Enhancing and Maintaining Gas and Energy System Resiliency:

Areas of Focus and Change

An American Gas Foundation Study
prepared by Guidehouse

American Gas FOUNDATION

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Informing Energy and Environmental Public Policy

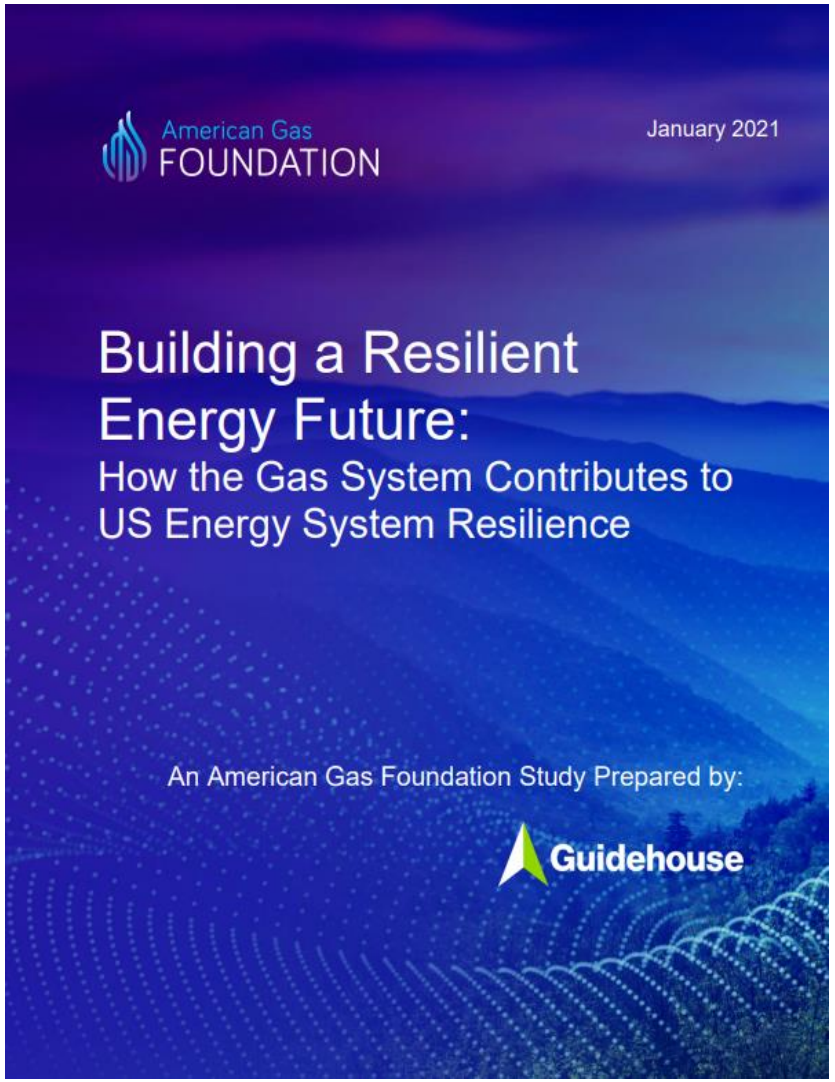
AGF funds independent, critical research that can be used by policy experts, government officials, the media and others to help formulate fact-based energy policies that will serve this country well in the future

Key Findings from 2021 AGF Study

Natural gas infrastructure is critical to supporting gas-powered electric generation systems – this is central to ensuring the resiliency of the overall energy system.

Natural gas pipelines and storage infrastructure are critical in supporting energy grid resilience by reliably delivering natural gas, even during short and long-term duration needs (e.g., including extreme weather).

Natural gas and other low-carbon fuels will remain a core element of the US energy system for decades to come and natural gas electric generation is critical to scaling the integration of renewables.



Resilience vs. Reliability

Resilience

The set of energy system abilities that allow it to prevent, withstand, adapt to, and quickly recover from system damage and/or operational disruption.

Reliability

The ability of the energy system to deliver services in the quantity and with the quality demanded by end-users.

Event

A major operation disruption occurs along a transmission pipeline, interrupting regional natural gas supply.

