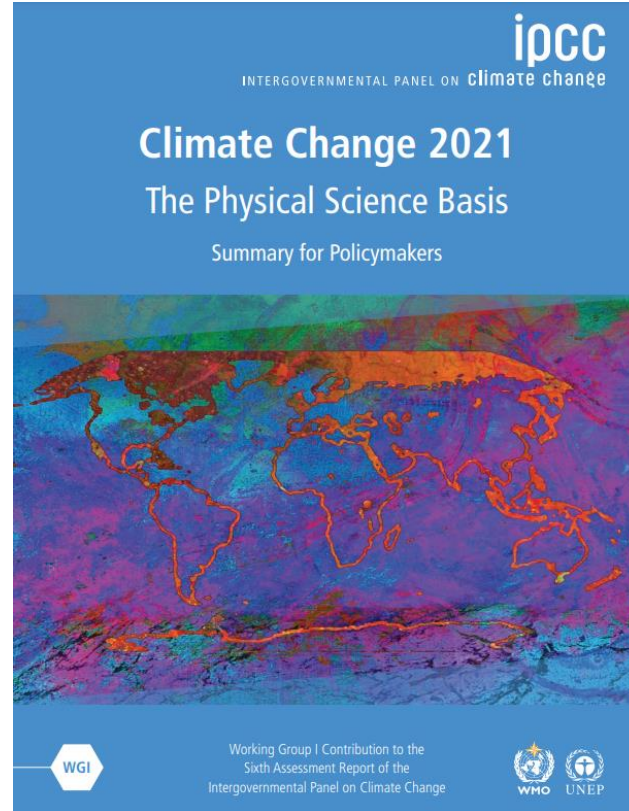


**NET-ZERO
EMISSIONS
OPPORTUNITIES
FOR GAS UTILITIES**

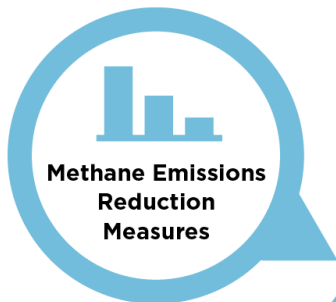
Climate Change is a Defining Challenge

Addressing climate change will require fundamental changes in energy use and reducing greenhouse gas emissions throughout the economy.



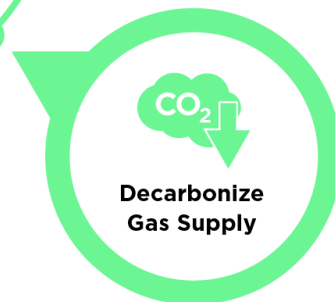
There are many gas utility solutions to reducing emissions

- Differentiated Gas
- Leak Detection and Repair Programs
- More Accurate Emissions Measurement
- Replacement of Higher Emitting Pipe and Equipment
- Operational and Maintenance Measures



- Expansion of Gas Energy Efficiency Programs
- Building Envelope Improvements
- Emerging Highly Efficient Gas Technologies

- Carbon Capture and Sequestration
- Direct Air Capture
- Greenhouse Gas Emissions Offsets



- Renewable Natural Gas
- Hydrogen Blending
- Methanated Hydrogen
- Dedicated Hydrogen Infrastructure

Net-Zero Emissions Opportunities for Gas Utilities

An American Gas Association Study
prepared by ICF



Project Objectives and Approach

- Evaluates the wide array of opportunities for gas utilities to achieve net-zero greenhouse gas emissions goals
- Provides in-depth assessment of illustrative pathways to achieve net-zero greenhouse gas emissions for gas utility customers by 2050
- Identify policy and regulatory actions to accelerate net-zero ambitions through gas infrastructure and technologies

Summary

The study finds that gas utilities and infrastructure:

- Play crucial and enduring roles in pathways to net-zero
- Can meet net-zero GHG emissions targets
- Ability to store and transport large amounts of energy to meet seasonal and peak energy use are valuable resources
- Can increase the likelihood of successfully reaching net-zero targets while minimizing customer impacts



