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Sandia National Laboratories

Impacts of Increased Reliance on Natural Gas

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Sandia National Laboratories

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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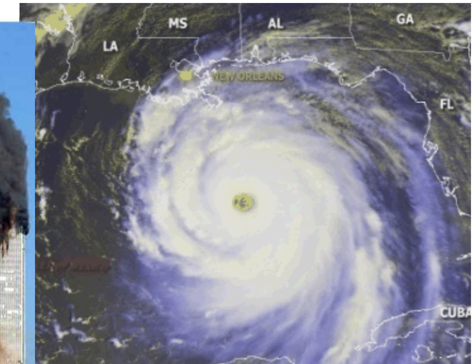
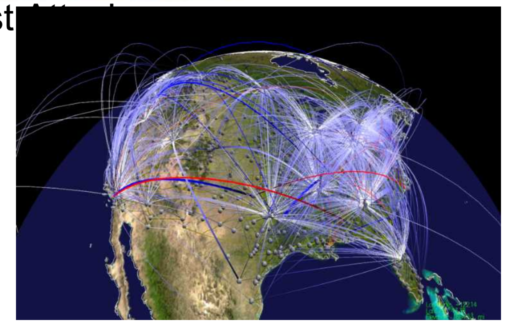
National Infrastructure Simulation and Analysis Center: Infrastructure Modeling and Analysis

- Improve the understanding, preparation, and mitigation of the consequences of infrastructure disruption
- Provide a common, comprehensive view of U.S. infrastructure and its response to disruptions
  - Scale & resolution appropriate to the issues
  - All threats
- Build an operations-tested DHS capability to respond quickly to urgent infrastructure protection issues
  - Rapid analysis and collaboration
  - 24/7 when needed