Power system demand starts peaking at 5:00 pm, just as variable solar generation starts ramping down for the evening.

Response

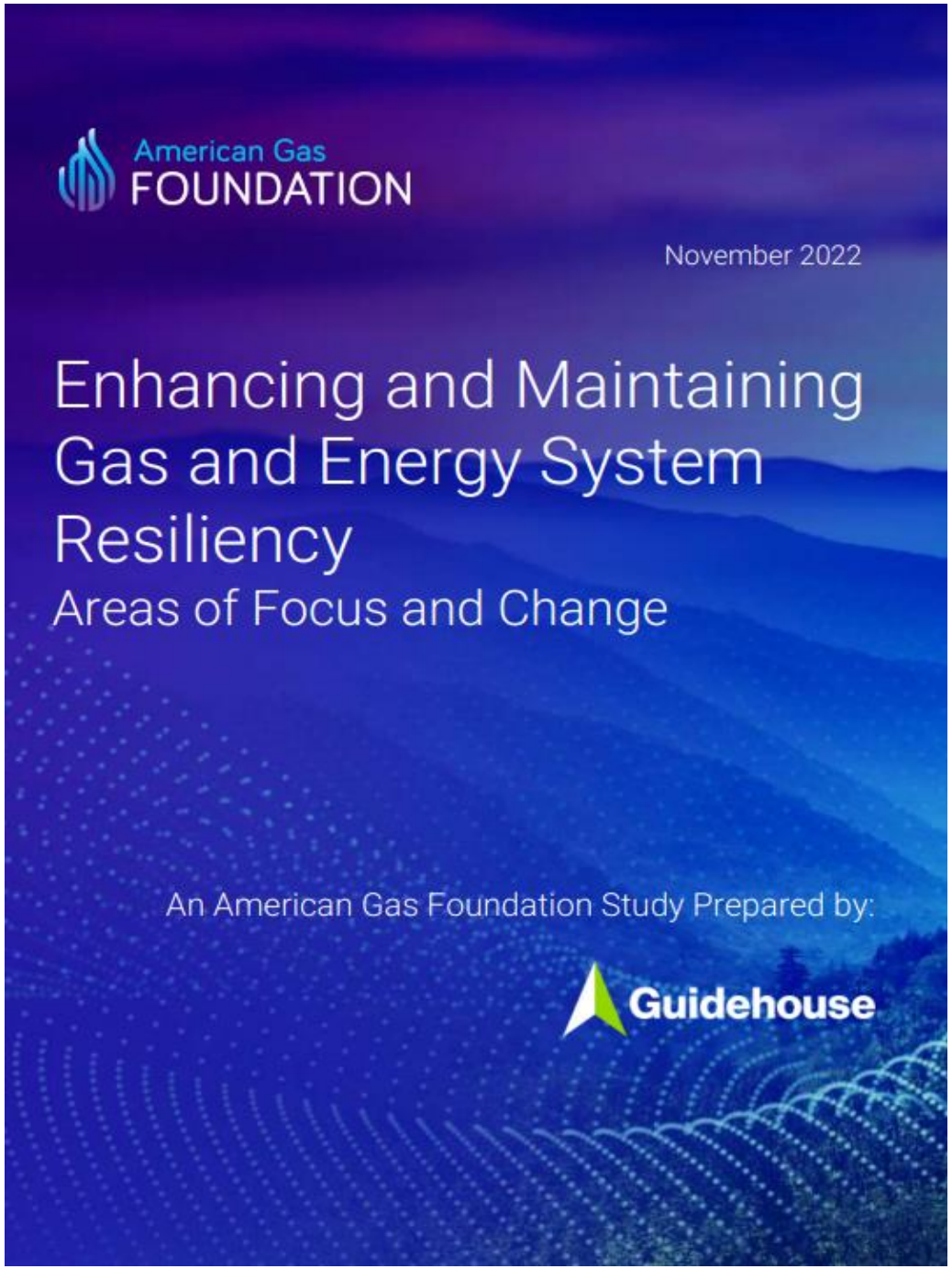
Gas from storage assets are quickly diverted and dispatch calls in demand response.