**Decarbonization
planning and
implementation
must support
five key tenets**

Safety

Affordability

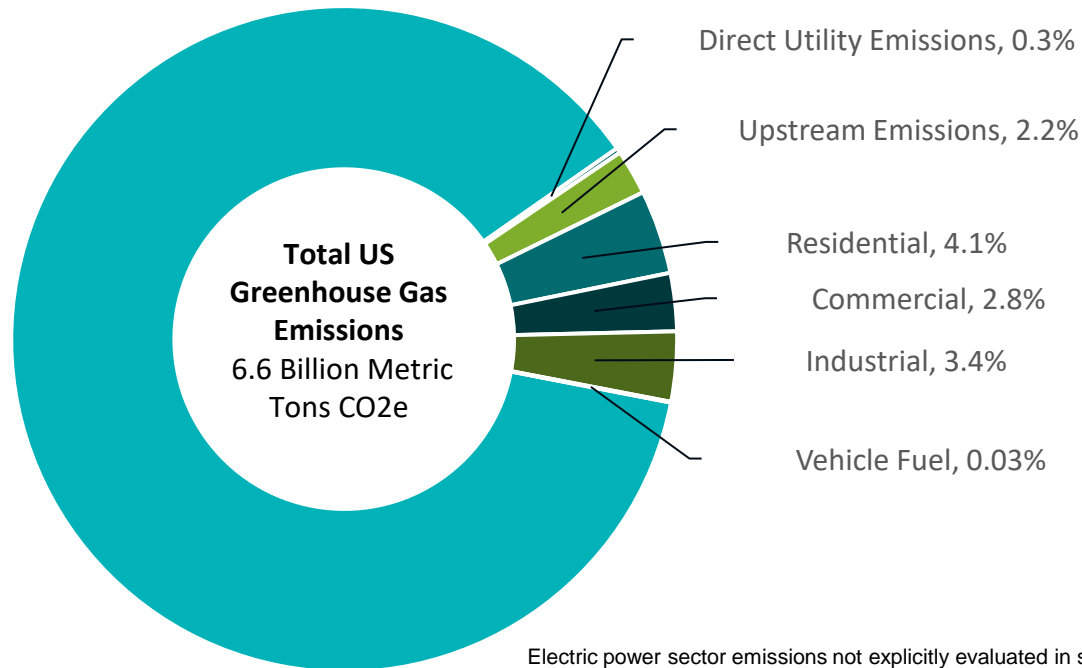
Reliability

Resilience

Feasibility

Gas Utility Associated GHG Emissions: 13% of total U.S. GHGs.

Gas Utility Associated GHG Emissions by Category 2019



Electric power sector emissions not explicitly evaluated in study
Source: EPA, EIA

Gas Customer Decarbonization Pathways

Each illustrative pathway reaches net-zero emissions for gas utility customers by 2050

Gas Energy Efficiency Focus

Significant demand reductions from gas heat pumps, utility efficiency programs, and building shell retrofits.

Hybrid Gas-Electric Heating Focus

Coordinated gas and electric infrastructure planning and optimization through use of hybrid gas-electric integrated heating systems.

Mixed Technology Approach

“All of the above” scenario with fuel-neutral policy where customers choose from a range of applications.

Renewable and Low-Carbon Gas Focus

Prioritizes the decarbonization of the energy supply and limit impacts on customers to make major changes in energy equipment and infrastructure.

