NATURAL GAS: RELIABLE AND RESILIENT

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Introduction

The United States has abundant natural gas resources that enable the natural gas industry to satisfy customer demand. In only a few years' time, the U.S. has become the largest producer of natural gas in the world. Since 2010, production has grown almost 30 percent. Government forecasts expect this trend to continue.[1]

At the same time, electric sector demand for natural gas has increased, driven by advanced economics, low-carbon greenhouse gas emissions, and more flexibility due to faster plant start-up time, which are among the same factors contributing to coal-fired plant retirements, as well as the comparatively low capital cost and smaller footprint of natural gas-fired power plants.[2] The growth in natural gas use for power generation has led some who are unfamiliar with natural gas operations and contracting practices to question the ability of natural gas to serve this market reliably.

For well over a century, customers have relied on natural gas for home heating in the dead of winter. Driven by the core values of safety and pipeline integrity, natural gas system resilience and reliability are engrained in the industry's DNA.

This document outlines the reliability and resilience of natural gas transportation, related regulatory authorities, and the contracting procedures necessary for large volume customers to best meet their service needs.

A Physically Reliable System

In the United States, there are more than a half million producing gas wells spread across 30 states. The growth of major onshore shale gas production has greatly reduced exposure to the effects of hurricanes to off-shore supplies and spot market prices. Onshore natural gas production accounted for 95 percent of total U.S. gross withdrawals of natural gas in 2016, up from 74 percent in 1990.

Because natural gas physically moves slowly through a pipeline at an average speed of 15-20 miles per hour, its flow can be controlled. This allows time for pipeline operators to manage the flow and adjust operations in the unlikely event of a disruption.

The natural gas value chain is extensive and spans from the production well-head to the consumer burner-tip (see illustration on page 2). Mostly underground, America's 2.5 million mile natural gas pipeline network is the safest form of energy delivery in the country[3] – transporting approximately one-fourth of the energy consumed in the U.S. Further, this pipeline and storage network is highly reliable. Production can be accessed from virtually all major North American gas-producing regions and securely delivered via a highly integrated pipeline transportation network. Very rarely, force majeure events such as catastrophic weather have the ability to potentially disrupt localized segments of this network, but typically only at above-ground facilities where the pipeline may be exposed and damaged.

Outages are extremely rare and are localized when they occur due to the interconnected nature of the transportation network.

The natural gas value chain includes three major segments:

- ***Production & Processing*** - Natural gas is found in reservoirs deep within the earth and brought to the surface through production wells. Gathering lines then transport natural gas from these wellheads to processing plants.
- ***Transmission & Storage*** - Transmission lines transport processed natural gas to large-volume customers (e.g., local distribution companies, natural gas-fired power generation, industrial customers, etc.) or to storage facilities.
- ***Distribution*** - Distribution lines deliver natural gas to residential, commercial, industrial customers, and natural gas-fired power generators.

Figure 1 on the following page provides an overview of these segments in greater depth.

Compressor Stations: Natural gas compressors pressurize the natural gas for transportation throughout the pipeline network. There are approximately 300,000 miles of interstate and intrastate transmission pipelines in the natural gas pipeline system. More than 1,400 compressor stations are strategically sited every 50 to 100 miles to maintain proper pressure on the pipeline network and guarantee the cross-country transportation. These compressor stations are typically designed with multiple compressor units. This compressor redundancy supports scheduled and unscheduled unit maintenance or repair while minimizing impacts to system delivery.