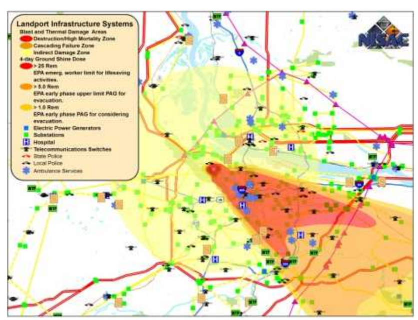
Terrorist



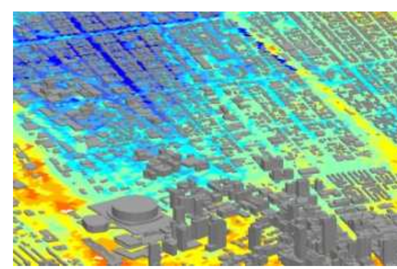
Hurricanes



Supply Chain Analysis



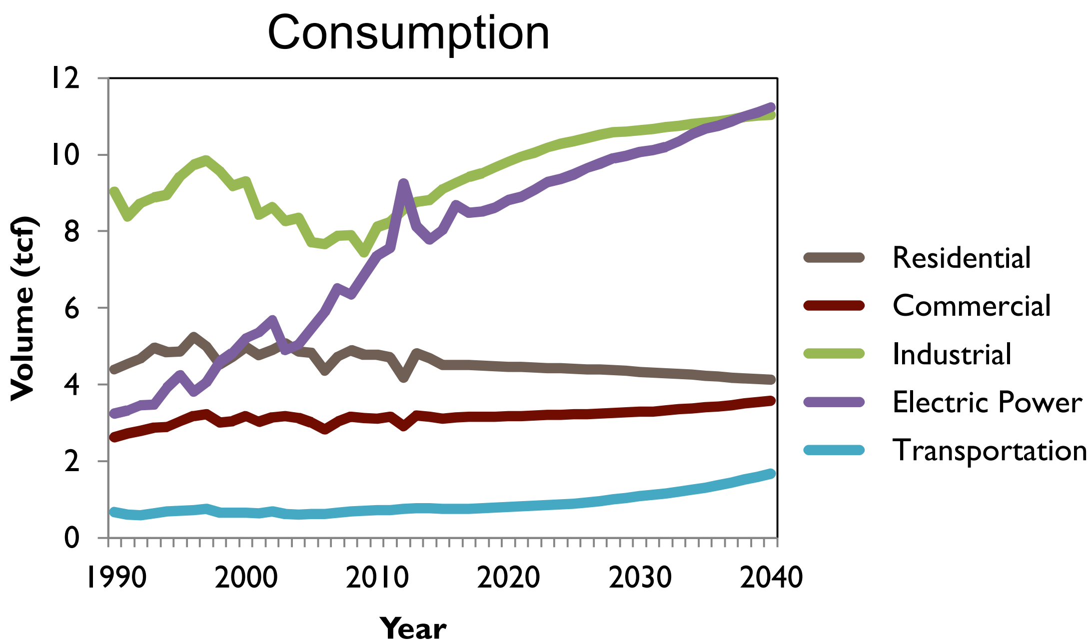
Population Impacts



Flooding

Wildfires

Motivation



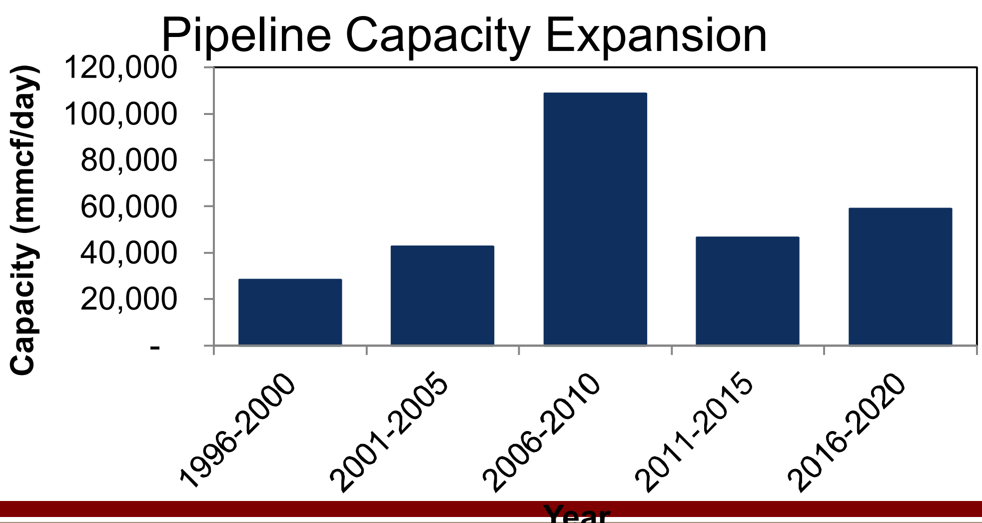
Projected Use of Natural Gas to increase over the next 25 years

- Industrial
- Electric Power

Historic Winters

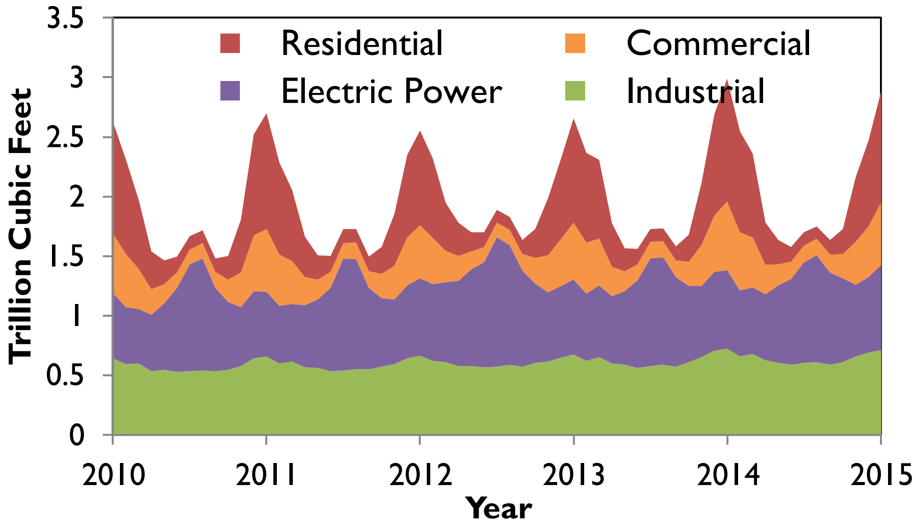
- Midwest
- Northeast

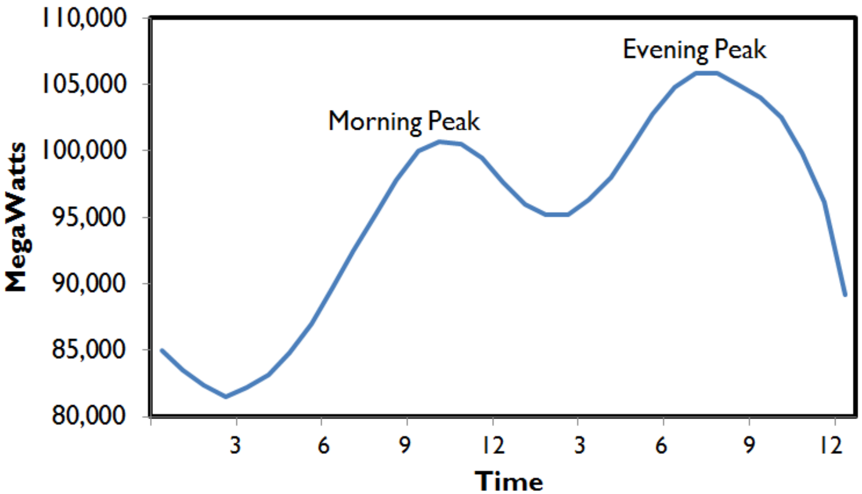
Modest & Unknown Pipelines Expansion



Can natural gas infrastructure reliably link supply and demand?