Natural gas-fired plants ramp up to meet the spike in system demand.

Outcome

Deliveries are maintained to customers during system repairs.

Customers maintain reliable service during daily supply and demand fluctuations.



AGENDA

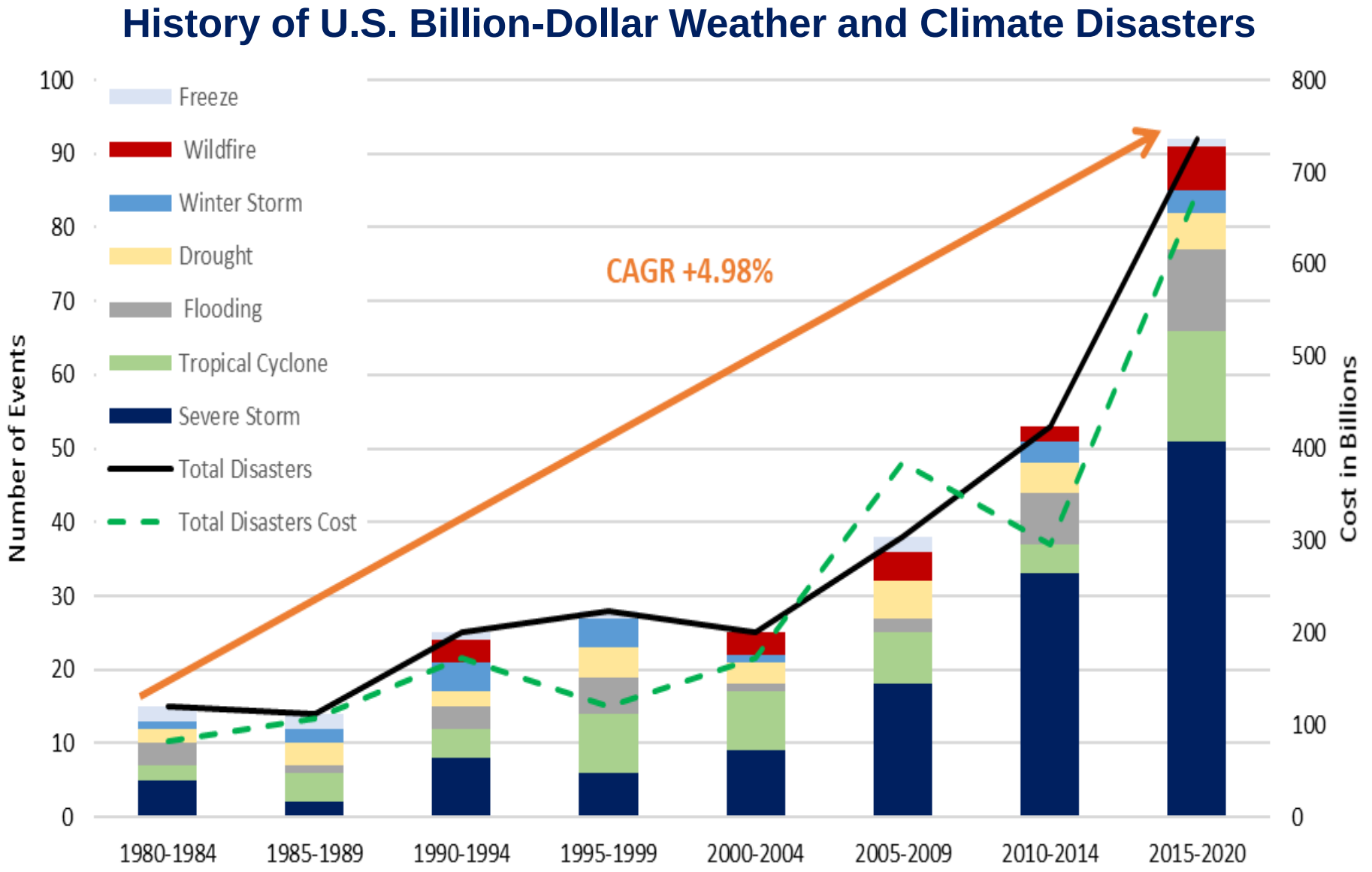
- Report Approach and Overview
- Research Insights
- Recommendations