Assumptions and Other Considerations

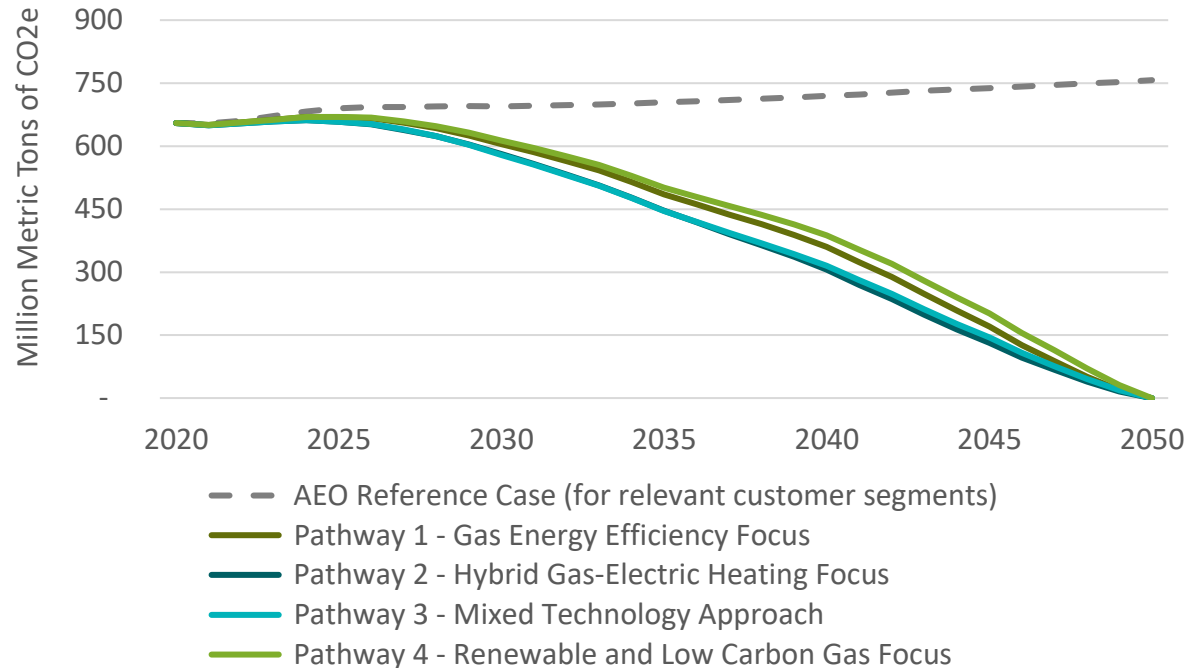


- Baseline - EIA Annual Energy Outlook 2021 (Ref Case)
- Net-zero requirements assumed economy-wide
 - Power generation & transportation not modeled
- Customer pathways include end-use sectors served by gas utilities
 - LNG exports not included
 - Propane / electric / fuel oil customers not modeled
- National-level results
- Costs must be based on highly-local factors outside analysis scope

Every pathway was designed to achieve net-zero greenhouse gas emissions.

- Emphasis was placed on developing pathways showcasing a diversity of scenarios
- There are many potential pathways to net-zero that include gas utility solutions and infrastructure.
- The number of natural gas customers grow in all pathways

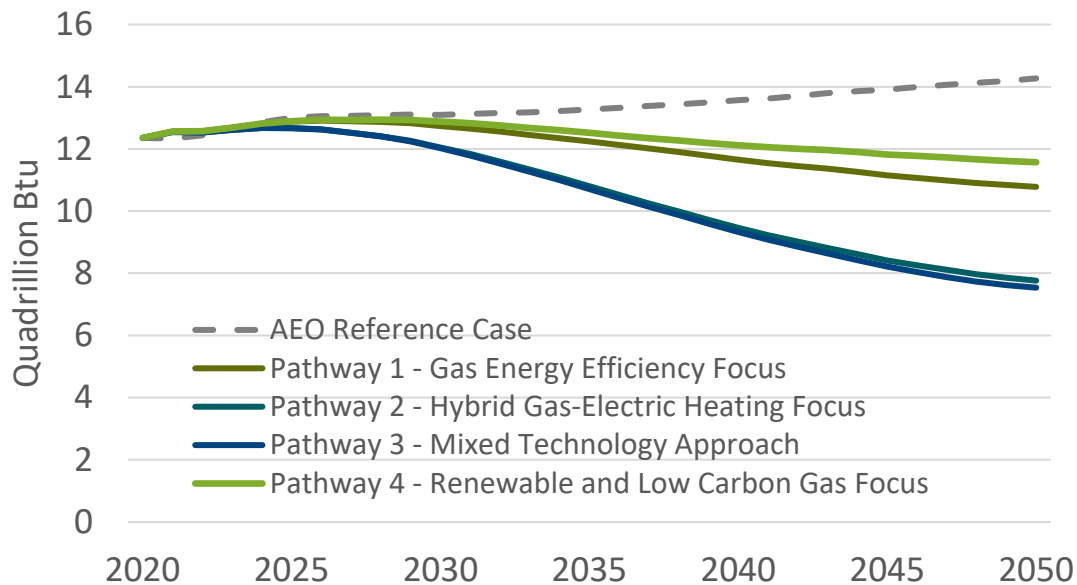
U.S. Gas Utility Customer Emission Reduction Pathways



All pathways require significant gas demand reductions achieved through energy efficiency

Total Gas Demand in Study Scope

(Residential, Commercial, Transportation, & LDC Industrial Customers)