Seasonal & Daily Variability





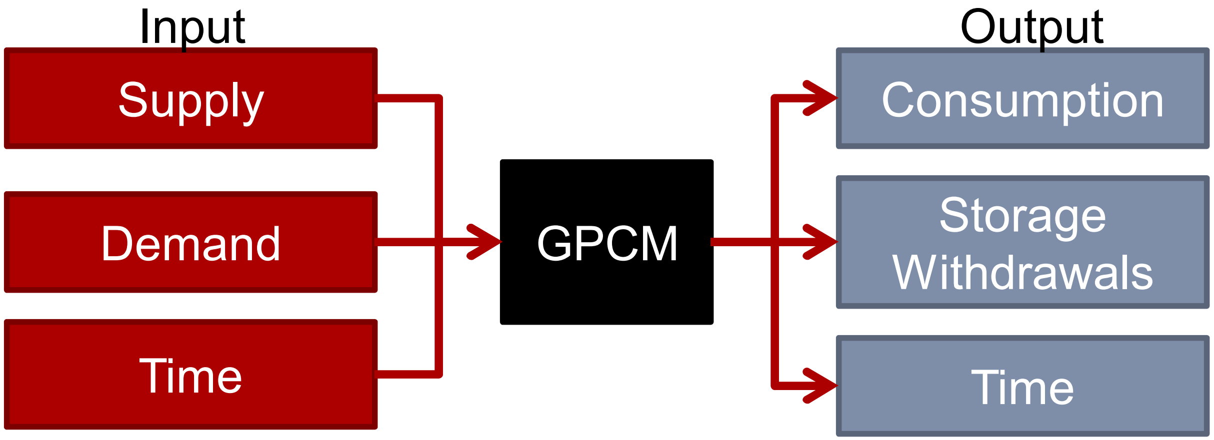
Firm (uninterruptible): Residential & Commercial, finance pipeline construction
Interruptible: Industrial & Electric Power, cheaper

Natural gas infrastructure must meet peak demand; both seasonally and daily
Pipelines designed to meet peak firm contract capacity; remainder sold on ’spot’ market

Modeling Approach

GPCM (Gas Pipeline Competition Model)*

- 89 supply areas
- 5 supply types (shale, coal bed methane, conventional, synthetic natural gas, LNG)
- 12 shale plays
- 24 LNG terminals (import and export)
- 210 pipelines (expansions through 2018)
- 443 storage areas
- 110 demand areas
- 5 demand sectors (residential, commercial, industrial, electric power, and vehicle)



* RBAC Inc.

Modeling Approach

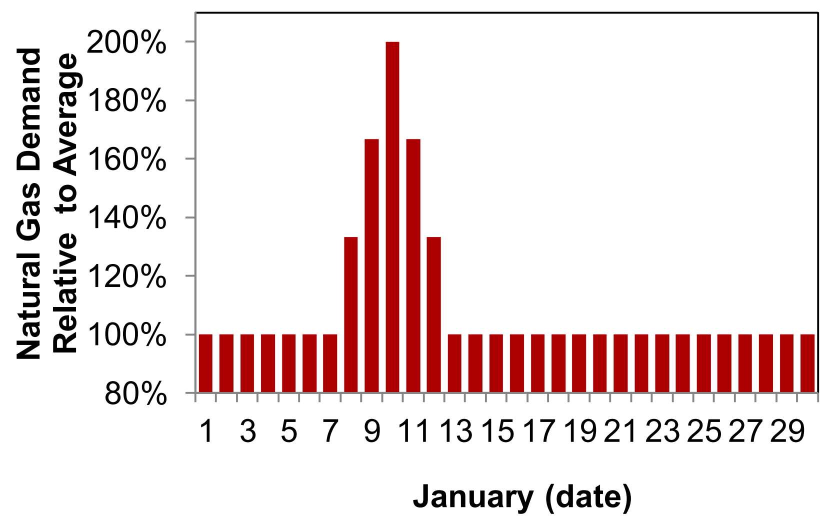
Monthly Model
Winter (December – February)
- 2015, 2025 & 2035

1. Normal (baseline)
2. High-Demand
3. High-Demand + Disruption (low supply)

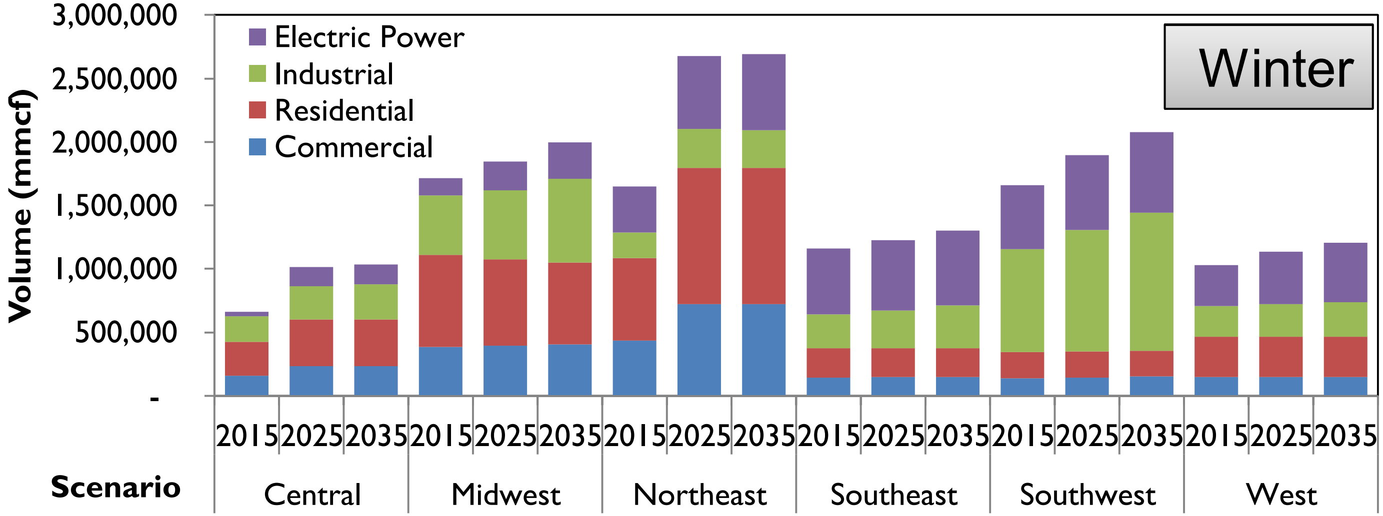
Daily Model
January 2026
1. Normal (baseline)
2. High-Demand
3. High-Demand + Disruption (low supply)

