁷ *Id.* at 1.

¹⁸ *Id.* at 140-142.

¹⁹ *Id.* at 153.

²⁰ *Id.* p. 212.

Cyber and physical security are integral to the natural gas industry. Natural gas pipelines, which move over one-third of the energy consumed daily in the United States, are considered critical infrastructure. All along the natural gas supply chain, from production to delivery, the industry employs a portfolio of tools to help ensure protection of its facilities from both physical and cybersecurity threats.

On the physical security side, fences, routine patrols and continuous monitoring, as appropriate, help protect above-ground facilities such as compressors, well sites, processing plants and meter stations. The natural gas industry routinely holds briefings and workshops to discuss security concerns, and it has developed industry guidelines and identified leading practices to protect facilities and data. Natural gas trade associations and their members regularly run simulated exercises in response/recovery efforts to help prepare in the event of natural or man-made disasters and work closely with government agencies to share threat information and practices.

On the cybersecurity front, the federal government partners with the natural gas industry on cybersecurity frameworks and initiatives to promote situational awareness, mitigating measures and response/recovery. Critical infrastructure sectors, including natural gas, electric, nuclear, financial, telecommunications, information technology and water, use Information Sharing and Analysis Centers (ISACs) as an adaptive tool to share comprehensive analysis of changing threats within the sector, other sectors and federal and state governments. The Energy Sector is represented by the Downstream Natural Gas ISAC, the Oil & Natural Gas ISAC, and the Electricity ISAC. These ISACs work closely with one another and with other critical infrastructure sector ISACs. The federal government promotes ISACs and Information Sharing and Analysis Organizations (ISAOs) as a best security practice.

As discussed at length in the beginning of this document, there is low risk of single point of disruption (regardless of cause) resulting in uncontrollable, cascading effects. Generally, supply and transportation disruptions can be managed through substitution, transportation rerouting and storage services. Recognizing the pipeline system resilience and redundancy, the federal government continues to partner with industry on cyber as well as physical security matters. This partnership is best experienced through the TSA Pipeline Security Guidelines and various completed and ongoing security initiatives that strengthen the industry's security posture.

One of the most important aspects of cybersecurity in the pipeline space is ensuring the integrity and operability of the Supervisory Control and Data Acquisition (SCADA) system of each pipeline against cyber compromise. From a cybersecurity perspective, natural gas functions are divided across an enterprise network and an operations network (which includes control system, SCADA, and pipeline monitoring). These two networks are generally isolated from each other, and a portfolio of tools and mechanisms is used to improve the prevention, detection and mitigation of cyber penetration. Pipeline safety regulations and standards state that back-up systems cannot be affected by the same incident that compromises the primary control system; thus fail-safes and redundancies must be independent of the cause of the primary mechanism's failure.

In addition, partnership between the private sector and the federal and state governments is a key part of addressing physical and cybersecurity threats to the nation's critical infrastructure. Industry members routinely participate in internal and industrywide security situation simulation exercises – training exercises that present real-world challenges – with

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Above, we discussed the high level of reliability provided by the natural gas industry in terms of its physical operations and ability to deliver to its customers. Yet, in order to benefit from this reliability, large-volume customers, such as industrial users, electric generators, commercial customers and LDCs, must do their part to ensure continuity of service by contracting for firm transportation services to meet their own or their customers' obligations. Absent customers' purchasing pipeline capacity on a firm basis, pipelines may not have spare transportation capacity available on their systems, or a higher priority firm transportation customer may bump the non-firm customers' service for reasons unrelated to physical gas or transportation disruptions. On the coldest days (known as "peak days"), when weather-sensitive firm transportation customers are using their full contractual entitlements, there may be little or no interruptible transportation capacity left over for interruptible customers.

In many circumstances, large-volume customers make arrangements to move natural gas from the wellhead to their burner-tip – that is, through the entire supply chain. In 1992, FERC, which regulates interstate natural gas pipelines, required interstate pipelines to unbundle (i.e., separate) their sales and transportation services, and to provide unbundled transportation service on an open access, not unduly discriminatory basis.²³ As a result of this restructuring, interstate pipelines exited the merchant sales function, meaning that they no longer sell the natural gas that they transport through their pipelines, and the rates they charge are only for the movement of gas through their systems. While FERC's restructuring of the natural gas industry created an

²³ The FERC's unbundling of the interstate natural gas pipeline industry was undertaken to improve the competitive structure of the industry to maximize the benefits of the Wellhead Decoupling Act adopted by Congress in 1989. Pipeline Service Obligations and Revisions to Regulations Governing Self-Implementing Transportation Under Part 284 of the Commission's Regulations; and Regulation of Natural Gas Pipelines After Partial Wellhead Decoupling, Order No. 636, 57 FR 13267 (April 16, 1992), III FERC Stats & Regs. ¶ 30,939 (1992) at p.4.

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cybersecurity by employing firewalls and other tools to improve the prevention, detection and mitigation of cyber penetration. Further, natural gas delivery systems are mechanical by nature and can still be run manually if necessary. Natural gas is moved by using pressure to control the amount entering and leaving the system. Layered onto this control system architecture are devices that detect changes in pressure, which serve as a safeguard to prevent internal gas pressure from threatening pipeline integrity.

Cybersecurity is also a priority in other areas of supply chain, such as production. Many companies orient their overall cybersecurity programs around the NIST Cybersecurity Framework for Improving Critical Infrastructure Cybersecurity. Using this framework and other consensus standards can equip upstream operators with the process and tools they need to prevent cyberattacks.

Cyber risk management at any company is tailored to that company's assets and potential risks and must also be flexible to respond to ever-changing external threats and internal deployment of digital assets. Although one size does not fit all, there are some common features of cyber risk management programs for industrial control systems (ICS) employed by many offshore and onshore oil and natural gas industry companies, including: training and security awareness, segregating process control networks, restricting access to computer hardware used to manage software and industrial control programs, restricting and monitoring vendor access to equipment and systems, and on-site inspections and cyber-related drills.

4. Firm Contractual Arrangements Assure Reliability of Service

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additional level of responsibility on the pipeline customer to separately contract for supply and pipeline transportation, it has been beneficial in creating competition by giving gas customers a choice of commodity suppliers and pipeline capacity.

4.1. Understanding Contract Options – Firm vs. Interruptible

The interstate pipeline industry today is contract-based. As such, pipeline customers select the type of service (firm or interruptible) for their transportation and storage service based on their desired level of certainty and reliability. Pipeline customers ensure their gas supply reliability by taking responsibility for choosing the portfolio of natural gas transportation and storage services that meets their needs adequately, not unlike what is necessary with other fuels, such as coal and fuel oil. Pipelines schedule their capacity based on a system of nominations, and, when necessary, restrict service based upon the type of service contracted. Broadly speaking, there are two main types of service that pipeline and storage operators offer to customers: (1) firm service, whereby a shipper chooses to pay a monthly reservation charge to the pipeline that entitles it to transport or store a certain quantity of gas each day, assuming the shipper nominates the quantity and delivers to the pipeline the equivalent amount of natural gas at the receipt points specified in the contract; and (2) interruptible service, which is a lower-quality pipeline service provided by the pipeline when it has spare capacity that is either not under firm contracts or not being used that day by firm transportation customers. Within firm service, many pipelines and storage facilities provide "no-notice" service. No-notice service is the highest level of firm service that a customer can contract. It allows for the reservation of pipeline capacity throughout the 24-hour gas day. This reservation of capacity allows the

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customer to nominate its firm service on a primary basis throughout the day, offering the highest level of flexibility available on a pipeline.

Under the FERC regulations,²⁴ a firm-service shipper is entitled to “segment” its capacity daily and utilize other delivery points within the path to its delivery point if capacity is available. These delivery points along the route are called “secondary firm points.” Once scheduled by the pipeline, the transportation capacity to secondary receipt and delivery points is as firm as primary firm delivery. Primary firm-service shippers receive the most reliable service, because they have the highest priority when scheduling and are the last to be curtailed in *force majeure* (or unexpected emergency) situations. Secondary firm-service shippers are next in priority for scheduling, but once scheduled, they are curtailed *pro rata* with other primary-firm service. Interruptible shippers, if scheduled, can be bumped by higher priority firm shippers until the Intra-day 2 (ID2) scheduling deadline, and interruptible shippers are curtailed before any firm pipeline customers – regardless of whether the interruptible transportation was scheduled. Subject to capacity availability on the pipeline, the option to contract for firm or interruptible service is the decision of the pipeline customer based on the level of service that it requires. If capacity is not available, a pipeline may decide to expand its system to accommodate customers’ requirements if firm commitments are made.