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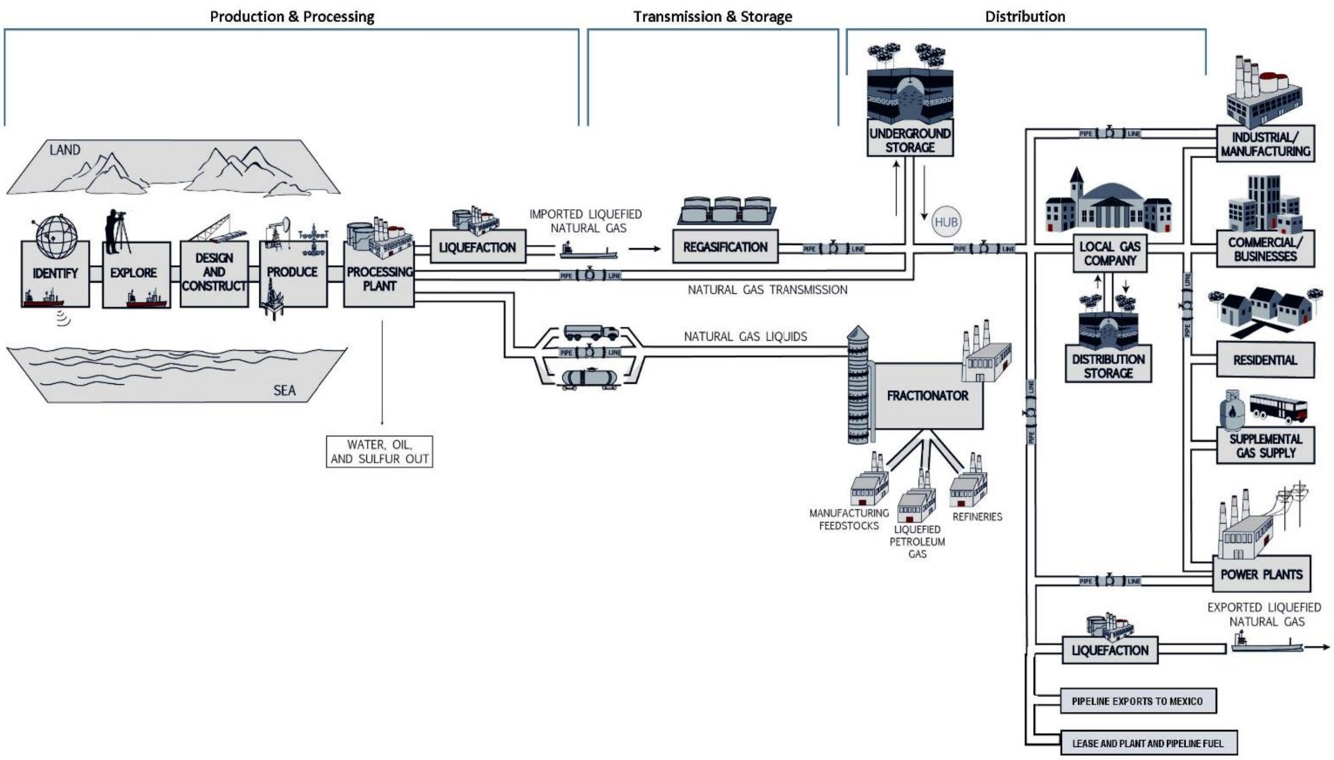
[1] See EIA *Short Term Energy Outlook*, May 2017, and EIA Natural Gas Summary |Custom Table Builder.

[2] See Leidos (formerly SAIC), *Comparison of Fuels for Power Generation*, 2016 .

[3] According to data in 2018 National Transportation Statistics (Department of Transportation Bureau of Transportation Statistics, https://www.bts.gov/sites/bts.dot.gov/files/docs/browse-statistical-products-and-data/national-transportation-statistics/220806/ntsentire2018q1.pdf.)

Figure 1: An overview of the Natural Gas Value Chain

Source: The American Petroleum Industry, Oil and Natural Gas Industry Preparedness Handbook, 2016.



The following operational capabilities minimize the possibility that a pipeline failure has more than a localized impact.

- An extensive network of interconnected pipelines offer multiple pathways to reroute deliveries;
- Parallel pipelines increase pipeline capacity and make it possible to shut off one while keeping others in service;
- Geographically dispersed production and storage ensure supply flexibility;
- A physical property of natural gas known as *compressibility* allows for additional volume of gas molecules to be packed into the pipeline. This excess volume of compressed gas is known as "line pack" and provides a flexible buffer of stored energy to be naturally available in the pipeline system.[4] The purpose of this buffer is to ensure the capability of the pipeline operations to accommodate changing conditions throughout the day. Though line pack neither creates incremental capacity (the pipe size itself doesn't change) nor is it a substitute for appropriate transportation contracts, it often can be used to help minimize the impact of short-term supply disruption;
- The combination of physical characteristics of natural gas and the interconnected pipeline system allows operators to control and redirect the flow around any potential pipeline outage (analogous to driving a 'detour').

Storage: Another significant physical property that reinforces natural gas' supply-chain resilience and reliability is the ability to store natural gas after production. The natural gas industry has developed large amounts of storage capacity to supplement gas production on peak days and during winter demand for customers that contract for such service. While natural gas production remains relatively constant year-round, storage enables customers to adjust for daily and seasonal fluctuations in demand.