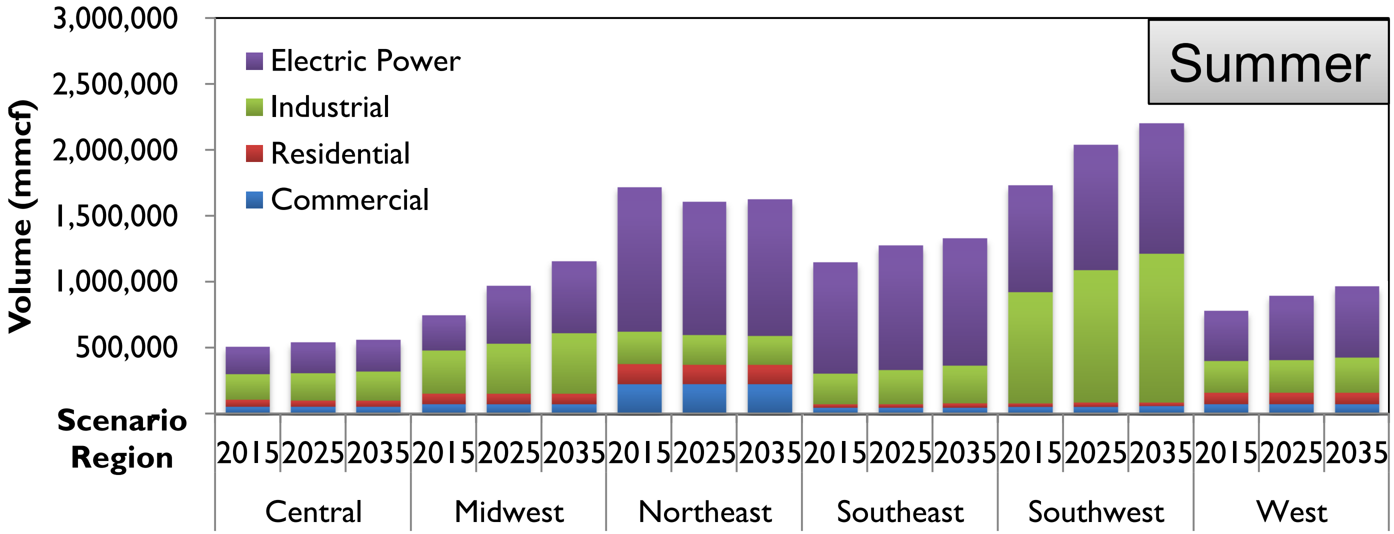
High-Demand: Highest demand, per month, per sector, from: December 2011–December 2016

Disruption: No production from Mid-Continent Basin Group during January.