“Interruptible” transportation contracts (“interruptible”) can be interrupted by a higher priority firm transportation shipper for any reason until 5:30 pm, which is the ID2 scheduling deadline.²⁵ A pipeline customer chooses the contract that best suits its needs and capability to be

²⁴ 18 C.F.R. § 284.7(d).

²⁵ If existing capacity is fully committed under firm contracts, interstate pipelines are not required to expand their facilities to provide transportation service. See 18 CFR 284.7(f) (“A person providing service under Subpart B,

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By holding a portfolio of physical capacity assets (pipeline transportation and storage) and supply contracts, a marketer can provide flexible and responsive service to customers. Therefore, a marketer’s services can be a reliable alternative source of supply for customers during peak periods, if the marketer holds primary firm transportation capacity to the relevant delivery points.

4.3. LDCs as Pipeline Customers

As part of FERC’s natural gas industry restructuring in 1992, LDCs converted their bundled firm pipeline sales entitlements to unbundled firm pipeline transportation rights to meet their state regulatory obligations to serve their firm “core” customers. (This is similar to the post-Order No. 888 conversions made by franchised public utilities to network integration service.) LDCs now purchase their natural gas commodity supply and arrange for the transportation of those commodity supplies on interstate pipelines to their systems. LDCs engage in long-range resource planning to ensure their access to supply and the continuous operations of their systems to ensure reliable service to these firm core customers. The delivery of natural gas to core retail customers is of primary importance to LDCs, and their planning involves assessment of potential supply chain disruptions, including commodity supply and interstate transportation disruptions, as well as disruptions that may impact their own local distribution systems.

4.4. Natural Gas-Fired Power Generation

Similar to LDCs, electric generators and other industrial and large commercial gas users must also arrange fuel supply to meet their respective requirements. These customers typically do not purchase their gas supplies from LDCs under their state-regulated tariffs – unless they are located on an LDC’s distribution system, in which case they may contract to use that system for transportation of their own gas supplies purchased in the wholesale market. More typically,

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at risk of disrupted service. During a *force majeure* (or unexpected emergency) event applicable to firm pipeline customers, curtailment by interstate pipelines is based on the transportation contract in place, in which case, interruptible transportation contracts that were already confirmed are curtailed first. Interruptible transportation that was not available and never confirmed is not a curtailment of service. **Interstate pipelines do not curtail based on the end-use of the gas: FERC’s nondiscriminatory open access regulations preclude this. In fact, an interstate pipeline cannot provide transportation service preferences based on customer classification.**²⁶

4.2. Portfolio of Choice

Interstate pipeline customers can decide to secure their fuel supply through a variety of options. For example, they can purchase firm transportation directly from the pipeline, obtain firm capacity rights through capacity release (reassignment) from another firm shipper, or enter into firm bundled transportation/supply contracts with marketers. Natural gas marketers are entities that can aggregate natural gas into quantities that fit the needs of different types of buyers and then can arrange transportation of that gas to their buyers. A marketer coordinates, through various contractual arrangements, all the necessary steps to transport the gas from the wellhead to the customer. Natural gas marketers also offer natural gas supply delivered on a firm basis, which includes both the commodity and the transmission capacity needed for delivery of the gas.

C or G of this part is not required to provide any requested transportation service for which capacity is not available or that would require the construction or acquisition of any new facilities.” This contrasts with the Federal Power Act provisions that impose obligations on electric transmission owners to expand capacity to provide interconnection and transmission services. Federal Power Act section 210 and 211, 16 U.S.C. §§ 824i and 824j. Of course, interstate pipelines have an incentive to expand capacity for shippers that commit to firm contracts for the expansion capacity.

²⁶ 18 C.F.R. §§ 284.7(a)(3) and 284.7(b)(1).

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many large commercial gas users are connected directly to an interstate or intrastate pipeline that transports the gas supplies they have purchased separately. Again, these large gas users are responsible for arranging their own fuel supply and must consider the entire fuel supply chain, from production to their plant.²⁷ In practical terms, this means taking into consideration congested transportation paths and pipeline scheduling and curtailment priorities when contracting for delivery of their gas supply. Location alone does not guarantee a large-volume customer security of its gas supply. Location is just one part of a bigger picture that includes the contract-based interstate transportation and storage system, and the utility obligations applicable to LDC systems.

5. Regulatory Requirements Are Relevant to Supply Chain Delivery Options

Historically, the natural gas industry has not been vertically integrated; instead each distinct industry segment’s price structure is subject to a different regulatory regime. Broadly speaking, the industry consists of three segments: (1) upstream natural gas production, gathering and processing; (2) pipeline transportation and storage; and (3) local distribution.²⁸ Congress removed all price regulation for natural gas sold by producers in the Wellhead Decontrol Act of 1989, which was followed a few years later by FERC’s removal of all price regulation for the sale of natural gas in the wholesale market. Gathering and processing are also not subject to

²⁷ See Frank Brock and Michael Sloan, ICF, “An Electric Gas Market Calls for Flexibility,” 2017, (available at https://www.ief.com/press/press-releases/2017/07/11/an-electric-gas-market-calls-for-flexibility?_chdc=GPfZ3RyYwSpQG5mZUab3Jmksrcipntual=lead-9f8e42aef47c5118109c4346bb5984f-27daa508c3494b1596b3c8b7a148e6bb&utm_source=ClickDimensions&utm_medium=email&utm_campaign=may11-2017-com-ene-energy-digital-newsletter&asid=728949b-8905-c711-8916-50655581f813).

²⁸ A more detailed diagram of the natural gas industry segments appears at the end of these comments.

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price regulation by the federal government. However, the price, terms and conditions of the interstate transportation and storage of natural gas remain regulated by FERC. Pure intrastate transportation and storage of natural gas is subject to state regulation. The distribution of natural gas by LDCs is also subject to state regulation. All pipelines are subject to safety regulation by the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration ("PHMSA") or state agencies. Numerous other federal and state agencies regulate various environmental and safety aspects of the natural gas system.

5.1. FERC Regulation of Interstate Transportation and Storage

As noted earlier, FERC's regulation of interstate transportation and storage is contract-based. A pipeline or a storage company's contract is with its pipeline customer. How that pipeline customer chooses to contract for service determines the scheduling of service on the pipeline as well as the firm service curtailment priorities in the event of a pipeline restriction or *force majeure* event. FERC regulations preclude interstate pipelines from undue discrimination in providing service based on the classification of customers. This means that the identity of the customer, whether it is an LDC, electric generator, or a producer, cannot have any bearing on priority of service. In addition, the pipeline is required to honor all firm service contracts.²⁹ Therefore, level of service that a customer has contracted for is of paramount importance.

5.2. State Regulation of Local Distribution – High Priority Customers.

²⁹ FERC gas regulations define "service on a firm basis" as a service that is "not subject to a prior claim by another customer or another class of service and receives the same priority as any other class of firm services." 18 C.F.R. § 284.7(a)(3).

fuels, maintain on-site fuel storage (such as LNG or CNG), or contract for a higher level of service from the LDC (such as firm transportation or emergency service).

LDCs are regulated by most states as local gas utilities that have an obligation to serve their firm core customers – the customers for which the system is built to serve reliably. LDC systems are built to serve these firm core customers and others on a "design day" (a forecasted peak-load day based on historical weather conditions). While gas utilities may offer an interruptible "bundled" sales service (which includes commodity supply and the transportation of the supply on the local distribution system) and/or a stand-alone interruptible transportation service for the transportation of customer-owned gas on the local distribution system, the LDC may not be able to maintain interruptible transportation service at all times. During periods of high usage and system constraints, often prevalent on the coldest winter days, LDCs may call on interruptible customers to cease gas usage temporarily, upon which these customers generally switch to a back-up fuel, such as fuel oil.³⁰

In the event of extreme situations that require action to be taken for reasons that include the need to maintain the operational integrity of the system and/or maintain natural gas service to designated high priority customers, including "essential human need" customers, state statutes and public utility regulations may allow an LDC to curtail services to some customers. Historically, these regulatory requirements give the highest priority to residential and commercial customers without short-term alternatives. As a result, a natural gas-fired power generator relying on an LDC distribution system, particularly on an interruptible basis, needs to consider these regulatory obligations of the LDC and, for example, plan for the use of alternate

³⁰ The tradeoff for these customers is a discounted rate for the interruptible natural gas delivery service, compared with firm service rates, and the customers enter into these interruptible contractual arrangements with that prior knowledge.