Natural gas is stored most commonly underground in depleted oil and gas reservoirs, depleted aquifers, and salt caverns. Natural gas can also be stored above ground in storage tanks as liquefied natural gas (LNG) or compressed natural gas (CNG). Storage not only provides a supply buffer but also provides vital operational flexibility should unplanned supply constraints develop in the pipeline and distribution network. LNG and CNG can also be transported by vehicle or vessel to serve remote areas in the event of a supply disruption.

Layers of Protection

The natural gas system – production, gathering, processing, transmission, distribution and storage – is

[4] The full volume in the pipeline is limited by the pressure permitted by federal pipeline safety regulations (49 CFR Part 192).

highly flexible and elastic. Natural gas delivery systems are mechanical by nature and operated manually if necessary. Control systems help monitor, and in some cases, operate the pipelines and their components to move the gas in a reliable, efficient and effective manner. The system, however, remains largely non-electronic, and most electronics have mechanical fail-safes. Operators manage the internal pressure of the delivery system by controlling the amount of natural gas that enters and leaves the system. This process of increasing or decreasing pressure happens relatively slowly because of the compressible nature of gas. Line pack lessens the immediacy of customer impacts due to an operational abnormality and increases the probability that such events can be resolved before customers are impacted.

Overpressure protection devices, designed to prevent internal gas pressure from threatening pipeline's integrity are layered onto the pipeline control system architecture.

In summary, natural gas service disruptions are rare and generally localized due to the physical characteristics of natural gas and the decentralized nature of the transmission network. Further, built-in pipeline and supply redundancies minimize disruptions that do occur. As noted in a report from MIT[5]:

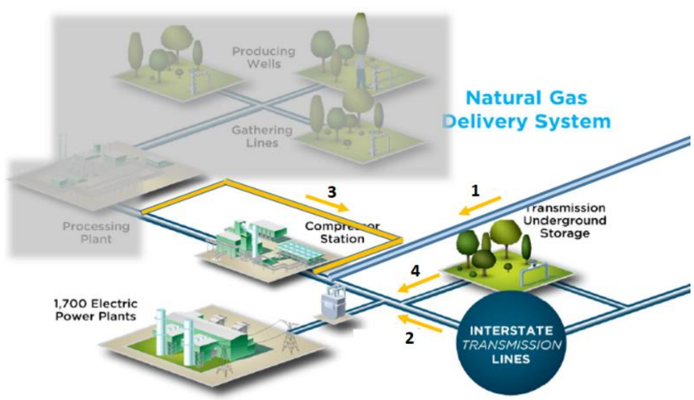
> The natural gas network has few single points of failure that can lead to a system-wide propagating failure. There are a large number of wells, storage is relatively widespread, the transmission system can continue to operate at high pressure even with the failure of half of the compressors, and the distribution network can run unattended and without power. This is in contrast to the electricity grid, which has, by comparison, few generating points, requires oversight to balance load and demand on a tight timescale, and has a transmission and distribution network that is vulnerable to single point, cascading failures.

The findings in that MIT report continue to hold true as natural gas pipeline operations and system design remain relatively consistent over the years. Further, production comes from a large population of gas-producing wells, minimizing the potential for single points of disruption. Production companies have an economic incentive to maintain a steady gas flow. To ensure this flow, producers often rely on multiple processing plants and pipeline routing options in production areas, especially when handling high volumes of production.

Multi-Sourced: Another factor contributing to the reliability and resilience of pipelines is that few pipelines in the U.S. are single-sourced. Most have multiple, if not hundreds, of interconnects and supply source points. Figure 2 below outlines the possibilities to deliver supply in the event of a disruption on the system.

- See #1: The major long-haul pipelines continue moving significant volumes of natural gas even when pipeline supply source point is removed.
- See #2: In general, natural gas pipelines are designed to be operated bidirectional. In an extreme or emergency situation, operators can change their system configuration to back-feed a pipeline and continue supplying natural gas to customers.
- See #3: Compressor stations are commonly constructed with bypasses to allow natural gas flow to continue even when the stations are down.
- See #4: Portable LNG and CNG may also be trucked to the market to assist with supply needs.