Approach and Overview

Questions Asked and Answered

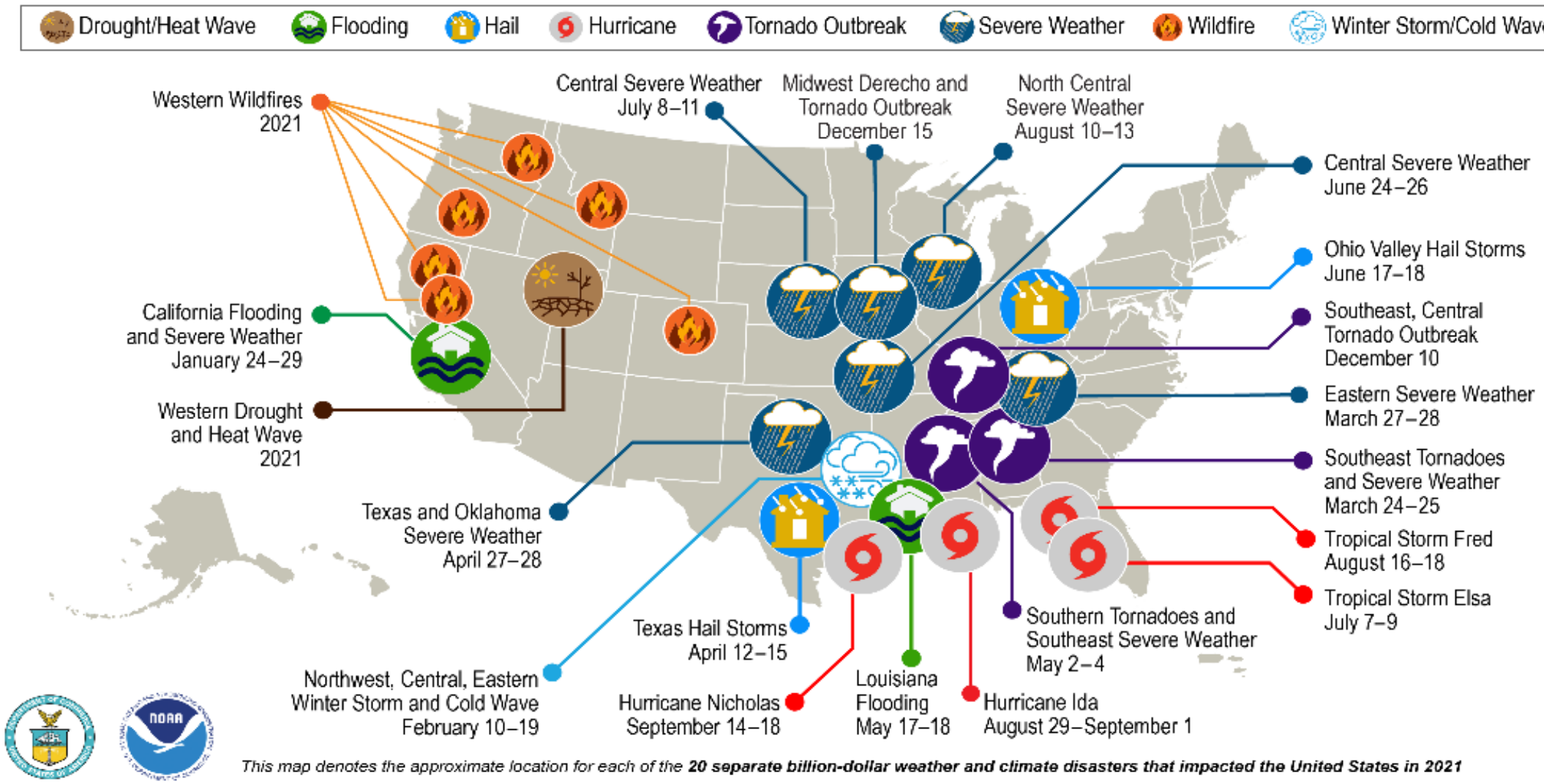
- **How does resiliency in the gas system enhance energy system resiliency?**
- **What characteristics of the current regulatory framework enable or disable gas resilience?**
- **How can resilience be measured and valued to better qualify gas infrastructure investments?**
- **What recommended changes are needed to enable gas and energy system resilience?**