6. Storage's Dual Role in the Gas Supply Chain

Underground natural gas storage is an integral component of the natural gas supply chain, with a function different than the other components of that supply chain. Storage serves to augment natural gas production, and the location of a storage facility can also provide operational flexibility for the natural gas delivery infrastructure. There are 385 underground storage facilities in the lower-48 states with a total of 4,688 Bcf of working gas design capacity.³¹ Natural gas storage enables LDCs and interstate pipeline companies to adjust for daily and seasonal fluctuations in demand, in contrast to natural gas production, which remains relatively constant year-round. Storage helps ensure that customers have reliable service and can provide increased price stability. Natural gas storage operators have consistently provided safe and reliable natural gas storage. Because of the critical importance storage plays in the nation's energy portfolio, natural gas storage operators are continually working to help improve safety and reliability through innovations in equipment, processes and methodologies.

6.1. New storage rules will have minimal impact on deliverability

PHMSA's December 2016 interim final rule promulgating safety regulations for underground storage facilities ("Storage IFR")³² will have minimal impact on deliverability. In fact, the Storage IFR is intended to reduce the likelihood of future storage incidents and ultimately improve underground storage safety and reliability. The Storage IFR, like natural gas pipeline safety regulations that preceded it, takes a functional integrity management approach to storage safety and standardizes the methodology by which operators will analyze risk at storage

³¹ <https://www.eia.gov/naturalgas/storagecapacity/>
³² See 81 Fed. Reg. 91,360 (2016).

facilities. The Storage IFR requires operators to develop rigorous risk-assessment programs that will be used to determine which preventative and mitigating measures are appropriate for the specific conditions at any given storage facility.

6.2. Underground Storage Facilities Are Not Identical

The gas pipeline and associated storage network is different in different regions of the United States. How an underground natural gas storage facility is configured and serves its market also differs across the country. Much attention has been focused on the Aliso Canyon underground natural gas storage facility. This particular facility is a prime example of how one facility's operational configuration and the way in which it serves its market differs from others.

PHMSA's underground storage rule was prompted by an October 23, 2015 leak at a SoCal Gas natural gas storage well at the Aliso Canyon storage field in California. Aliso Canyon is an integrated gas utility-owned storage facility tied directly to intrastate pipelines that serve market load. As a result, the gas delivery system in the area is dependent upon storage withdrawals to meet market demand. However, the gas pipeline and storage network is different in other regions of the United States, where storage operators instead interconnect with multiple pipelines and storage facilities from which they can access supply and transport gas.

Based on the event data reported since 1990, including the Aliso Canyon incident, the likelihood of an unplanned release from an underground gas storage well, calculated using the

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computer threats, and has a resilient, interconnected system that allows it to come back on line quickly in the rare case of a disruption.

While the natural gas industry is committed to continuing its high level of reliability, there is an equally important component of assuring continuity of service that remains the responsibility of large-volume customers. These customers should contract for the appropriate level of firm transportation service they require to ensure reliable service. Together, these two components – operational reliability and contractual continuity of service – make natural gas a secure, reliable and resilient choice for customers.

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Center for Chemical Process Safety 5 ("CCPS") American calculation for hazardous process facilities, results in a "very unlikely" to "extremely unlikely" or "remote" classification.³³

One well failed at the SoCalGas facility at Aliso Canyon and, in an abundance of caution, California State Regulators ordered the other 113 wells to be temporarily sealed until they could be tested to ensure their integrity and safety or plugged and abandoned. To date, 49 storage wells at the Aliso Canyon Storage facility have passed all the tests required under the Division of Oil, Gas and Geothermal Resources' ("DOGGR").

There was no mechanical failure of the other 113 storage wells at Aliso Canyon; the regulator's decision to shut down the entire facility is an example of regulatory action taken to help mitigate risk. Nevertheless, the consequences of such actions to gas and electric reliability need to be clearly understood when gas flows are restricted.

7. Conclusion

The natural gas industry is not susceptible to wide-spread failure from a single point of disruption in the same manner as the electric system because of the dispersion of production and storage, its redundant characteristics from the extensive integrated pipeline and distribution network, and its low vulnerability to weather-related events. The natural gas industry also has in place robust cyber and physical security protocols to minimize disruptions from manmade or

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³³ American Petroleum Institute, American Gas Association, and Interstate Natural Gas Association of America "Underground Natural Gas Storage: Integrity and Safe Operations," (July 6, 2016) at 10, available at <https://primis.phmsa.dot.gov/LNG/docs/AGA%20White%20Paper%20-%20UNGS%20Integrity%20and%20Safe%20Ops%2020160706.pdf>

APPENDIX B

TYPES OF PIPELINE SERVICE AND IMPLICATIONS FOR GENERATORS



Prepared by RBN Energy LLC for the Natural Gas Council

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A Primer on Types of Service Customers Can Choose and the Results

Basic Pipeline Service Offerings Customers Can Choose:

1. **Firm Service:** The customer pays a fixed monthly charge to reserve capacity between specific points on the pipeline, essentially leasing space whether gas flows or not. This is the highest-priority service, for which the pipeline invests capital.
2. **Interruptible Service:** The customer pays a charge per unit, only as gas actually flows, incurring no cost if gas does not flow. A lower priority service than firm, subject to availability of pipeline capacity with no guarantee of service. Pipelines generally do not invest capital to support interruptible service.
3. **Secondary Firm Service:** A hybrid, this service occurs when a firm customer deviates from the designated contractual receipt and delivery points—service is allowed, but is lower priority than service between the contractual points, which is known as “Primary Firm.”

Together, Secondary Firm and interruptible service are referred to by some pipeline customers as “non-firm service,” although Secondary Firm is really a lower-priority category of firm service as compared with Primary Firm service.



Prepared by RBN Energy LLC for the Natural Gas Council

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The Meaning of Firm Service

- » “Firm” vs. “non-firm” service is not an obscure distinction drawn by the pipeline industry for some arbitrary reason. The distinction is at the heart of customer choice in the open-access pipeline environment: The type of service is a choice by the customer, determining the customer’s selected level of reliability and the pipeline’s financial commitment to supporting that reliability:
 - Firm customers are making a fixed financial commitment to the reservation of capacity, a commitment that underpins the pipeline’s investment in that capacity.
 - Non-firm customers are choosing to “pay as they go” as capacity is available, thus running the risk that firm customers will use all the pipeline’s capacity (for which they have pre-paid).
- » The firm/non-firm distinction is directly analogous to the difference between an airline passenger with a reserved seat, and a standby passenger:
 - If the plane is full, the standby passenger (“non-firm”) must wait until space is available, while the reserved-seat (“firm”) passenger has priority.
 - “Non-firm” natural gas pipeline customers are in the same situation—by not having made a commitment to the pipeline, they cannot expect equal priority to committed firm customers, or expect new investment on their behalf.



Firm Transportation Has Been a Success

Physical Reliability of Firm Service

- » As noted earlier, due to the reliability characteristics and the capable and sophisticated operation of pipeline systems, the industry exhibited a 99.79 percent reliability in fulfilling its firm contract obligations (primary service between contractual points) over the ten years through 2016.

Price Stability through Access to Major Supply Points

- » Additionally, firm customers have been able to buy supply at supply-area prices, then transport it through their reserved capacity--avoiding regional constraint-driven price escalation. Conversely, during constrained periods, non-firm customers frequently are subject to very high constraint-driven market-area prices in the spot market, because they are subject to a sellers’ market.

Marketers Offer Additional Transportation Options

- » Other contract options can include rebundled service offered by marketers, for example providing flexible capacity on the pipeline throughout 24-hour gas day, along with options for a range of other service and levels of firmness.