Figure 2: Natural Gas Value Chain Redundancy



The North America Electric Reliability Corporation (NERC) also conducted an assessment[6] on natural gas and electric interdependence. The study analyzed the potential impacts to bulk power system (BPS) reliability as a result of a large disruption on the natural gas system. NERC observed that natural gas system disruptions that impact BPS reliability are extremely rare and dependent on a variety of factors. The study found that firm natural gas pipeline transportation, dual fuel capability and ample infrastructure, provides the highest level of reliability for natural gas delivery. Furthermore, diverse natural gas

5 Massachusetts Institute of Technology, Lincoln Laboratory, "Interdependence of the Electricity Generation System and the Natural Gas System and Implications for Energy Security," May 15, 2013.

6 November 2017, NERC Special Reliability Assessment on Bulk Power System (BPS) Impacts Due to Severe Disruptions on the Natural Gas System

supply sources reduce the likelihood of natural gas infrastructure outages affecting electric generation.

Service disruptions are rare. There is low risk of uncontrollable, cascading outages in the natural gas system, as supply and transportation disruptions can typically be addressed through substitution, re-routing and storage services.

Security – Physical & Cyber

Throughout the natural gas value chain, the industry utilizes a broad portfolio of tools to protect facilities from physical and cybersecurity threats. Recognizing industry's commitment to security and the resilience and redundancy built into pipeline systems, the federal government has opted to partner with industry on cyber and physical security instead of providing mandatory and prescriptive regulations. This partnership is notably reflected by the natural gas pipeline industry's commitment to updating and implementing the *TSA Pipeline Security Guidelines*, which provide a risk-based approach to protecting pipeline infrastructure from cyber and physical security threats.

Physical Security: Fences, routine patrols, and continuous monitoring, as appropriate, help protect above-ground facilities such as compressors, well sites, processing plants, and meter stations. Unmanned aerial systems (UAS), also called "drones", video-monitoring, intrusion cameras, motion-detectors, and biometrics are all examples of technologies deployed to address physical threats. The natural gas industry routinely holds threat briefings and workshops to discuss and improve security and has developed industry guidelines and identified practices to protect facilities and data. Natural gas trade associations and pipeline operators regularly run simulated response/recovery exercises to help prepare for natural or man-made disasters. The industry also works closely with government agencies to share threat information.

Cybersecurity: One of the most important aspects of pipeline cybersecurity is protecting the integrity and operability of pipeline operational technology (OT), primarily industrial control systems (ICS), against cyber compromise. Cybersecurity is a priority for companies that operate natural gas pipelines and other infrastructure and these companies manage cybersecurity risks with Board and Senior Executive oversight. Natural gas companies orient their cybersecurity programs to several key frameworks and standards, including but not limited to: the NIST Cybersecurity Framework, the ISA/IEC 62443 Series of Standards on Industrial Automation and Control Systems (IACS) Security, ISO 27000, NIST 800-82, the TSA Pipeline Security Guidelines, and API Standard 1164.

From a cybersecurity perspective, natural gas functions are divided across an enterprise network (business systems) and an operations network – including process control networks, Supervisory Control and Data Acquisition systems (SCADA), distributed control systems (DCS), and other pipeline monitoring. Network segmentation, or isolating the enterprise networks from the operational network, is a critical cybersecurity defense implemented by natural gas companies. Individual companies deploy a customized portfolio of tools and mechanisms to provide further "defense-in-depth," holistically improving the prevention, detection, and mitigation of successful cyber penetration.

In collaboration with the federal government, companies operating natural gas infrastructure are continuously responding to cyber threats and evolving the sophistication of their defenses. The federal government partners with the industry on cybersecurity initiatives to promote situational awareness, mitigative measures, and response/recovery. Critical infrastructure sectors, including natural gas, use Information Sharing & Analysis Centers (ISACs) to share analysis of changing threats within the sector, other sectors, and federal and state governments.

Regulations & Authorities

Natural gas pipelines are subject to strict pipeline safety regulations mandated by the Department of Transportation's (DOT) Pipeline & Hazardous Materials Safety Administration (PHMSA) and to the pipeline security authority of the Department of Homeland Security (DHS) Transportation Security Administration (TSA).