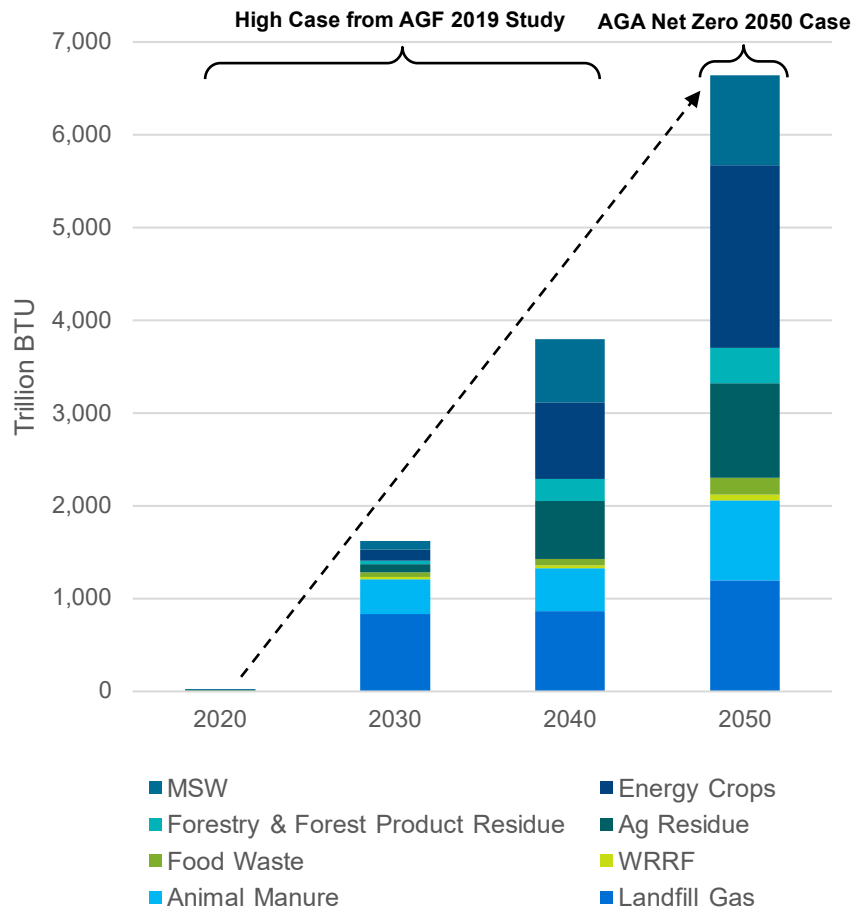
2050 VS 2020 % Change

	Total	Res	Com	Ind	Transp
AEO Reference Case	+16%	-3%	+13%	+32%	+413%
4. Renewable and Low Carbon	-6%	-9%	-5%	-13%	+413%
1. Gas EE Focus	-13%	-23%	-11%	-11%	+413%
2. Hybrid Heating	-37%	-54%	-46%	-19%	+413%
3. Mixed Approach	-39%	-52%	-44%	-29%	+413%

All pathways studied incorporate a significant expansion of renewable natural gas (RNG) and hydrogen

- The renewable natural gas and low-carbon supply mix is underpinned by a significant resource potential expansion compared with the American Gas Foundation (2019) study
- Low-carbon fuels technology are evolving rapidly.
- RNG resource development is a key strategy to unlocking gas decarbonization opportunities.

Comparison of 2040 and 2050 Cases for RNG Supply



Gas Energy Efficiency Focus Components and Pathway

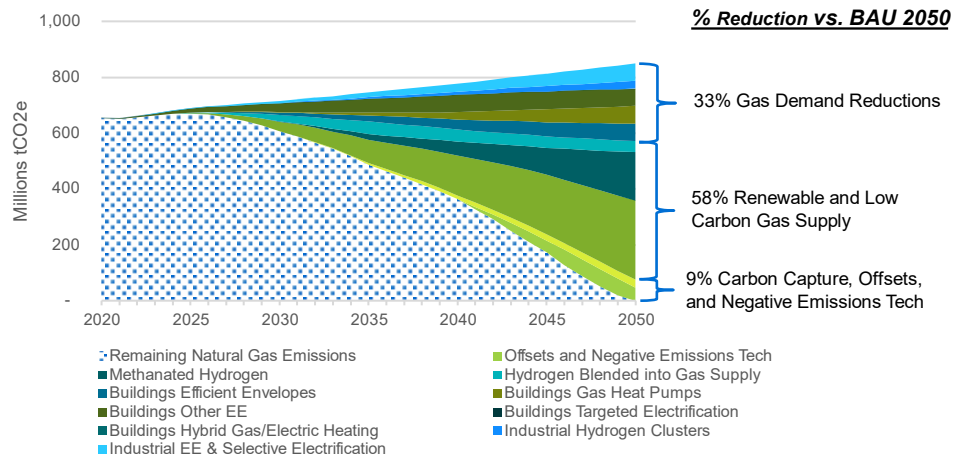
Gas Energy Efficiency Focus

- Gas heat pumps
- Major building shell retrofits
- High-efficiency gas appliances
- Other energy efficiency (E.E.) measures
- RNG & hydrogen blending
- Negative emissions technologies
- Aggressive fuel-neutral building energy codes