Research Insights – Growth of Extreme Weather Events



Research Insights – Extreme Weather Events Continued in 2021

U.S. Year 2021 Billion-Dollar Weather and Climate Disasters

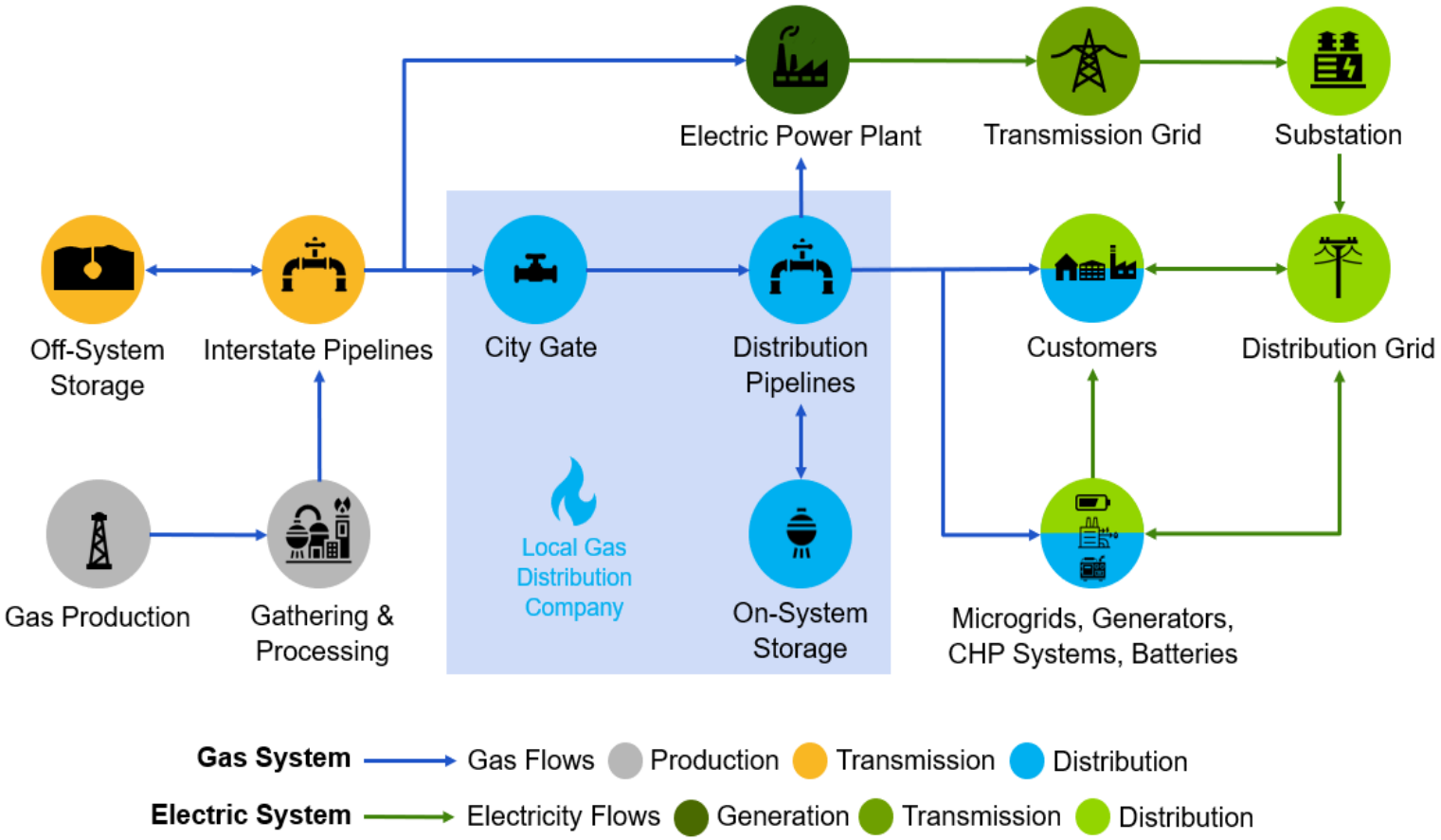


*This map denotes the approximate location for each of the **20 separate billion-dollar weather and climate disasters that impacted the United States in 2021***

Research Insights – Interdependencies Across the US Energy System

Lack of coordination between the electric and gas systems creates issues in ensuring the resiliency and operation of critical natural gas infrastructure.