Figure 3: Natural Gas System Rate Structure

Pipeline Safety: These regulations stipulate engineering, operational, and public safety requirements for pipeline construction and use. Other federal and state agencies regulate various environmental, security, and safety aspects of the natural gas system. As outlined below and in Figure 3, natural gas industry segments are subject to different regulatory regimes – the product of a long evolution

Interstate Pipelines: In 1992, the Federal Energy Regulatory Commission (FERC), which regulates interstate natural gas pipelines, required interstate pipelines to unbundle (i.e., separate) gas commodity sales and gas transportation services, and to provide transportation service on an open access, non-discriminatory basis.

As a result, interstate pipelines exited the gas merchant function and became contract carriers that transport gas molecules owned by third party shippers – roughly analogous to a semi-truck driver transporting loaves of bread to a store. As such, interstate pipeline operators charge for the movement of gas through their systems, while the gas commodity itself must be purchased separately, from gas suppliers – typically producers and marketers.

Local Distribution: Natural gas LDCs are regulated at the state and local level and obligated by public service regulations to reliably meet the natural gas supply needs of their firm customers at regulated rates. These are the customers, such as residential consumers, hospitals, etc., for which the LDC system was built to serve reliably on a "design day" (a forecasted peak-load day based on historical weather).

In the event of an LDC disruption, service priority is typically specified in a public utility commission-approved tariff [7], as applicable. This may or may not be the case for municipal gas companies, depending on the jurisdiction. Generally, the highest service priority is given to maintaining the operational integrity of the system and/or maintaining natural gas service to designated high priority customers, including "essential human need" and residential and commercial customers without short-term alternatives. A natural gas-fired power generator relying on an LDC distribution system, particularly on an interruptible basis, needs to consider the LDC's primary service obligations and plan for the use of alternate fuels or contract for firm transportation or other services the LDC may provide. These contracts and services are described in greater depth on page 6.

Pipeline Security. The amalgamation of the 2001 Aviation & Transportation Security Act (which created TSA within DOT) and the Homeland Security Act of 2002 (which created DHS and moved TSA from DOT to DHS) granted pipeline security authority to TSA under DHS. Since its inception, TSA has strategically chosen to partner with pipeline operators to advance infrastructure security.

In partnership with industry, the Pipeline Security Program, within the Surface Division of TSA's Office of Security Policy and Industry Engagement, developed Pipeline Security Guidelines (Guidelines). These Guidelines are designed to help operators strengthen their security posture and provide the basis for the TSA Pipeline Security Program Corporate Security Reviews and Critical Facility Security Reviews.

While TSA has authority over pipeline cyber and physical security, a number of other organizations have authority over the security of other elements of the natural gas value chain.[8]

Contractual Obligations

The interstate pipeline industry is contract-based. Pipeline and storage companies contract with customers under the terms of their FERC-approved tariffs. Customers select transportation and storage services (firm or interruptible) based on the level of certainty and reliability that they desire. Firm-service shippers[9] receive the most reliable service, because they have the highest scheduling priority and are the last to be curtailed in force majeure (or unexpected emergency) situations.[10] Service to interruptible shippers, if scheduled, can be interrupted by

[7] A tariff is a "collection of rules that defines the relationship between a utility and its customers." See http://puc.nv.gov/About/Docs/Tariffs/

[8] !Post the ONG SCC Doc Online at ongsubsector.org (once approved by ONG SCC)

[9] A "shipper" is a company who owns the physical product and pays the pipeline company for transport. See http://www.pipeline101.org/how-do-pipelines-work/who-operates-pipelines.

[10] 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)

higher priority firm shippers. Therefore, the level of interstate pipeline service for which a customer has contracted is of paramount importance.

Some large-volume customers (e.g., LDCs, industrial users) purchase gas upstream at or near the point of production and contract separately for pipeline service to transport the commodity to the point of delivery. Others purchase gas at a market center and contract for transportation from that point to their delivery point. Others purchase a bundled commodity and transportation package from marketers, who deliver the gas using the pipeline capacity for which they have contracted. It is the responsibility of pipeline customers to ensure their gas supply reliability by contracting for the portfolio of commodity, transportation and storage that best meet their needs and risk tolerance.

CONTRACTUAL SERVICE TYPES

Interstate pipelines schedule the available transportation system capacity based on a system that includes nominations and confirmations. When necessary, service restrictions are based upon the type of service contracted.