Winter vs. Summer





Winter vs. Summer
Residential
Commercial
Industrial
Electric Power

Southwest & Southeast are similar for winter and summer

Mid-Continent Basin Group

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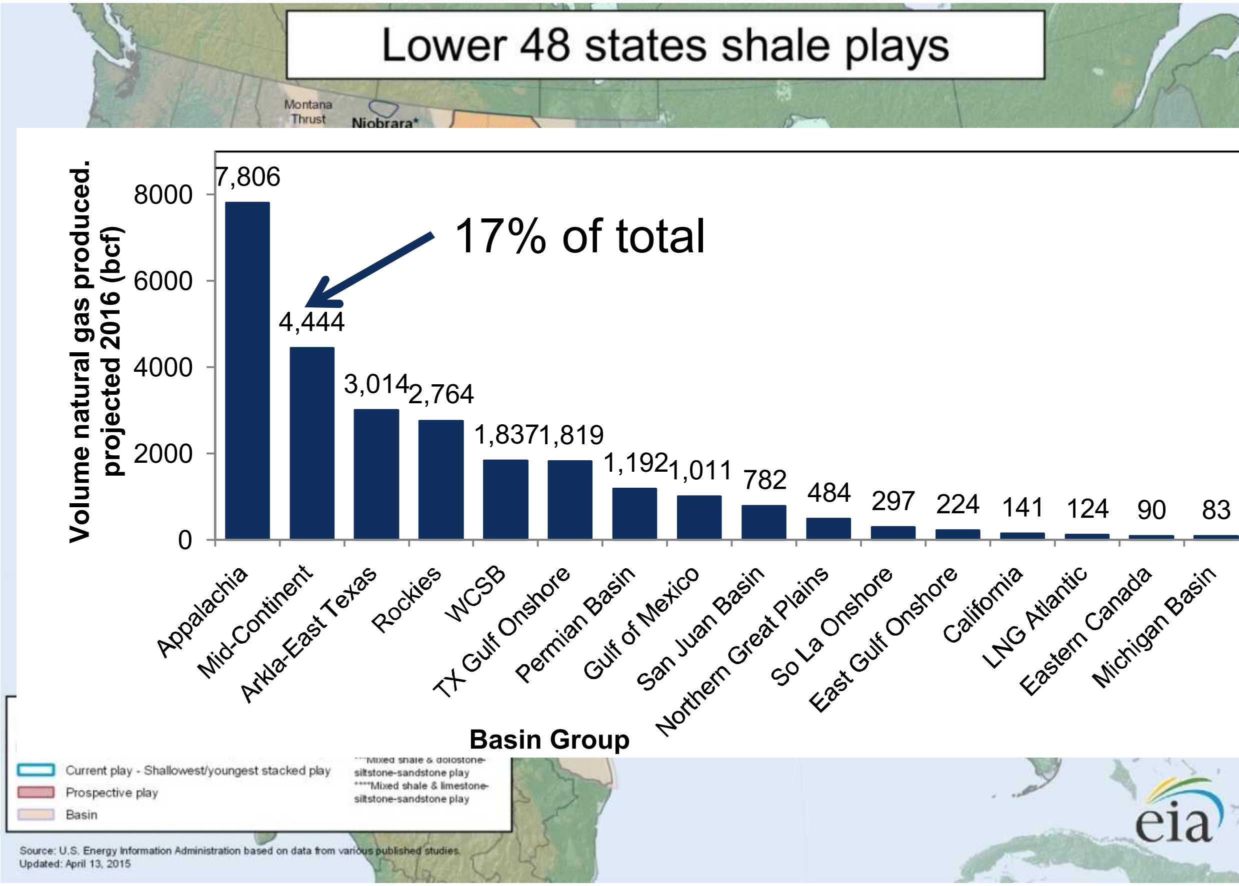
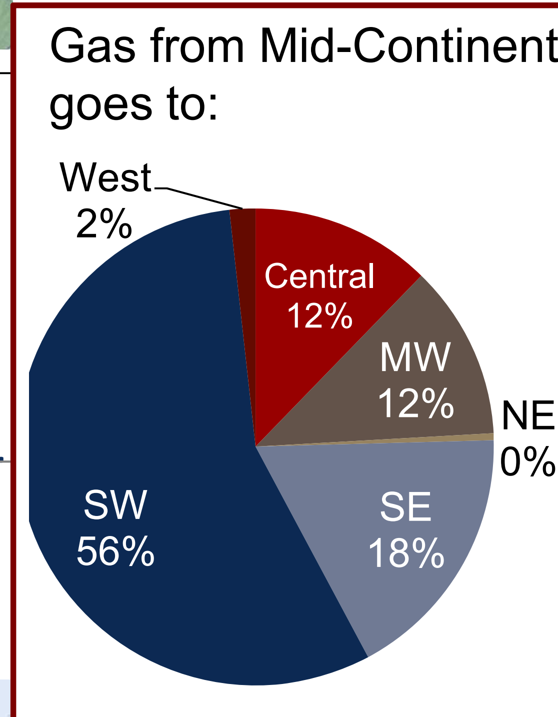
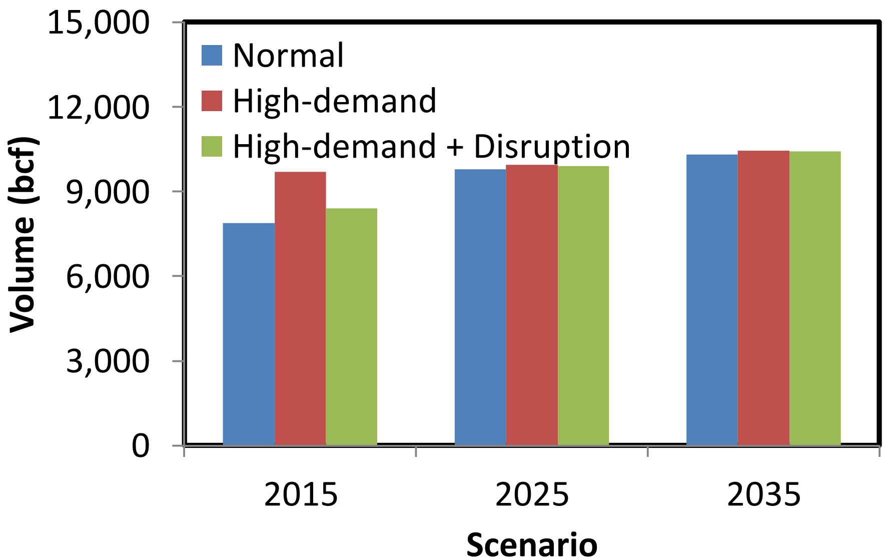


