American Gas FOUNDATION

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Building a Resilient Energy Future:

How the Gas System Contributes to US Energy System Resilience

Executive Summary

An American Gas Foundation Study Prepared by:

Guidehouse

Background and Methodology

This study was conducted to investigate the resilience of the US gas system and the ways in which the gas system contributes to the overall resilience of the US energy system. This work was directed to ask and answer four key questions:

- What are the characteristics of the US gas system that contribute to its resilience?
- How do those resilience characteristics allow the US gas system to contribute to the overall resilience of the US energy system?
- How can the US gas system be leveraged more effectively to strengthen the US energy system?
- What are the policy and regulatory changes that may help ensure that gas infrastructure can be maintained and developed to continue to support energy system resilience?

These questions were explored through a qualitative assessment conducted by Guidehouse, including discussions and interviews with many energy industry subject matter experts. Case studies and examples of resilience were identified as a part of these discussions. Guidehouse used these studies and examples to develop a framework for considering the resilience of the US gas system and to identify barriers and opportunities related to the gas system's role in supporting the resilience of the US energy system. The findings presented in this work identify issues that merit consideration and further exploration when developing future energy policy and regulation to ensure a resilient, reliable, and clean future energy system in all regions and jurisdictions.

Disclaimers

American Gas Foundation

Founded in 1989, the American Gas Foundation (AGF) is a 501(c)(3) organization focused on being an independent source of information research and programs on energy and environmental issues that affect public policy, with a particular emphasis on natural gas. When it comes to issues that impact public policy on energy, the AGF is committed to making sure the right questions are being asked and answered. With oversight from its board of trustees, the foundation funds independent, critical research that can be used by policy experts, government officials, the media and others to help formulate fact-based energy policies that will serve this country well in the future.

Guidehouse

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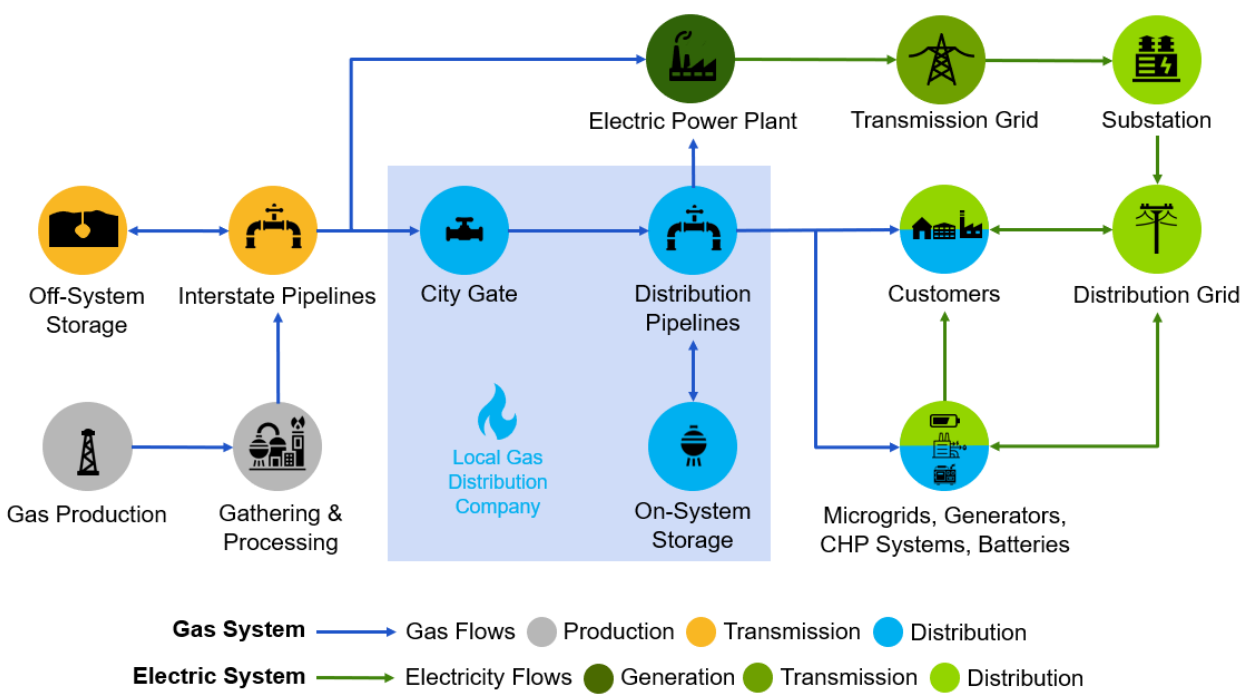
EXECUTIVE SUMMARY

A resilient energy system is essential to the operation of nearly every critical function and sector of the US economy as well as the communities that depend upon its services. Disruptions to the US energy system create widespread economic and social impacts, including losses in productivity, health and safety issues, and—in the most extreme cases—loss of life. As utilities, system operators, regulators, and policymakers deliberate the design and structure of the future energy infrastructure, they must consider the resilience of the entire energy system. As the transformation of the energy system accelerates, it is important for stakeholders to understand the increasing interdependence of gas and electric systems and their role in creating a more resilient future.