1. "Firm" contracts – customer pays for highest level of delivery of the commodity; on a pipeline, usually the customer pays a monthly charge reserving capacity on the pipeline to transport or store up to a specified amount of gas every day
2. "Interruptible" contracts – customer pays for a lower level of delivery of the commodity which can be interrupted at any time for any reason unless scheduled by the pipeline and past the "no bump" period. The pipeline will schedule the interruptible customers to use the capacity as long as the capacity is available. Capacity is often not available during peak demand periods when higher priority customers are using their capacity. Further, service can be interrupted for higher priority services.
3. Other contract options even include "no-notice" service, which gives capacity on the pipeline throughout the 24-hour gas day.

On occasion, interstate pipelines may not have uncontracted transportation capacity available for sale. Moreover, on the coldest days (i.e., peak days), when weather-sensitive firm transportation customers are using their full contractual entitlements, there likely will be little or no transportation capacity left over to provide interruptible transportation service. These interruptions are unrelated to the disruption of pipeline transportation or the unavailability of the natural gas commodity. Rather, the interruptions are the result of higher priority customers exercising the entitlement to natural gas transportation on a firm basis for which they have contracted.

Customers that do not hold pipeline capacity often attempt to purchase transportation capacity on the vibrant "secondary market", where firm transportation customers can release their capacity for resale. Independent natural gas marketers also offer gas supply services that can be tailored to meet the needs of different types of buyers.

Interstate pipelines do not prioritize transportation service based on the end use of the natural gas.[11] Rather, service priority is a function of the service level the customer has contracted with the pipeline, with firm and "no-notice" services being the highest priority. If large-volume customers, such as power generators, seek the highest level of reliable service, they must contract "firm" or, in some cases, "no –notice" service to ensure pipeline capacity and/or storage service is available when needed.

If a force majeure event reduces available pipeline capacity such that a pipeline cannot provide all scheduled delivery obligation, a pipeline will curtail service base on the priority of customers' contracted transportation service. A pipeline will curtail interruptible transportation contracts first.

Electric generators in the organized wholesale electric markets may need appropriate incentives and cost recovery mechanisms to contract for firm transportation and storage services that may be needed to satisfy their reliability needs.

Many power generators and other industrial and large commercial gas users are connected directly to an interstate or intrastate transmission pipeline. Others are connected directly to LDC systems. The gas customers typically do not purchase gas from the LDC, but rather contract to use that LDC system for transportation of gas that they purchase in the wholesale market.

Large gas users are reminded to consider the entire fuel value chain, taking into consideration congested transportation paths, pipeline contract scheduling, and curtailment priorities when contracting for gas delivery.

Time-Tested Resilience

Decades of operational experience demonstrate the natural gas industry's effective response to historic weather events, notably the 2011 Southwest Cold Weather event, 2012 Superstorm Sandy, 2014 Polar Vortex, and the more recent 2017 Hurricane Harvey and

[11] FERC's non-discriminatory open access regulations preclude this.

2018 Bomb Cyclone. During each of these events, natural gas supply and transportation service were provided in an exemplary manner.

History has shown that during these sorts of unprecedented weather events, the natural gas systems fairs well. Natural gas operations are built with resilience upfront and designed to remain in service. To address threats from natural disasters, such as earthquakes, pipeline construction standards are appropriately scaled up in high risk/high consequence areas, relative to those regions with lower risk. Further, pipeline controllers are postured to receive emergency notifications upon detection of earthquakes which include GPS coordinates of the earthquake's epicenter and allow for quick identification of potentially impacted assets and broader operational risk.

In the Face of Storms…

In February 2011, the southwest region of the U.S. experienced historically cold weather (known as the **Southwest Cold Weather Event)** resulting in electric and natural gas service disruptions. Due to the loss of some production to well freezing at a time of increased gas system demand, nearly 50,000 retail gas customers experienced curtailments when gas pressure declined on interstate and intrastate pipelines and local distribution systems. The interstate and intrastate pipeline network showed good flexibility in adjusting flows to meet demand and compensate for supply shortfalls. No evidence was found that interstate or intrastate pipeline design constraints, system limitations, or equipment failures contributed significantly to the gas outages.[12]

Superstorm Sandy hit the Northeast in 2012 wreaking havoc on New York and New Jersey. The use of natural gas-powered microgrids and combined heat and power systems allowed certain businesses and hospitals to remain open[13].

The **2014 Polar Vortex** weather event stretched across the U.S. 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]

Hurricane Harvey flooded Houston in 2017. Natural gas transportation was not disrupted, and the local gas utility distribution systems remained operational in Houston and surrounding impacted area.