Gas and the Power Industry (1)

- » Evolution of the power industry to greater reliance on natural gas has brought fuel reliability and resilience into sharper focus.
 - The generator, like any customer, is free to select the level of service priority that suits its needs and willingness to pay.
 - The pipeline resilience and reliability are independent of the level of service priority contracted by the generator.
- » Instances in which natural gas was not available to power generators virtually always involved non-firm service, rather than the firm-service offerings of the pipelines.
- » Additionally, in examining reliability, it is important to know the character of the gas-supply arrangements feeding the subject transportation.
 - Has the generator arranged for pipeline transportation with ready access to the large, flexible and liquid gas supply markets throughout the industry?
 - Is the generator relying upon the daily spot market, at the outlets of constrained portions of the pipeline network (portions in which the committed firm customers are using all of the capacity for which they have paid)?
 - It also matters whether the customer chose to make arrangements (contractual or portfolio structures) to be able to call on commodity gas supply upon short notice (e.g., over a weekend when multi-day arrangements can cause much of the available supply to be spoken for).
- » ***Reliability for any individual customer is a function of the contractual relationships for both supply and transportation that the customer has chosen to put in place. The overall system physical reliability is a separate issue and has been excellent.***



APPENDIX C API TRANSCRIPT REGARDING HURRICANE PERFORMANCE



AMERICAN PETROLEUM INSTITUTE

September 8, 2017
11:30 a.m. ET

Reid Porter: Good morning. Thank you for joining today's call.

Today's call will be led by APT's President and CEO, Jack Gerard. We've also been joined by a leading energy expert, Guy Caruso, who's a senior and national security advisor at the CSIS, Center for Strategic and International Studies. As well as Bob McNally with the Rapidan Group, a fellow – and also a fellow at the Columbia University Center on Global Energy Policy, and former international and domestic energy advisor in the Bush Administration.

As this discussion will involve supply and economic impact as well as historical trends, we will begin this call with a reminder of APT's obligations under antitrust law.

Mara Zimmerman: So, as a reminder to everybody during today's call, there should not be any discussion or predictions about future prices, supplies, or costs. Please don't share; to the extent you have it, any confidential or nonpublic information about particular companies or vendors. And please do not make any derogatory comments regarding specific companies or vendors.

At any point during today's call, if you have a question related to an antitrust issue, please let us know.

Reid Porter: And with that, we give the floor to API President and CEO, Jack Gerard.

Jack Gerard: Well, thank you, Reid, and thank you, Mara, for that reminder as we begin today. And thank each of you for joining us on this important call today. I

want to start off, I'm sure I'm expressing your sentiments as well, that our thoughts and prayers are with those who are recovering, not only from Harvey in Texas and Southern Louisiana, but also to those who are now facing the impacts from Irma and potentially Jose; especially some of you in the regions that are in the impacted areas right now.

We – our thoughts and prayers are with you and we greatly appreciate you joining us today for this broader conversation. Also want to say how inspired we are to see the way the communities have come together in the affected areas to help one another out. That true American spirit, if you will, or local spirit of those who realize the seriousness of these storms and what we can do to deal with them.

So today, we thought as you were writing on these events in the coming days and weeks, that it might be useful for you to have further insight knowledge about kind of the historical context of the energy landscape today, relative to other storms, to also talk about infrastructure resiliency, constraints, challenges, market demand, domestic supply dynamics in the wake of Harvey and now Irma and potentially Jose to come.

As Reid mentioned, we've invited two independent experts to join us today to talk about those issues and to answer any questions that you might have. And so we greatly appreciate Guy and Bob for taking their time today in what's a very demanding window. So with that, let me turn it to Guy Caruso. And Guy, if you'd like to share any opening thoughts and after which we'll turn to Bob McNally for his opening thoughts and we'll open the phone lines up and let you ask the two of them whatever questions you'd like about what's going on and their perspective as experts in the energy area. Guy, go ahead.

Guy Caruso: Thank you, Jack. I associate myself with those remarks about the personnel effect of this on both the industry and the consumers out there. I'm going to focus my remarks on the integrative nature of this oil, gas, and electricity sectors that have been hit so hard by Harvey, especially, in South Texas and Southern Louisiana. Harvey has hit all of the sectors from the upstream, midstream, and downstream.

It once again has been a lesson that we need to take precautions in all sectors from the production side where offshore production was off as much as 400,000, 500,000 barrels a day. Now most of that is back. Onshore, still some offline in the Eagle Ford area and the processing facilities that are needed to process both the oil and gas are affected by lack of electricity and flooding.

Those are coming back in both the oil and gas, as well as natural gas, liquid sectors. Downstream refineries in that region represent about 25 percent of the U.S. capacity and much of that was offline but it's coming back nicely. I think four to five are still offline. But many of the others are well on their way to recovery. Midstream ports and terminals are mostly open with some restrictions.

That's important, even more important, for Harvey than, let's say, it was for Katrina because now we are a major exporter of both, refined products in particular, but also crude oil. So the ability of having ports and terminals open is more important now than ever that they're coming back pretty rapidly. Another new development since Katrina is the need for rail capacity to move not only crude oil, particularly from the midcontinent to the south refineries, but also the movement of ethanol which is needed for blending to bring the gasoline to meet the 10 percent requirements.

That is also important and fortunately is coming back well. On the downstream, pipelines are critically important. Colonial pipeline serving the southeast and northeast part of U.S. is now back almost to full capacity as they're linking up with the refineries that are coming back online. The Explorer pipeline bringing product up to Tulsa and Midwest is now practically back full capacity.

And that's critically important, particularly for Colonial, because it brings gasoline into Georgia and other areas that are then serving Florida by truck. One common denominator for all sectors is electric power. And one of the differences in Harvey's impact versus Katrina is that there has been less impact on electric power capacity and outages for customers during Harvey than it was for Katrina.

So that has facilitated the recovery efforts, so it's been more of water damage than a windstorm and damage in Harvey relative to Katrina. And I think we've had some – had some lessons learned and I think we're having a smoother recovery. When you turn to Irma, that's going to be a very different risk factor and that is going to affect the petroleum industry mainly because of impact on distribution and marketing.

It's the gasoline, diesel, and jet fuel markets that are at risk from increased demand, for evacuation as well as getting the proper product into the states, mainly by barge and trucks. There's no production in Florida, there's no refineries, so it's a very different risk profile as we look ahead with what might happen in Irma's case.

There's an important role for government to play in this facilitation of recovery. On the federal side, the SPR, there have been three SPR exchanges approved by the Department of Energy aiding with the supply of three refineries that were unable to get direct connection with their previous suppliers. At the EPA level, there've been some lifting – waiver, temporary waivers of environmental restrictions having to do with volatility of gasoline and ability to put that gasoline into the distribution system as well as ethanol requirements that have been waived in some instances.

38 states have now had some form of a waiver approved. And that has ethanol facilitated, I think, the relatively strong recovery, even though it's still being hampered by some personnel not being available due to their own personal situations. So there are – many companies are operating at much lower than full staff at this point in Texas and less so in Louisiana.

I think there's an overarching point I'd like to make based on my experience of having been involved with disruptions, whether they be weather-related or politically motivated, such as the Arab oil embargo of '73, '74 when we had price controls allocate – rigid allocation systems, those in my view and in many studies that have been done about that disruption were part of the problem as opposed to part of the solution.

Today, we have open markets, less restrictions on the movement of (food and add) products, and I think that has shown itself to be effective allocator of supplies even during Katrina, but even more so (with) Harvey, as I mentioned now exporting a significant amount of petroleum products. We're not able to export crude oils, and I think that facilitation of markets is really the important part of this story, and when we look back on this, perhaps several months from now, we will, I think attribute so of it to that.

And my colleague Bob McNally has recently written a book about the global impact of markets on the petroleum industry. So, with that, I'll turn it over to Bob for his opening remarks.

Bob McNally: Thanks a lot, Guy and Jack, and everyone. I'm delighted and honored to be with you. As Guy mentioned, I recently wrote a book on the history and the outlook of boom bust oil priced, so if you'll allow me before we get maybe into the nitty gritty – and Guy covered many excellent points – and (I'll have) a few things to add, but just to step back for a second and think about history, we've been in the modern oil era for about 158 years now, since Drake's first well in western Pennsylvania struck oil.

And from that day until now, if you study and you look at the oil industry, I think what will strike you is how resilient it is, how innovative it is, how it rises to the occasion, how it absorbs blows and challenges and comes back faster often than most expect. And it's really remarkable, some of those first drillers in western Pennsylvania through the great wars we had an ramping up and then dealing with some of the crises in '56, '67 and '73, and now it seems major storms one after the other. And they can be weather related, they can be geopolitical, but the oil industry, again, demonstrates remarkable resilience, and I'll talk a little bit about how we're seeing that today.