A Primer on the Energy System

An energy system is defined as the full range of components related to the production, conversion, delivery, and use of energy. Energy in the US can take many forms; this report focuses on the natural gas system, herein referred to as the gas system, and its interdependencies with the electric system (Figure 1).

Figure 1. Interdependencies Between the Gas and Electric Systems



Source: Guidehouse

What Is Resilience?

Resilience is defined as a system's ability to prevent, withstand, adapt to, and quickly recover from system damage or operational disruption. Resilience is defined in relation to a high-impact, low-likelihood events. The most common examples of these events are extreme weather events (which go beyond standard hot days or snowstorms) of a size and scale to cause significant operational disruption, system damage, and devastating societal impacts. Recent resilience events that affected the US energy system include the 2020 California heat waves, Hurricane Isaias, and the 2019 Polar Vortex.

> *Resilience and reliability are often referenced together, but they reflect critical differences in system design and operation.* ***Resilience*** *is defined as a system's ability to prevent, withstand, adapt to, and quickly recover from a high-impact, low-likelihood event such as a major disruption in a transmission pipeline. In comparison,* ***reliability*** *refers to a systems' ability to maintain energy delivery under standard operating conditions, such as the standard fluctuations in demand and supply.*

The increasing frequency and severity of climatic events amplifies the need to maintain the resilience of the US energy system. System resilience is gained through diversity and redundancy. The resilience of the US energy system is increased through evolving and holistic management of the gas and electric systems, valuing each of their unique characteristics. To ensure resilience, the energy system needs pipeline delivery infrastructure and storage capabilities meeting both short- and long-duration needs.

The nation's gas system is a critical resource for addressing resilience threats to the overall energy system. This report examines how the characteristics of the US natural gas system enable energy reliance today and opportunities to effectively use the gas system to achieve future energy resilience.

Resilience Characteristics of the Gas System

The gas system supports the overall resilience of the energy system through its inherent, physical, and operational capabilities (Figure 2) that enable it to meet the volatile demand profiles resulting from resilience events.

Figure 2. Resilience Characteristics of the Gas System

Inherent Resilience of Gas

A molecular form of energy storage; the natural gas molecule is an abundant energy form with long-duration and seasonal storage capabilities.

- Compressibility
  - Storage
  - Linepack
- Abundance and Diversity of Supply

Physical Resilience of Gas System Assets

Most gas system assets are underground and shielded from major disruptions. In most cases, the system is self-reliant, reducing its exposure to disruption.

- Underground infrastructure
- Looped and Parallel T&D Network
- Self-Reliant Gas-Fired Equipment
- Distributed Customer Generation
- System Storage Capacity

Operational Resilience of the Gas System

Operational flexibility is designed into the gas system within a set of system standards that ensure the system's safety and security.

- Robust Management Practices
- Flexible Delivery
- Demand Side Management
- Large Customer Contract Design

Source: Guidehouse

Resilience in Action

Large, catastrophic failures of the energy system have been few and far between—the energy system has performed well, overcoming periods of high stress that have threatened its resilience. These high stress events are becoming more frequent due to the increase in the frequency and severity of extreme weather events associated with climate change. To successfully build for the future and invest in the right set of resilience solutions, it is important for stakeholders to understand how the energy system has performed under recent resilience events.

Recent climate events have revealed the US energy system's potential vulnerabilities. However, the multitude and diversity of resilience assets that already exist as part of the energy system have made the difference—facilitating energy flows to critical services and customers. As the following case studies illustrate, the resilience assets that are part of the gas system have supported the overall integrity of the energy system during these high stress periods.

2019 Polar Vortex

In 2019, the Midwest experienced record-breaking cold temperatures, which led to increased demand on the energy system to meet heating needs.

- CenterPoint Energy curtailed gas service to interruptible customers and pulled gas from every possible storage resource to maintain service to homes and businesses. In one day, CenterPoint delivered almost 50% more than a standard January day.
- On January 30, 2019, Peoples Gas, North Shore Gas, and Nicor Gas together delivered gas in an amount equivalent to more than 3.5 times