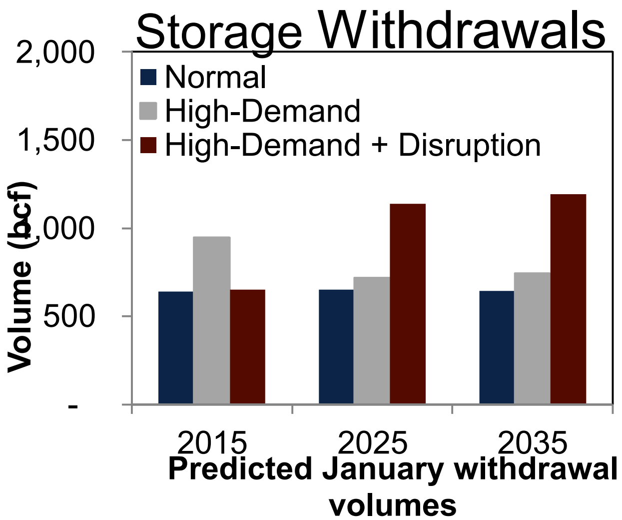


Mid-Continent Basin Group made of: Fayetteville, Woodford, and Cana Woodford shale plays

Results: National & Monthly

Pipeline capacity additions mitigate disruption





Storage mitigates

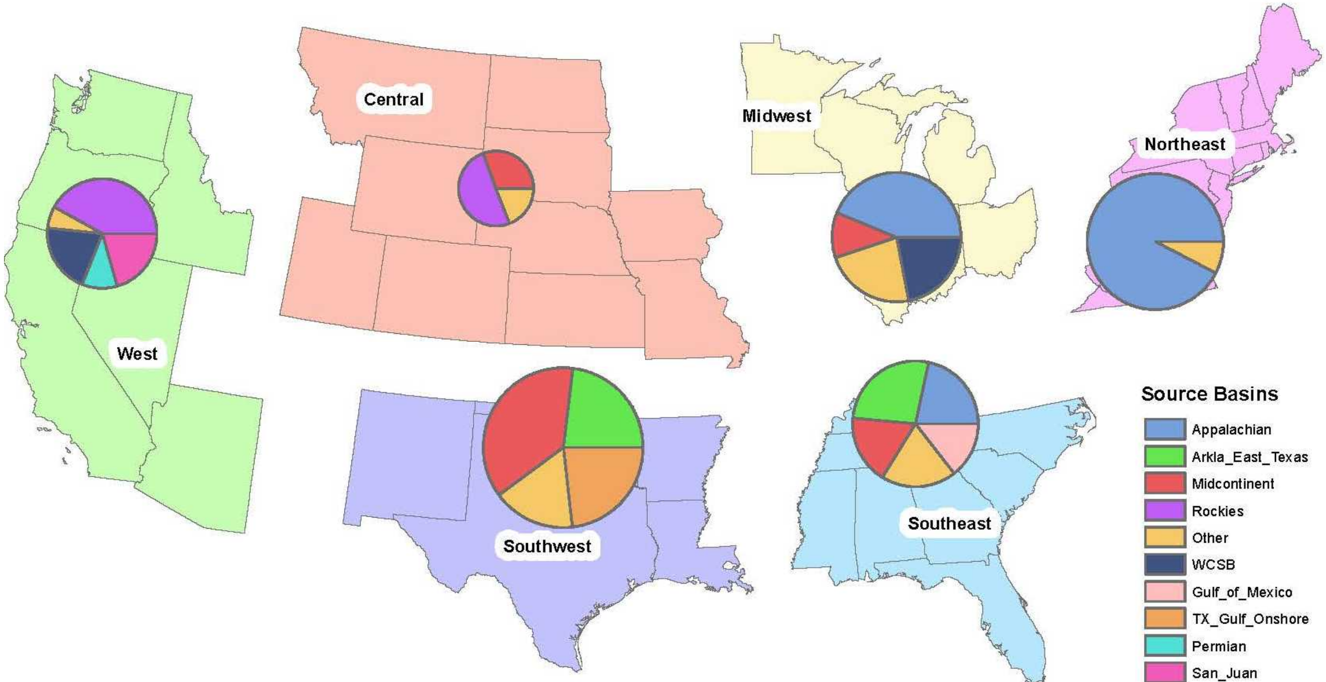
Winter demand exceeds supply

Pipeline Utilization

	Pipeline Zones			Pipeline Nodes		
	Normal	High-Demand	High-Demand + Disruption	Normal	High-Demand	High-Demand + Disruption
January 2016	51	88	75	45	48	37
January 2026	92	88	94	63	65	64
January 2036	116	108	111	62	64	64

Results: Regional & Monthly

4 of 6 regions receive >75% of gas from 3 or less production basins



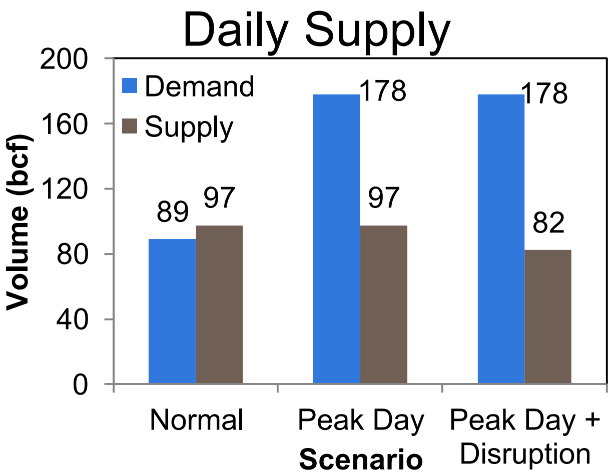
Regional Consumption of Gas from Production Basins