Gas System is Critical to Overall Energy System Resilience - Gas and Electric System Interdependencies

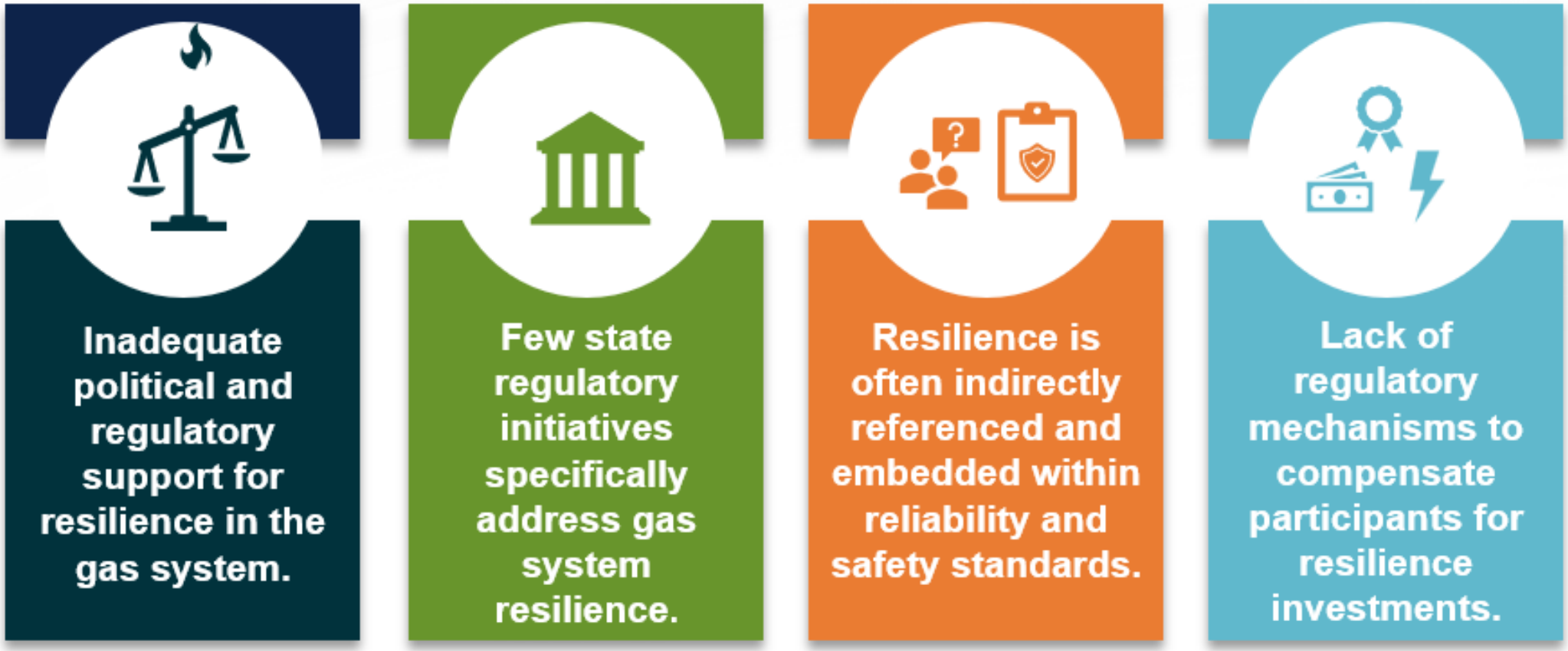


- Resilience of the overall energy system rests upon gas system resilience since **natural gas accounts for one-third of primary energy consumption** across all principal sectors of the economy and is the primary fuel for the generation of electric power in the US.