Key Insights

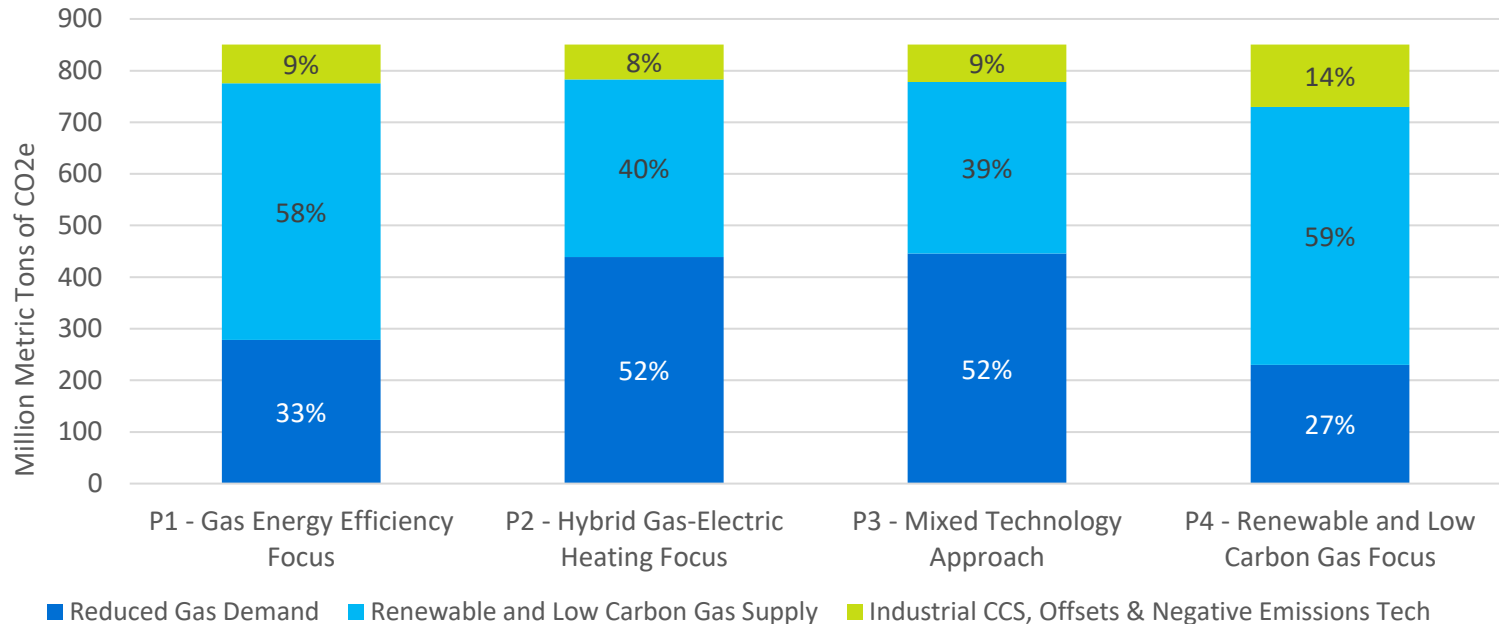
- 24% customer growth over the 30-year period
- The potential of gas heat pumps is significant, but requires technology deployment
- Gas DSM programs and infrastructure can drive emission reductions

Pathway to Net-Zero Customer GHGs (Gas Energy Efficiency Focus)



The relative contribution of measures varies by pathway, showcasing a diversity of potential approaches

Summary of Types of 2050 Emission Reductions



Supportive policy and regulatory approval will be essential for gas utilities to achieve net-zero emissions.

- Expanded Utility **Energy Efficiency** and Demand-Side Management Programs
- Create Market Structures and Incentivize Demand for **Renewable and Low Carbon Gases**
- Coordinated **Gas and Electric Planning**
- **Utility Regulatory Updates**
- Address Cost Allocation and **Consumer Equity Issues**
- Considering methods to compensate gas customers for **system cost savings**





Other Key Findings

- Expanded energy efficiency, renewable fuels, and methane emissions mitigation are no-regrets actions
- Large amounts of renewable and low-carbon electricity and gases, and negative emissions technologies, will be required
- Increased RD&D and coordination with the electric sector unlock more decarbonization measures
- Supportive policy and regulatory approval will be essential

The Path Forward

AGA and the natural gas utility industry will enable gas utility emissions reduction solutions through activities and initiatives in seven key areas.



Energy Efficiency and Improved Energy Management



Methane Mitigation Technologies and Strategies



Advanced Gas End-use Technologies



Renewable and Low-Carbon Fuels



Negative Emissions Technologies



Infrastructure Modernization



Workforce Development