The **2018 Bomb Cyclone** or "snow hurricane" slammed on the East Coast in early January during an already severe cold wave and blizzard that had begun in December 2017. Spot gas prices hit record highs, and national prices elevated a degree. Despite impacts on the market, natural gas service was maintained.

Should an "act of man", or anthropogenic event, occur, structural and procedural processes are often already in place. For instance, in areas at high risk of wildfire (natural or manmade), companies typically work with local authorities to have markers in place so that when "firebreaks" are deployed, pipeline safety management can more readily be applied. In addition, all companies have business continuity plans in place to deal with a broad range of disasters.

Unlike electricity systems, which are often designed to shut down under abnormal conditions, natural gas operations are designed to remain in service. Because the majority of natural gas pipelines is buried, interruptions tend to be localized, and widespread recovery is rare.

Specific to the LDC system, should natural gas service be shutdown, the process of bringing the system back online is a labor-intensive, multi-step process; whereby, the gas utility performs integrity tests on each repaired pipeline, visits individual homes and businesses to shut off individual services, re-pressurizes the distribution pipelines, and finally inspects and turns on individual services meters and appliances. For this reason, natural gas cannot be subject to rolling blackouts as can be done with the electricity system. Also, for this reason, LDCs contract appropriately for gas supply and transportation. Often, the pipeline has been repaired; is re-pressurizing and ready to supply natural gas; but, the structures that use the natural gas are not yet repaired or replaced.

Natural Gas-Fired Power Generation

The natural gas and electric systems are each uniquely complex; the systems operate and are regulated differently; and each industry uses its own terminology applicable to its infrastructure as well as physical characteristics of the energy commodity being transported. Gas-electric coordination efforts over the years have helped each industry better understand the other's operations, regulatory structure, and needs. From a practical perspective, the extent to which a natural gas transportation disruption impacts a natural gas-fired electricity generation facility depends on multiple factors, including:

- the availability of alternate natural gas feeds/supplies,
- the drawdown or quantity of natural gas required by the generator during the duration of supply constraint, and/or
- contractual agreements.

12 "Outages & Curtailments During the Southwest Cold Weather Event," FERC & NERC, 2011

13 "How CHP Stepped Up When the Power Went Out During Hurricane Sandy," ACEEE, 2012

14 *EIA, Market Digest: Natural Gas (2013-2014).*

15 See https://www.ferc.gov/media/news-releases/2014/2014-4/10-16-14-A-4-presentation.pdf. Also see https://www.ferc.gov/legal/staff-reports/2014/04-01-14.pdf Slide 4.

The needs of a generating facility as well as those of the pipeline system that is supplying the natural gas are unique to the markets served, the regional location, and the environmental conditions.

While gas-fired generation demand is growing, it still only represents one-third of the total market for natural gas in the United States. The other two-thirds include direct-use in the residential, commercial and industrial sectors. To ensure gas and electric reliability, stakeholders must:

- develop adequate infrastructure, where it is needed;
- offer firm pipeline transportation and storage services, including enhanced firm services which are flexible to meet their unique needs;
- be provided the appropriate incentives for electric generators to sign up and pay for the firm services they may need to ensure reliability;
- consider dual fuel options;
- understand common and disparate regulatory requirements; and
- consider environmental, safety, and affordability considerations.

FERC has issued orders to help effectuate the coordination efforts between interstate pipelines and the electricity market.

- **Order No. 787** helps facilitate communication of non-public, operational information between electric public utilities and interstate natural gas pipelines to promote reliable service or operational planning. The Order also authorizes interstate natural gas pipelines and electric transmission operators to share non-public, operational information to support the reliability of their systems.
- **Order No. 809** modified scheduling practices of interstate pipelines to better coordinate the wholesale natural gas and electricity markets.

Conclusion

The operational characteristics of the natural gas transportation network in combination with the physical properties of natural gas effectively minimize the likelihood and severity of service disruptions. In the rare event of a disruption, impacts are typically localized and brief. History demonstrates that disruption of firm pipeline transportation and/or storage services resulting from severe weather events are extremely rare.

Bottom line: there is virtually no risk that a single point of disruption will result in an uncontrollable, cascading outage.