Now, for the first 50 years of the oil industry was all about replacing whale oil and stuff and lighting, and the government could really care less. But for the last 100 years, it's been about transportation – primary use of oils in transportation, and the government could care about a little more. And so, if you look at the history really, since about World War I, the government – especially the United States, at the state and federal level, takes oil very

in the oil market recently and that is the surge in U.S. exports of crude and especially (refining) products.

We also went from nothing years ago to where it's over 6 million barrels a day in recent months, about almost 1 million of that roughly is crude and the rest is finished gasoline and distillate and NGLs and things. So, that's good, we benefitted from that trade, but in a crises like this, we benefit from freely traded and open markets, because now if you've been in Europe the last couple weeks, you saw the prices move in your favor, you booked cargos and sent those – more cargos than normally – and you sent them across the Atlantic heading to our markets to help fill the gap.

But again, as those – as that capacity restarts and those barrels flow from elsewhere, the prices come down. So having a freely traded, open market benefits us in those crises, it makes us more resilient, if you will. Guy mentioned some of the environmental temporary (ravers) we've seen, and indeed. We've seen that on many occasions in recent years. In the last 10, 12 years, both the Obama administration, the Bush administration, now the Trump administration has had to issue temporary waivers of reformulated gasoline and so forth.

We've also seen – and don't quote me on this, because I'm just seeing it on Twitter – but I saw one journalist on Twitter say that the administration apparently has preemptively issued a Jones Act waiver for Irma, which is very important if it's true, and I would expect this, and that's because as Guy mentioned with Florida, it's about getting gasoline into that state when there's no production, no refining and pipelines could be damaged and so forth – and they get a lot of waterborne crude. So that Jones Act waiver, if necessary, and if that's what the Trump administration did, it kind of makes sense in a case like Irma. And apparently they may have done that preemptively.

And then as guy mentioned, the SPR releases, the Strategic Petroleum Reserve release, we can do (broad) drill downs and we can do and have done sort of company by company releases, and that's what we did in this case. And that speaks to the importance of having a strategic petroleum reserve and thinking carefully about that reserve, and especially we just sort of mindlessly

seriously. Whether you're a Democrat administration or republican, I mean, they understand that oil is – ad for the foreseeable future will be the lifeblood of modern civilization, and they act accordingly and they take it very seriously.

When you have these crises, you have government action – the government acts with great concern as they should, whether they're acting wisely or not is a debate for historians and so forth, and guy mentioned '73 and the '70's and we're in a very different place now and I think for the better. But let me just – so with those two ideas, the resilience of the oil industry and then government understanding that again, for better or for worst, oil is the lifeblood of modern civilization, and in crises, we have to see to the quick restoration of capacity, the movement of supplies, et cetera and so forth.

Let's just think about what we've seen since Harvey, and now looking at unfortunately, Irma and Jose. I mean what strikes you is how quickly the Gulf capacity came back. I think we were – we lost at the max, with Harvey two weeks ago, some 25 percent of U.S. refining capacity underwater. No electricity, employees scattered, and now I think this morning, I saw Bloomberg reporters – roughly about only 8 percent is out and in the process of restarting.

Prices, price signals – we're in a market determined oil world now and very different in some ways than the '70's, and price signals came along in result to Harvey and it worked. Gasoline futures prices, before Harvey, they were about \$1.68 a gallon – this is wholesale prices now, not retail – you prices, this is the wholesale price. And at their peak, they surged up to \$2.15, up 28 percent, but today they're down at a – I'm looking at my screen – I think about \$1.66, so below where they were when we started this.

They shot up because of the uncertainty and the outage that I mentioned, 25 percent of refining capacity and folks didn't know how fast it would come back, how long we would have these disruptions. And those price signals were important because they did something they said to Asia and Europe, hey, we need gasoline in the United States, if you've got it, send it over here. Which in a way is kind of a turnaround temporary from the remarkable trends

sell it off to raise budget revenues, which is what we're in the process of doing. So one wonders if this resort to the SPR maybe makes folks just stop and think for a second and maybe think about maybe having a discussion about how the SPR should be – and reasonable people can differ on that.

But again, Harvey has reminded of the importance of having a government stockpile when you have a major, kind of, severe supply interruption, whether geopolitical, or in this case, weather, where companies just simply weren't able to ensure against that and unable to get supplies. And so, in that crisis, those – even if it's a few barrels – are very, very valuable barrels.

So, again, I think notwithstanding, Irma heading toward us and the damage has been caused by Harvey already, I think we've seen on display recently, some of the characteristics of the oil industry and government – some of the best characteristics and – which have helped us sort of weather the storm, if you will, and come through with relatively manageable impacts. And so that's, I guess, just some initial thoughts; and welcome other comments and back and forth (in) Q&A, thank you.

Guy Caruso: And with that, Operator, if you could please explain the process for the Q&A?

Operator: Certainly. At this time, I would like to inform everybody, in order to ask a question, please press star, then the number one on your telephone keypad. Again, that is star, one, on your telephone keypad. We'll pause for just a moment to compile the Q&A roster.

Your first question comes from Chris Knight from Argus, your line is open.

Chris Knight: Hi, thanks for doing this. This will either be for Bob or anyone else on the panel. With the rumored Jones Act that the senior administrator was talking about, is the idea to get gasoline into Florida before the storm hits, or where on the kind of on the back end once it hits, you want to be able to ship it any way you can?

Bob McNally: That's a great question. This is Bob and I'll defer others who may have more sort of on the ground, minute by minute knowledge. But with the storm, I think suppose to hit now in full force on Sunday, I'm unaware of an issue that

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may involve a cargo that needs to get into there tomorrow, so getting supplies in before hand. That would -- I just don't know.

And it's reasonable that if they're moving that quickly, that may be the case. But certainly anticipating that the damages and certain the ladder is I'm what they're looking at. And I think they want to probably start getting cargo's lined up now for Monday and Tuesday.

But again, I just don't have any knowledge. There may be a cargo they need to get in like now today or something. An opportunistic cargo that can move quickly, that may be the case but I have no knowledge of that. I don't know if any of our friends at API have got any visibility on that.

Male: Yes, I would agree with that Bob. That's most likely to be for the post supply that would be needed to refill the depleted inventories. And the more flexibility the industry has -- it just makes it -- facilitates recovery. Thank you next question please.

OPERATOR: Your next question comes from Jen Dlouhy from Bloomberg. Your line is open.

Jennifer Dlouhy: Thanks for doing this call. I was curious if you could talk a little bit more about the terms that govern some of these (pro) exchanges. You know, of course we have the number of barrels that have been delivered. We know deliveries are ongoing to (Valera, Marathon, and Placid) but I'd love to hear about you know, what the trigger is for repayment. You know the -- and frankly I'm curious if there's any wriggle room for our (inaudible) in that process of repaying and replenishing (sprill).

Guy Caruso: Yes I think -- normally you have the exchanges that were done during the time I was at the deal. We've had 30 -- between 30 and 90 days to repay or replenish that. We've had 100,000 barrels you had 90 days to get that 100,000 barrels back to -- back into the (sprill). I haven't seen these specific contracts that were agreed to this time. But that's probably the time frame between 30 and 90 days.

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Bob McNally: Bob here, just to add, yes, nor have I seen the specific details of the exchange. I imagine those are publicly available though. But I haven't seen them. I know, you know in the case of Hurricane Isaac, I know there was an exchange of a million barrels. And gosh, I'm not even quite sure how long it took. I know it was like 60 or 90 days. Normally it's a -- it's a return within a certain time, and then with an added amount of oil is Premium. I know there was a case for example, yes; usually that's how they do it. It's the -- I believe with these exchanges you're delivering a little more back.

That's your interest if you will. I do know that in the case of -- there were exchanges I think after President Clinton ordered exchanges in September of 2000, I believe there were instances where those were maybe delayed and renegotiated afterwards and so forth. But, there may have been cases where I think the terms can change, I'm not saying they have now, but normally it's a straight forward, here's your oil, get it back to us in three months or two months and with a little bit extra for interest.

Jennifer Dlouhy: Got you.

Guy Caruso: The other ...