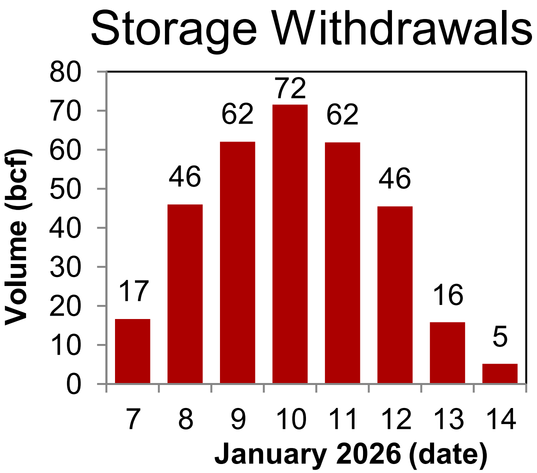
January 2026 Storage Withdrawals

Region	Normal (mmcf)	High-Demand + Disruption (mmcf)	Percent Increase
Central	67,167	155,205	131%
Midwest	209,660	331,094	58%
Northeast	133,951	139,346	4%
Southeast	49,296	107,168	117%
Southwest	136,615	328,165	140%
West	54,357	76,420	41%
Total	651,046	1,137,398	75%

Future demands on storage will increase during high-demand and/or decreased supply

Results: National & Daily

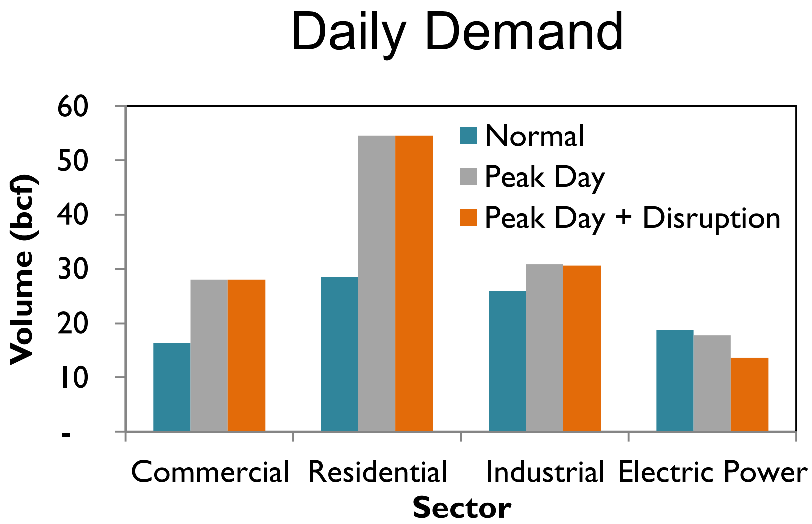




Normal Conditions:
Supply ~ Demand

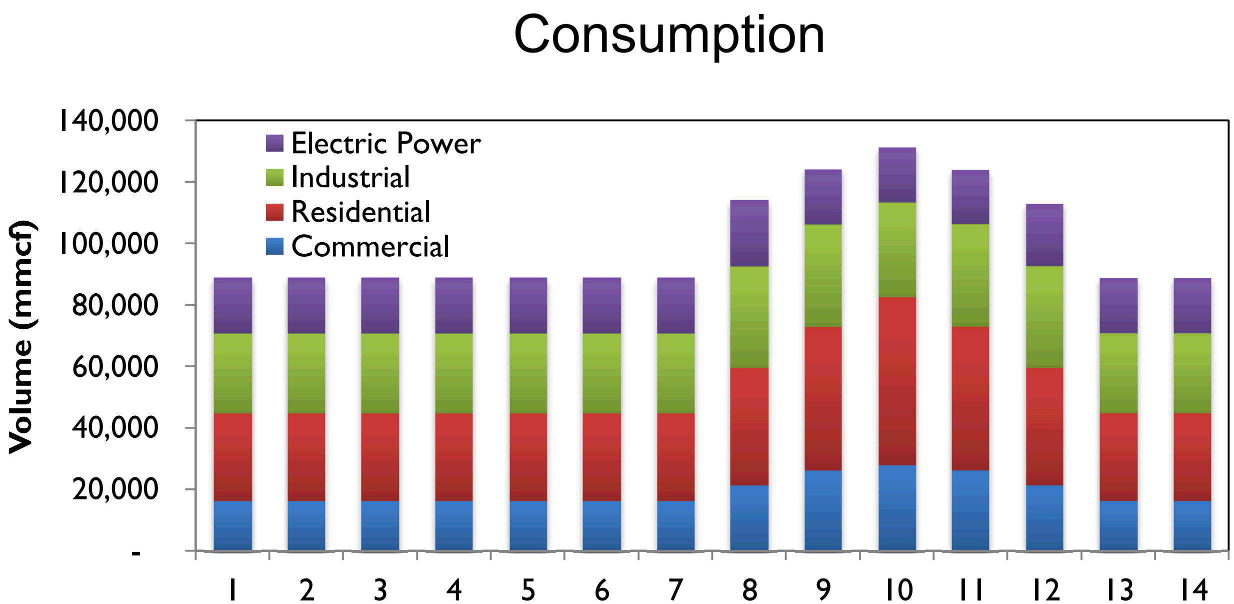
Peak Day:
Demand >> Supply

Storage mitigates difference



Demand decreases for Electric Power (25%) and Industrial (1%)
Residential and Commercial (firm) contracts are met