Natural gas delivery systems are mechanical by nature and can be run manually if necessary. Natural gas is moved by using pressure to control the amount entering and leaving the system. Pressure-relief devices are layered into the pipeline infrastructure to prevent internal gas pressure from threatening pipeline integrity. Typically, supply and transportation disruptions can be managed through substitution, transportation rerouting, and storage services.

Cyber and physical security are a priority for industry, and the value chain segments use a portfolio of tools to protect infrastructure from threats. As with pipeline safety, layers of resilience support robust security risk management.

FERC's restructuring of the natural gas industry created an additional level of responsibility on the pipeline customer to contract separately for gas commodity supplies and pipeline transportation, and to determine the level of reliability the customer chooses. In turn, this has encouraged competition, customer choice, and service innovation.

Natural gas service is safe, secure, reliable, and plentiful. The industry has demonstrated its willingness to work with customers, including electric generators, to design new services that meet customers' needs. If capacity is not available, the gas industry will work with customers to design infrastructure expansions. However, reliability is not free. Gas service must be aligned with market incentives for generators to enter into firm service contracts. Operational reliability coupled with contractual continuity of service makes natural gas a secure, reliable, and resilient choice

Is America's Natural Gas Pipeline Network Prepared for Cyber-Attacks?

System Operational Characteristics

The natural gas transportation network is diverse and interconnected, offering multiple pathways to reroute deliveries in the event of a disruption.[1]

Pipeline operators purposely design systems to limit points of failure.[2]

Natural gas under firm delivery contracts is delivered with 99.79% percent reliability.[3]

Supply flexibility is ensured by geographically dispersed production and storage systems.[4]

Most components of the natural gas pipeline infrastructure are underground and protected from the elements, making them far more resilient to extreme weather events or external threats.[5]

Natural gas pipelines continue to operate during power outages because most of the compressors that keep gas flowing through the lines are fueled by natural gas .[6]

Natural gas pipelines have numerous backups and fail-safes. They ensure that the system can continue to operate in the event of an outage of the computer systems that help operate the pipeline (called "SCADA").[7]

Cyber Practices

The NIST cybersecurity framework is just one of many standards that pipeline operators use to improve the security and resilience of critical infrastructure.[8]

Pipeline operators use resources like the Oil and Natural Gas Information Sharing and Analysis Center and Downstream Natural Gas Information Sharing and Analysis Center to share threat intelligence and recommended mitigations in real-time.[9]

Gas pipeline and electric grid operators conduct joint tabletop exercises to test response plans and increase gas-electric coordination, reliability and resilience.

Pipeline operators routinely maintain both backup control rooms and backup data rooms at alternate locations to ensure quick system and data recovery in the event of a successful cyber intrusion.[10]

Pipeline Operators Use a Variety of Tools

- API Standard 1164: Pipeline SCADA Security
- Department of Energy Electricity and Oil and Natural Gas Subsector Cybersecurity Capabilities and Maturity Models
- Transportation Security Administration Pipeline Security Guidelines
- NIST Guidelines for Smart Grid Cyber Security (NISTIR 7628)
- Department of Homeland Security's Industrial Control System Cyber Emergency Response Team assessments

Natural gas operators partner with academic and research organizations to design and improve cyber-reliance systems, including:

CREDC Cyber Resilient Energy Delivery Consortium

SEEDS Cybersecurity Center for Secure Evolvable Energy Delivery Systems

1. Interstate Natural Gas Association of America, 2018. Pipeline Security.
2. Massachusetts Institute of Technology, 2013. Interdependence of the Electricity Generation System and the Natural Gas System and Implications for Energy Security.
3. Natural Gas Council, 2017. Natural Gas Systems: Reliable & Resilient.
4. American Petroleum Institute, 2017. Diversity of Reliability Attributes: A Key Component of the Modern Grid.
5. Natural Gas Council, 2017. Natural Gas Systems: Reliable & Resilient.
6. American Gas Association, 2014. Natural Gas Pipeline Systems: Delivering Resiliency.
7. Massachusetts Institute of Technology, 2013. Interdependence of the Electricity Generation System and the Natural Gas System and Implications for Energy Security.
8. National Institute of Standards and Technology, 2018. Cybersecurity Framework.
9. DNG-ISAC, 2018 and ONG-ISAC, 2018.
10. Transportation Security Administration, 2018. Pipeline Security Guidelines.

Interstate Natural Gas Association of America, August 2018