Bob McNally: ... And you know offline I'd be happy to point you to the DOESPR office is usually very responsive and they have a lot of information on their website too. So, I'd be happy to help with that.

Jennifer Dlouhy: Thanks Bob.

Guy Caruso: Jen the other thing in that is the -- in during Katrina we asked the international energy agency to activate their sharing system. And we have particularly requested that they make product available that was in surplus in Europe. I haven't heard whether or not the US government is working with the -- I'm sure they're consulting them but I haven't heard any calls for activating the IEA system. That's another way of making more product available.

Jennifer Dlouhy: Do you take anything -- I mean if in fact there haven't -- hasn't been any push to use that, is that a -- is there something I should take from that? Is there any instructive -- anything instructive about that?

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Guy Caruso: My impression is that they -- that people who are managing this at DOE feels saw the recoveries going relatively smoothly, and making the exchanges they've done already with the (Cru off and spro) that their feeling that they're taking a wait and see approach. And it may well be that the Irma is puts enough further stress in the system that they may want to fall on the IEA. But as of -- as of last night when I talked to one of the DOE individuals about -- they had not requested that as of yet.

Jennifer Dlouhy: Thank you.

Bob McNally: And you know Jen if I could add, and just and Guy's point about you know, not necessarily the IEA not necessarily seeing a cause for a Katrina like release get's to a little bit. I mean again, not to downplay at all the severity of what's happened or will happen, but in some ways it could have been worse in terms of the timing. This hits at the end of Gasoline season with high gasoline stocks, and so again, in a way I think lessens the severity to some degree. And so I think that's yes.

Jennifer Dlouhy: Thanks.

Bob McNally: You bet.

Operator: Your next question comes from Casey Logan from News-Press. Your line is open.

Casey Logan: Hey guys thanks for doing the call. This is Casey Logan from the news press, and the USA today network. Here in Fort Myers, Florida, South West, Florida. I'm learning a lot about the macro industry. I don't cover up the petroleum industry specifically, so I'm learning a lot on that. I wondered if you can speak at all to Floridians in particular obviously as you've mentioned we got the Hurricane Irma out there looking like it's going to make land fall, probably Sunday, and impact probably a good deal of the state.

And so, for our area in particular we've had people -- quite a few evacuations and South Florida, South West Florida. People are facing some gas shortages along the way but I guess are able to eventually make their way up. As you

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look at all this, anything you'd like to share particularly you know, what you'd like Floridians to know today, or in the coming days as the Hurricane moves through and then you know goes on up Sunday, Monday and so on?

Bob McNally: Guy you want to go first ...

Guy Caruso: One thing I would say is that it's been heartening to see the refinery that produced much of the gasoline that winds up in Florida, coming back on rather steadily in the colonial pipeline, which brings a lot of gasoline into South East and into Georgia, that the supply situation looks reasonably good. Obviously demand is spiked by the evacuation, but that -- the big picture is that overtime there's going to plenty of gasoline obviously in the short run. There could be some spematic outages in certain retail outlets of the evacuation routes.

Bob McNally: Right. And I would just add to that, again the history and what were seeing right now shows that the oil industry and the government -- the federal government and the state government is going to move heaven and earth to make sure that the energy disruptions are short as possible.

Now they can get oil and gasoline to the stations, and they will as fast as they can. You do need electricity you need the refineries working, and you cant -- you can never be sure exactly when. But you can be sure government and industry are going to work really hard to make sure the supply system can get that gasoline to the communities and so. I think at some point though, and then it's the behavior of the motorist. And I know I've seen officials and so forth make appeals to folks to you know, try and not hordle if you really don't need that gasoline right away. And so I think those are important messages.

That's sort of at the very end of the supply chain. So, everyone has to do their part of the oil industry, the government to make sure that restarts happen and oil products flows from the refineries to the terminals to those gas stations where the public can get to them, and then the public has access to those supplies at that time. And that sort of requires everyone doing their job and so forth.

Casey Logan: Thank you.

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Bob McNally: Yes.

Male: Thank you. Next question, please.

Operator: Your next question comes from Libby George from Reuters. Your line is open.

Libby George: Hi, thanks for that. My question is, I guess, following up on that. When the storm hit, there is a huge amount of oil products available in the U.S. but more than 30 percent of it is concentrated in the Gulf Coast. (Curious if this) – in (PADD 3) District, does this event indicate a need for the stocks to be more evenly distributed throughout the country or more investments infrastructure to be able to get it out?

Guy Caruso: Well ...

Bob McNally: Well – yes, go ahead, Guy.

Guy Caruso: I think, with 25 percent of our refining capacity concentrated in the path of Harvey, it's difficult not to say we couldn't do with more diversification. The problem is, and has been, as you know, that infrastructure development has been blocked in many areas. While ideally, would be nice to have (greater) distribution of both the refineries and the – and the inventory holdings around.

But the reality is, it's been difficult to really get (citing) for many of these facilities and we haven't had a grass-roots refinery built in a long time, although much investment has been made to (de-bottleneck) refineries and make them more efficient. So I think we're – it's a difficult political situation to be able to actually diversify as much as we would like. And one aspect of that is that we did look – when I was at the DOE and I know they've done more work on it since then – the possibility of strategic petroleum reserves and products.

And they have gone forward with a couple of small developments in that – start down that road with heating oil in Northeast and gasoline being talked about. But it's very expensive. And as Bob mentioned, the mood of the

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John Siciliano: Hey, guys. Yes, thanks for having the call. I was just trying to figure out, I saw some reports that the Saudis are pulling back on production amid some of the refinery restrictions in the United States. I was wondering how exports – or, I mean, imports to the U.S. are going to affect any of this disruptions during these storms?

Male: Well I think the main issue is the with the ports and terminals. In terms of any actions by any producers, I think that is highly unlikely. I think the Saudi's issue is mainly supplying their Motiva refinery, which is one of the largest in the country, and that sustained significant damage. That may be more related to more to what this – the report you're talking about, John, on the Saudis reducing its shipments. It may just be that a bunch of that was that (over in Motiva) and now there's demand for ...

Male: What if I just make it (three or four), I can't tell the difference?

Male: Yes, that's fine.

Male: (All right), thank you, next question please.

Male: (Oh, I'm sorry) ...

Operator: The next question comes from Devika Kumar from Reuters News. Your line is open.

Devika Kumar: Hi, guys. Thank you so much for doing this call. I just wanted to go back a little bit into the difficulty. Guy, you mentioned that one of the challenges in setting up a strategic reserve of product or gasoline especially, is that it's more expensive.

Can you talk a little bit more about what the pros and cons are to setting up something like this? I know after Sandy, the conversation about this started relatively quickly to set up a reserve of a million barrels here. So I just wanted to know if it's being discussed at all and what the pros and cons of such a conversation would even entail?

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Congress seems to be more towards selling off our (SBR), as opposed to adding to it.

Libby George: OK. Thanks. And, I mean, can you say anything else about kind of where industry stands in terms of the idea of an (FPR), or for products, or the idea that maybe – maybe, I mean, do some of these products need to be stored more evenly throughout the country? I mean, is there any kind of need for that from the industry's point of view?

Guy Caruso: I do know that there was not that much support for the products when I was looking at that issue, when – during the Bush administration – Bush W. Not sure ...

Bob McNally: Yes. I don't know if Jack, or (Eric), or somebody wants to speak for the industry to that question?

Jack Gerard: I would say generally, Bob, as we – as we've talked about in times past, that – as you guys mentioned earlier in the historical context, we support the boarder marketplace (allowing) there's a reason for – (a wealth of) economic reasons et cetera of why that infrastructure is located down in that Gulf Region. Of course, we produce a lot of product off the Gulf, (deep water), (shallow), et cetera.

We refine a lot of it there but there are also refining centers elsewhere around the country. You look up in New Jersey, Philadelphia Corridor, Chicago Corridor, Salt Lakes, some out in (California). So it's got a reasonable diversity the way it is. So rather than try to (manage it), you'll see where supply and demand goes, much like the (Floridian) situation. Our hope is, once again the market will eventually find a supply and demand equilibrium. And that's the broader approach we generally take as industry to those questions.

Libby George: Great, thank you.

Operator: Your next question comes from John Siciliano from The Washington Examiner. Your line is open.