	the amount of energy that ComEd, the electric utility serving an overlapping territory has ever delivered in a single day. • The Consumers Energy's Ray Compressor Station fire on January 30 took a primary storage supply resource offline. Consumers leveraged several gas resilience characteristics (linepack, backup storage, and a highly networked gas system) to ensure that no critical, priority, or residential customer lost service.
2014 Polar Vortex	During early February 2014, a polar vortex brought extreme cold temperatures, snowfall, and high winds to Oregon. On February 6, during the system peak, NW Natural set a company record for natural gas sendouts, which still stands today. Nearly 50% of this peak demand was met by natural gas storage capacity. In combination with diligent planning and dedicated employees, this case study highlights the critical role that natural gas storage plays in meeting demand during extreme weather events.
2020 Hurricane Isaias	On August 4, 2020, Hurricane Isaias made landfall in North Carolina. It caused significant destruction as it moved north, triggering electric outages that affected more than 1 million New Jersey homes and businesses. Many customers experiencing electric outages turned on their natural gas backup generators, resulting in a massive increase in demand for New Jersey Natural Gas (NJNG). In 24 hours, NJNG experienced a 60% increase in daily demand on its gas system—the daily demand for this one day was higher than any other August day for the previous 10 years. Because of the built-in storage capacity (compressibility and on-system storage) and flexibility of the gas system, NJNG was able to ramp up service to customers with disrupted electricity supply.
2020 Heat, Drought, and Wildfires	In August 2020, California was in the middle of its hottest August on record,[1] a severe drought, and its worst wildfire season in modern history. Concurrent to increased demand on the electric system driven by increased cooling loads, California also experienced a decrease in renewable output (due to smoke from the fires)[2] and lower imports than had been anticipated by electric supply planners. To meet increased electric demand, system operators turned to gas-fired generation facilities. During the week of August 11, all of SoCalGas' system storage assets were employed to fill the gap between abnormally high electric demand and low renewable energy generation experienced in Southern California.

In all of these case studies, the gas system provided significant support to the energy system in maintaining resilience and ensuring that energy service was maintained to customers. To understand the gas system's contribution to resilience, it is important to differentiate between the pipeline infrastructure system and the natural gas molecules that flow through it. The gas pipeline system is defined as a series of physical assets that transport energy molecules from the source of production to end users, including residential, commercial, and industrial customers who use gas in their buildings and processes, and electric generators who use gas to

[1] NOAA. *National Climate Report*. August 2020.

[2] EIA. *Smoke from California Wildfires Decreases Solar Generation in CAISO.* September 30, 2020.

make electricity. Today, the gas system is used to transport mostly geologic natural gas, but it can be leveraged to transport low-carbon gases such as renewable natural gas (RNG) and potentially hydrogen in the future as utilities move to decarbonize the energy system.

The Growing Resilience Challenge

Driven by changes in the cost and availability of new technologies and increasing political and social pressure to decarbonize, our energy system is undergoing a transformation. This transformation exposes an issue of energy system resilience related to the interaction of the gas and electric systems.

> *As the percentage of electricity generation from intermittent renewable sources increases, the volume of natural gas used for electric power generation may decline; however, in responding to resilience events the necessity of the services provided by gas-fired electric generators may increase. As current compensation models for the gas system serving the power generation sector are tied to the volume of gas delivered to the facility, there becomes an increasing disconnect between the value of the services provided and associated remuneration for said services.*

To further highlight the need for energy system resilience as part of the current transformation, it is worth considering a recent review of the root cause of the California Independent System Operator (CAISO) electric outages during the August 2020 heatwave. One of the three factors identified was: "In transitioning to a reliable, clean and affordable resource mix, resource planning targets have not kept pace to lead to sufficient resources that can be relied upon to meet [electric] demand in the early evening hours. This makes balancing demand and supply more challenging. These challenges were amplified by the extreme heat storm."[3]

The current model for maintaining the resilience of our energy system was built to support a legacy view of how the energy system operates. As an example, natural gas infrastructure replacement and modernization programs were designed to enhance reliability and safety. As noted in this report they have also contributed to resilience. As the transition to the future energy system accelerates, it is important to understand how these programs complement future energy state resilience needs. The manner in which this energy system is regulated and managed is becoming outdated, and an update is necessary to maintain resilience of the evolving future energy system.

Ensuring a Resilient Future Energy System

The increasing frequency and intensity of climatic events combined with the transformation of the energy system to one increasingly powered by intermittent renewable sources establish the need for a new consideration of the resilience of the energy system. Utilities, system operators, regulators, and policymakers need to recognize that resilience will be achieved through a diverse set of integrated assets—for the foreseeable future, policies need to focus on optimizing the characteristics of both the gas and electric systems.

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[3] CAISO. *Preliminary Root Cause Analysis: Mid-August 2020 Heat Storm*. 2020.

Achieving this is easier said than done. It will require a realignment of the valuation and cost recovery mechanisms that currently define the development of the US energy system:

- Energy system resilience must be defined as a measurable and observable set of metrics, similar to how reliability is considered.
- Resilience solutions must be developed considering all possible energy options and across utility jurisdictions, requiring electric, gas, and dual-fuel utilities to work together to determine optimal solutions.
- Methodologies need to be built to value resilience, such that it can be integrated into a standard cost-benefit analysis. Value should consider the avoided direct and indirect costs to the service provider, customers, and society.

The resilience of the current energy system is largely dependent on the gas system's ability to quickly respond to events and use its extensive long-duration storage resources to meet peak and seasonal demand. Ensuring future energy system resilience will require a careful assessment and recognition of the contributions provided by the gas system. Utilities, system operators, regulators, and policymakers need new frameworks to consider resilience impacts to ensure that resilience is not overlooked or jeopardized in the pursuit to achieve decarbonization goals.