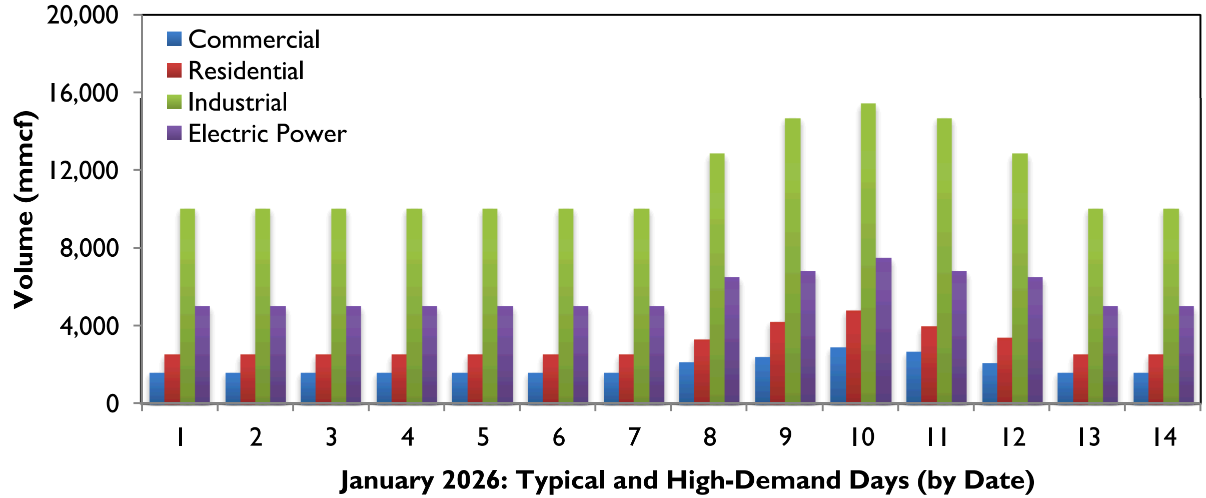
Results: National & Daily



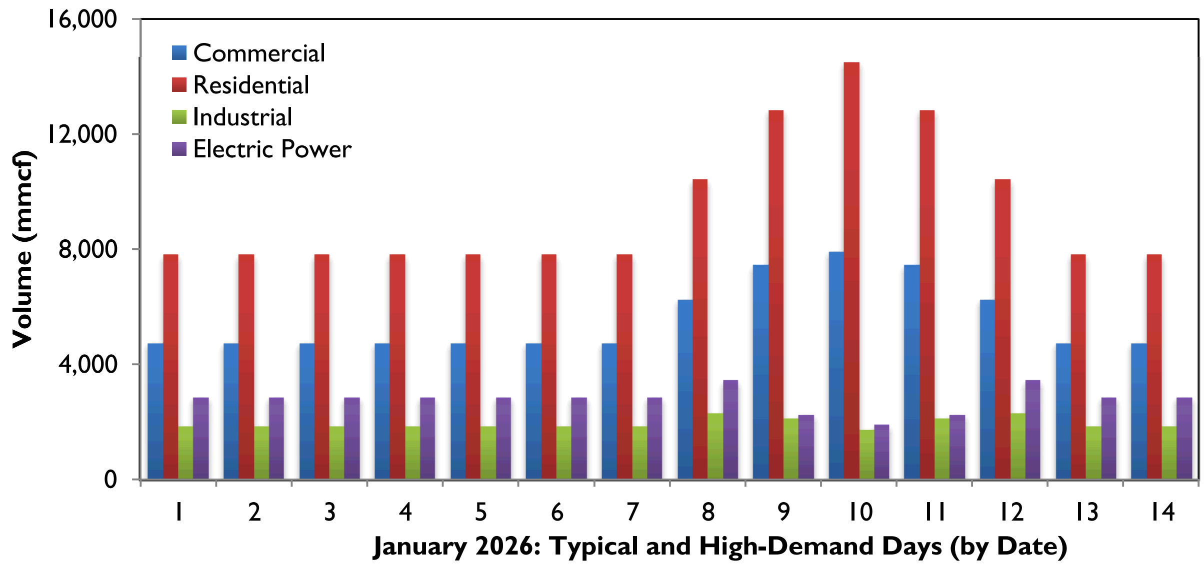
- Residential and Commercial use increase
- Electric Power and Industrial use constant

Results: Regional & Daily

Southwest
- Dominated by industrial use
- Able to meet firm and most interruptible contracts



Northeast
- Dominated by residential use
- Able to meet firm but not most interruptible contracts



Conclusion

Summer utilization of natural gas will increase but will not created impacts on availability of natural gas in winter months

The natural gas system is able to satisfy demand under normal conditions for the next two decades for residential and commercial use.

During periods of natural gas systems stress, the execution of interruptible contracts will increase

Daily modeling results show that the Northeast, with limited amounts of electric power and industrial demand for natural gas, is susceptible to disruptions

The Southwest is able to meet firm contracts fully and to meet a significant portion of interruptible contracts even during periods of high-demand and disrupted supply.