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Guy Caruso: Yes, I think cost is number one on the list of the cons. And also, the (inaudible) and having enough supply in the right places because you don't want to be moving. You may have a lot of gasoline in California, and if you have a Sandy that affects New Jersey and New York, it's not very useful.

So I think the real problem is, you need enough of it in the right places. Which it – since it's all above ground for products, that's the most expensive way to store refined products. And it has to be turned over on a regular basis, so that also costs money because you can't leave gasoline in the tank for years because it loses (specification). It goes (off-spec) so you have to rotate your inventory. So it's not difficult. It just costs money to do that.

And it's what the Europeans do in meeting their international agency obligations. They keep most of them in products and they have parastatal organizations that are in place to actually – to turn that product over and keep it fresh for any emergencies. But it's cost then, and having enough at the right places at the right time.

Which is the reason we designed the (SPR) the way we did, was to keep it close to our refining centers and then you can make it into whatever you need at the time you need it. So we've seen the difficulties of that with Katrina, and Rita, and Sandy. But it's still, I think, probably the most efficient way to have a strategic reserve for our system.

Devika Kumar: Right. And if I could quickly follow-up, I just wanted to also touch back on the point where you get – that you had started with, which is that the energy landscape has changed significantly since the last time we had a hurricane of this magnitude. Right? And how the U.S. has kind of become a powerhouse in terms of exports, especially for products, does that change the conversation at all from the last time something like this was discussed?

Guy Caruso: Yes. I think the – two things. One is the renaissance in light tight oil and shale gas has transformed the infrastructure requirements of the U.S. and that certainly affected the midstream in particular. So many of our refineries used to carry product and crude from south to north now we need to – we have reversed a number of those. The refineries were used to running heavier sour

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crudes, now we have this large (feed stock) of light sweet from Bakken and other producers of light tight oil, Eagle Ford.

So these things all make the logistical system a bit more – more complicated and – but it also, by lifting restrictions on exports of – of crude and taking – and the availability of refined products, I think the system is much more flexible and I think the mention of the Jones Act waiver that Bob said may be happening – and would add to that flexibility, if there were a need to move product from the Gulf Coast to Florida or even further up the East Coast, depends on where Irma goes.

So the – it's represented challenges to the infrastructure and investment but it also has added to the flexibility. So I think, on balance, we're better prepared for – during a Harvey disaster than we were even for Katrina only 12, 13 years ago.

Devika Kumar: Alright. Thank you.

Reid Porter: Thank you. We have time for two more questions please.

Operator: Your next question comes from John Funk from "The Plain Dealer", your line is open.

John Funk: Thanks a lot. My question has to do with whether fuel, refined products, were redistributed after Harvey? Meaning, were you able to reverse pipelines – say, move gasoline from Chicago to supply (racks) in Texas? Or did you use rail or did nothing like that happen?

Guy Caruso: I think it's been – the infrastructure is still under such stress that I don't think much of that has happened, to my knowledge. But I must admit, the companies would be in a much better position to answer that question. But I think the focus has been on the recovery and the restart, which, this time, has been facilitated by lesser damage to electric power facilities compared to Katrina.

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Electric power was out much longer, covering a much wider area during 2004 and '05, after Rita and Katrina. So, probably was less need for that kind of repositioning in the very short term, last two, three weeks.

But, certainly, the incentive was there to do that because of the large spike in prices. So any movement – the incentive, the market incentive was certainly there for that reallocation. So, probably, everything was done that could have been done, given the lack of available facilities due to damage.

John Funk: Thank you.

Operator: Your next question comes from Nick – Sorry Ed Crooks from "Financial Times", your line is open.

Ed Crooks: Hi, good afternoon, thanks very much for taking the call. Yes, just for – wanted to kind of broaden out a thought you just raised. You were talking about – or you've just been talking Rita and Katrina and sort of similarities and differences to what we've been experiencing this year.

And you talked about the industry and everyone – the authorities being better prepared now. Just wondered if you could sort of expand on that, other thoughts that come to mind just in terms of sort of preparedness and were there lessons that were learned from Rita and Katrina that have been useful this time around with Harvey and possibly now with Irma.

Guy Caruso: Yes, I think definitely better prepared. One is the appreciation of the need to deal with all of the energy aspects, including the electricity and may have been circumstances were easier to deal with because of less electric power damage.

But also the better communication between the state and federal authority teams have gone much more smoothly this time and you're not hearing – I – tell (schools) (sort of out school) but I've been out of government long enough now.

I mean, the stories we were hearing right away from – post Katrina was there was enormous lack of communication between states – and I won't name

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names – and FEMA. And that – you're not hearing that this time and I know that's – we don't have access to every bit of information but certainly my impressions are that that was a big reason – one of the big reasons things have gone more smoothly.

Ed Crooks: Right. And that's true of the – sort of the recovery effort in general but also it specifically, has it affected the energy industry you'd say?

Guy Caruso: Yes.

Ed Crooks: Yes. Got you.

Guy Caruso: That's what my – my impression is and what I hear from my industry contacts and – and my contacts back in DOE.

Ed Crooks: Right, got it, thanks.

Jack Gerard: This is Jack Gerard; we've got time for one more. I'm just going to add one thing to that that Guy mentioned, didn't know if Bob wanted to comment on it, but if you go on our website we have a hurricane preparedness booklet and much of that was kind of in the post-Katrina world that was developed. Working with DOE – Guy's experience and his successor and secretaries and all – we actually worked with the previous administration and White House on that.

And it outlines, in many ways, not only kind of the full charts of how our industry functions but it identifies all those areas like the waivers we've talked about today and how we need to focus on those issues quickly to bring maximum flexibility to the market to address concerns as we have the outages as the storm impacts are dealt with.

So, if you want to take a look at that on our website or feel free to call us after the call offline, we're happy to share that with you. But I think that little booklet's probably a good summation of lessons learned and how we're prepared to deal with it now, to Guy's point is probably as smooth – or smoother than it's ever been in terms of an actual disaster like this.

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Ed Crooks: Fantastic, thanks very much, I'll take a look. Sounds interesting.

Reid Porter: Thank you and we have time for one last question.

Operator: Your last question comes from Nick Snow from "Oil and (glass) – Gas", your line is open.

Nick Snow: Well, my question, basically has been answered. I just wanted to thank you guys for having this teleconference, it's been very informative and I should be able to make a pretty good story out of it.

Male: Thanks Nick.

Reid Porter: Thanks. All right, thank you all for joining today's call.

Jack Gerard: Let me thank our guests, in particular Guy and Bob for joining us today. We greatly appreciate you taking some time to help inform the situation that's taking place. Again, our thoughts and prayers are with those in harm's way and I know as we all work together and communicate as best we can, it'll be helpful.

So please don't hesitate to reach out to us. I'm sure Guy and Bob, to the extent they're available, will be happy to answer further questions as well. Thank you all and we look forward to being in touch. Thank you.

Reid Porter: If there are additional questions please don't hesitate to reach to the API media line, that's (202) 682-8114. Thank you.

Operator: This concludes today's conference call. You may now disconnect.

END

APPENDIX D EIA REPORT ON BOMB CYCLONE



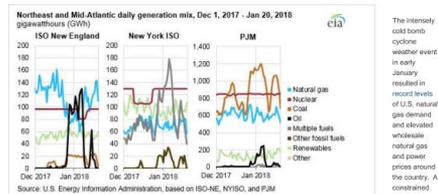
Prepared by RBN Energy LLC for the Natural Gas Council

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6/4/2018 U.S. Energy Information Administration (EIA)

Energy Market Alerts
Northeastern Winter Energy Alert
Release date: January 22, 2018

Market design changes and winter preparedness actions help Northeast and Mid-Atlantic electricity markets handle January's bomb cyclone weather event



During the cold weather spanning the end of December to early January, oil use jumped from almost nothing to a high of 36% of the daily generation mix on the ISO New England (ISO-NE) system and 6% on the PJM system covering an extended Mid-Atlantic region. On the New York ISO's (NYISO) system, the output of dual-fuel generators, most of which are natural gas generators that can switch to oil, and other fossil fuel generators rose significantly. Coal generation also increased substantially in PJM.

Day-ahead daily average peak-period power prices for January 5, 2018, one of the coldest days of the weather event, reached \$247 per megawatt-hour (MWh) in New England and New York and \$202/MWh in the Mid-Atlantic, compared with \$33-\$50/MWh average prices in the preceding six weeks. These prices were far lower than the \$440-\$600/MWh peaks seen during the polar vortex event in January 2014 despite natural gas prices that spiked higher this year than in 2014.