- **Natural gas interstate and local distribution are inherently more resilient than electric transmission and distribution systems** since underground pipelines are insulated from extreme weather events.

Research Insights – Identified Obstacles

Regulatory constraints exist in the gas system - many times gas utilities are not appropriately compensated for resiliency investments.



Recommendations – Measure Resilience

North American Electric Reliability Corporation (NERC) reliability standards can be used as starting point to establish improved natural gas resiliency.

	Resilience Phase			
NERC Electric Reliability Standards	Prepare	Withstand	Recover	Adapt
(BAL) Resource and Demand Balancing (43)	x	x	x	
(CIP) Critical Infrastructure Protection (95)	x		x	
(COM) Communications (12)	x			
(EOP) Emergency Preparedness and Operations (36)	x	x	x	
(FAC) Facilities Design, Connections, and Maintenance (38)	x			
(INT) Interchange Scheduling and Coordination (35)	x			
(IRO) Interconnection Reliability Operations and Coordination (61)	x	x	x	x
(MOD) Modeling, Data, and Analysis (55)	x			x
(NUC) Nuclear (6)	-			
(PER) Personnel Performance, Training, and Qualifications (13)	x			
(PRC) Protection and Control (99)	x	x	x	x
(TOP) Transmission Operations (44)	x	x		
(TPL) Transmission Planning (35)	x			
(VAR) Voltage and Reactive (26)	x	x	x	

- **These standards outline specific requirements for operators to ensure reliable energy delivery and are presented for potential applicability for natural gas.**
- **NERC standards were developed with a focus on reliability without a strong emphasis on resiliency.**

Recommendations – Policy Support is Needed

Federal and state energy policies and regulatory mechanisms to increase resilience are required to support resilience investments across the energy system.

Principles for Implementing Resilience

Public Support

- Public acceptance of resilience investment costs
- State and Federal political support

Regulatory Support

- Regulations and frameworks emphasizing reliability and resilience
- Collaborative actions across the natural gas and electric industries

Financial Support

- Cost recovery mechanisms for LDCs to recover resiliency investments

Actions to Implement Resilience

- ✓ Federal and state legislative approval of resilience measures
- ✓ Resilience regulatory requirements are written into state and federal frameworks
- ✓ Federal and state funding support for energy system resilience investments
- ✓ Energy system management across the natural gas and electric networks

Recommendations – Enable Resilience Investments

Integrated solutions are required for resilient gas service to LDC customers – the primary driver of enhanced energy system resilience is enabling gas system resilience investments.

Upstream of the City Gate Investments

- **Ensure preparation for extreme weather** - Increase investments in the weatherization of well-heads, gathering, and processing systems, gas transmission networks, and storage facilities
- **Continue replacing aging pipelines and interconnections** with long lived assets that support broader energy system resilience
- **Design systems to accommodate low-carbon fuels** for future operations to provide resilience benefits and support decarbonization goals

Downstream of the City Gate Investments

- **Increase investments** in pipeline and storage infrastructure weatherization
- **Expand upstream pipeline interconnections**
- **Develop additional distributional storage facilities** to enhance the resilience of the overall pipeline distribution system
- **Expand integration of alternatives fuels** (e.g., H2 and RNG) or locally produced LNG
- **Continue to modernize infrastructure** to lower emissions and enhance safety, reliability, resiliency, and affordability

Conclusion and Key Takeaways

1. **The frequency and intensity of extreme wather events have created direct and indirect costs** due to disruptions in electric and gas supply and vulnerabilities of energy infrastructure.

2. **Lack of integrated operational coordination and regulation** between natural gas operations (i.e., pipelines, storage infrastructure) and electric operations (i.e., ISOs and electric utilities) – this exposes the entire energy system to increased risk.

3. **Need to increase momentum for regulators to address energy system failures -** stakeholders and the public need to better understand the role **pipeline and storage infrastructure** needs to play in the future energy system.

4. **Recommended resilience investments** include replacing aging infrastructure, increasing weatherization standards, building additional storage facilities, and developing systems to integrate low-carbon fuels

5. **Public, regulatory and financial support** are the foundational principles to implement resilience.

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