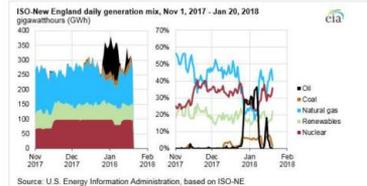
Day-ahead natural gas spot prices for January 5, 2018, reached \$83.75 per million British thermal units (MMBtu) in New England, \$140.25/MMBtu in New York, and \$96.07/MMBtu in the Mid-Atlantic, compared with \$3-\$5/MMBtu average prices in the preceding six weeks. These prices exceeded January 2014 polar vortex prices by about \$4-\$20/MMBtu.

Power markets in the Northeast and Mid-Atlantic have become more reliant on natural gas over the past several years following the retirement of electricity generators using fuels other than natural gas. However, the relative moderation in power prices spikes during this year's cold snap—despite higher natural gas prices—reflects a host of market rule changes and winter preparedness actions taken by the region's grid operators to improve winter reliability.

https://www.eia.gov/special/alerts_winter_cooler

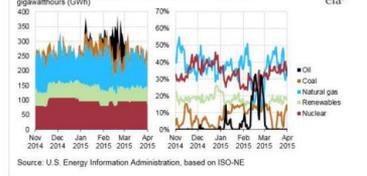
6/4/2018 U.S. Energy Information Administration (EIA)

New England
ISO New England daily generation mix, Nov 1, 2017 - Jan 20, 2018



In New England, retirements of the Vermont Yankee nuclear plant, the Brayton Point coal plant, and the Salem Harbor coal and oil-fired plant (which is currently being converted to natural gas), as well as incremental expansions of the natural gas pipeline network, have led the region to become more reliant on natural gas over the past couple years.

New England
ISO New England daily generation mix, Nov 1, 2014 - Apr 1, 2015

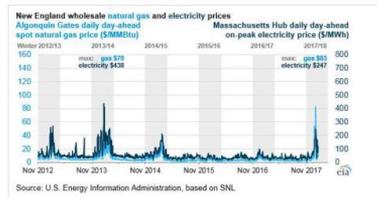
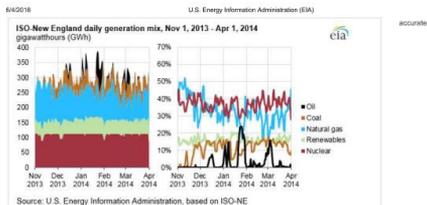


During the 12-day span from December 28, 2014, to January 9, 2015, oil and coal made up on average 29% and 6%, respectively, of ISO-NE's generation mix. Natural gas dropped at one point to a low of 17% of generation. One of the region's three nuclear plants, Pilgrim, experienced an unexpected outage for six days during that period. Dual-fuel reporting changes in late 2014 make direct comparisons to the polar vortex (2013-14) generation mix difficult, but oil provided similar contributions during the 2014-15 winter for shorter stretches of time.

ISO-NE's Winter Reliability Program, implemented after the polar vortex, has incentivized generators to procure adequate onsite fuel supplies for winter and spurred 1,774 MW of natural gas-fired generators to add dual-fuel capability, which allows them to switch fuels or co-fire multiple fuels simultaneously. More than one-third of New England's natural gas capacity has dual-fuel capability with oil as their secondary source, while about 40% of oil capacity can switch to natural gas, and about 50% of coal capacity can switch mainly to oil.

ISO-NE has also made market design changes to improve winter reliability, including allowing generators to submit and update supply offers for each hour of the day as opposed to a single supply offer for an entire day. Dual-fuel generators can now specify the percentage of fuels they plan to use and the costs for each fuel. These changes allow generators to offer their resources into the market with more

https://www.eia.gov/special/alerts_winter_cooler



representations of their operating costs.

Other parts of ISO-NE's winter preparedness initiative include adjusting the daily timeline of their day-ahead market clearing process to better align with day-ahead natural gas procurement timelines, requiring dual-fuel testing, and increasing real-time communication with natural gas pipeline operators and generators about the status of fuel supplies and potential outages.

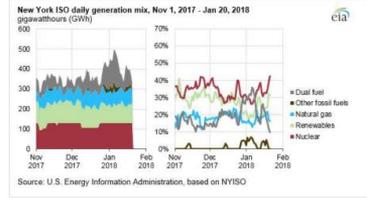
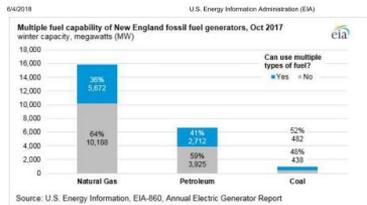
New York

During the 12-day period from December 28 to January 8, dual-fuel generators burning oil and natural gas accounted for, on average, 30% of NYISO's generation mix, while coal and oil-only generators together averaged 5%. The increase in fuel for dual-fuel generators is not currently reported. Nuclear generators provided roughly 30%, while natural gas-only and renewables provided the remaining 30%.

In New York, natural gas makes up more than half of the state's total generating capacity with about 70% of natural gas capacity able to switch to oil. About 20% of oil capacity can switch to natural gas and 13% of coal capacity can switch to oil or natural gas.

https://www.eia.gov/special/winter_prep/

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operating reserve requirement from 1,965 MW to 2,820 MW and implementing new pricing methodologies that allow energy and ancillary services prices to rise higher to more accurately reflect costs for maintaining reliability, especially during reduced supply periods.

PJM

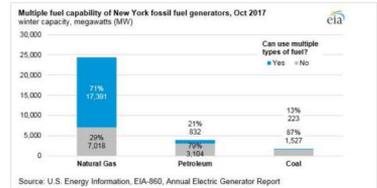
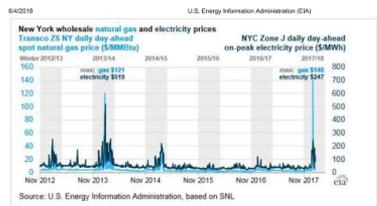
PJM is a much larger system that relies on natural gas to a lesser extent than ISO-NE and NYISO. Oil generation peaked at 9% of the generation mix on January 7 and averaged 4% during the 12-day period from December 28 to January 8. Coal generation, which hovered around 30% of the generation mix beforehand, grew to about 40% during the same time period.

About 40% of PJM's natural gas generators can switch, mainly to oil, while 15% of coal capacity can switch to natural gas or oil, and 4% of oil capacity can switch mainly to natural gas.

PJM has improved its winter readiness by conducting fuel inventory surveys, cold weather exercises, emergency drills, generator testing and training, and increasing communication with natural gas pipeline operators and generators.

https://www.eia.gov/special/winter_prep/

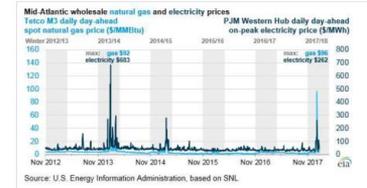
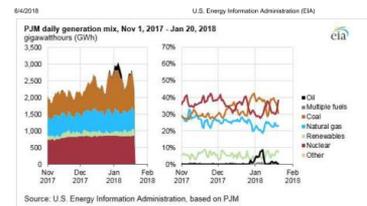
NYISO has taken actions similar to ISO-NE to improve winter reliability. The grid operator increased generator fuel surveys and site visits, made use of generators with higher-priced offers when units committed in the day-ahead market could not run, and developed a streamlined process with New York state agencies for generators to request temporary emission waivers if needed for reliability. NYISO made several market design changes including increasing the system's total



unprecedented amount of generator and equipment outages during the January 2014 polar vortex. PJM has gradually transitioned over the past couple years to new capacity market rules under its Capacity Performance proposal that increase capacity payments to generators while also imposing strict penalties for not performing when called upon by the grid operator during emergency events. These changes are intended to incentivize generators to invest in equipment maintenance and adequate fuel supplies to reduce generator non-performance.

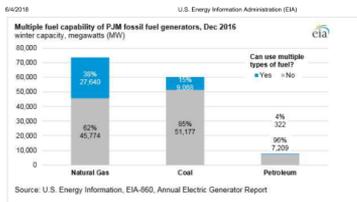
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