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INVESTING IN THE US NATURAL GAS PIPELINE SYSTEM TO SUPPORT NET-ZERO TARGETS

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Outline

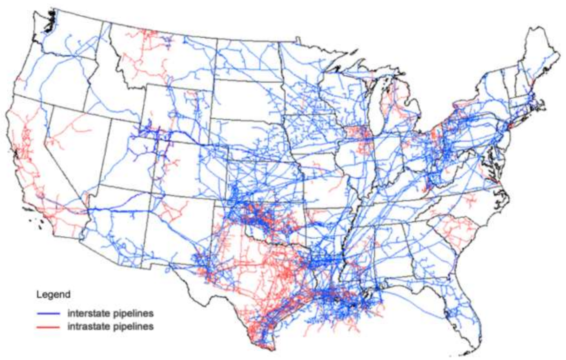
1. Introduction
2. Current natural gas consumption and future scenarios
3. Overview of the natural gas pipeline network and future uses
4. Conclusions and policy recommendations

Why should we invest in the US gas pipeline system?

Investing in natural gas pipelines will aid the journey towards net-zero by preparing existing infrastructure for future clean fuels and, in the meantime, reducing methane leaks

How stakeholders talk about the issue:

- Stranded assets
- Locking in a fossil fuel future
- Electrification should be the focus

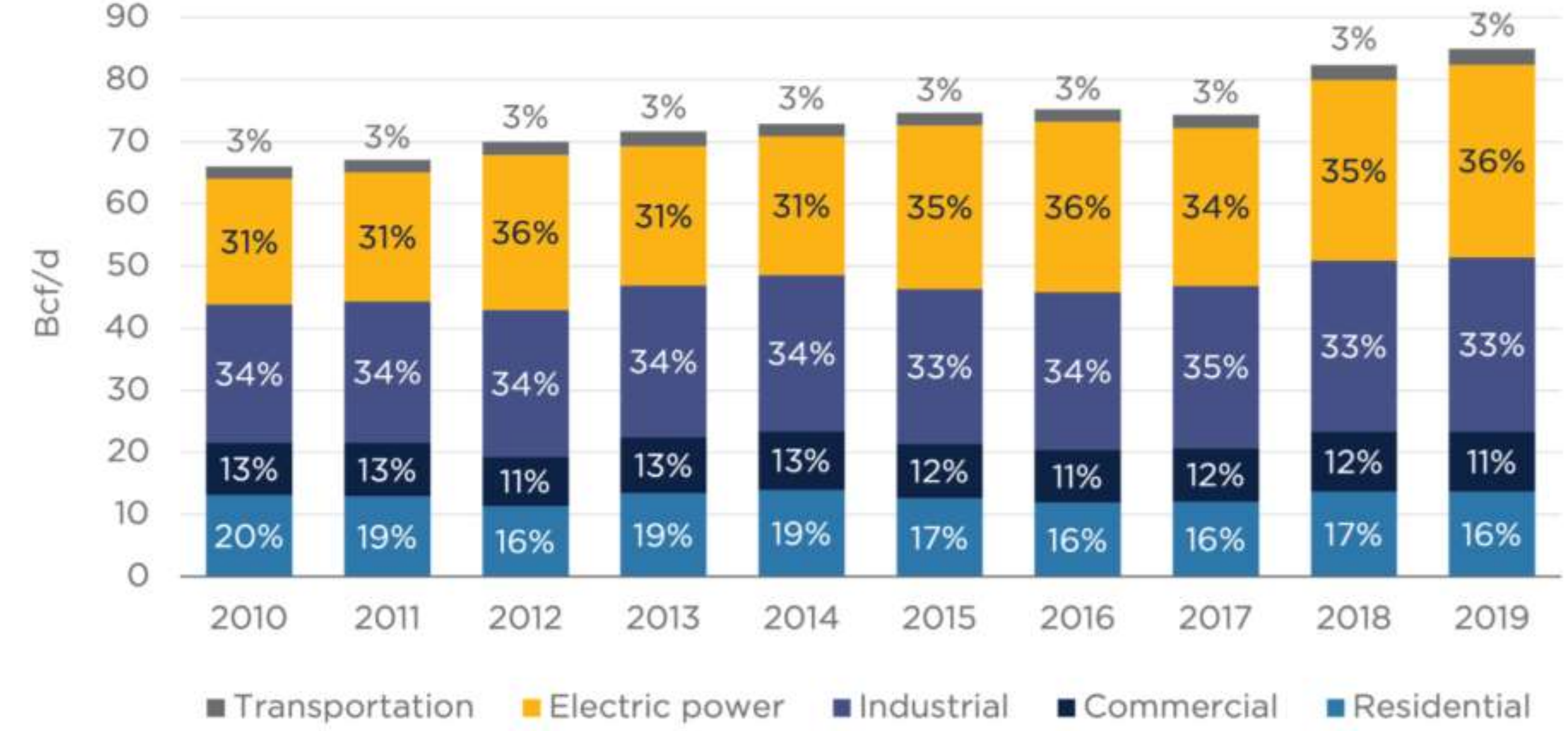


How they should: Reuse and recycle

1. We will need to make **large investments** in new infrastructure in order to transition to a net-zero economy
2. This is **not a choice** between natural gas and electrification or between fossil fuels and zero-carbon fuels
3. The natural gas grid should be viewed as a way **to enable** increasingly low-carbon molecules to be transported

Total consumption of natural gas has grown by 25 percent in the last decade

Total US natural gas consumption by sector (includes sector share)

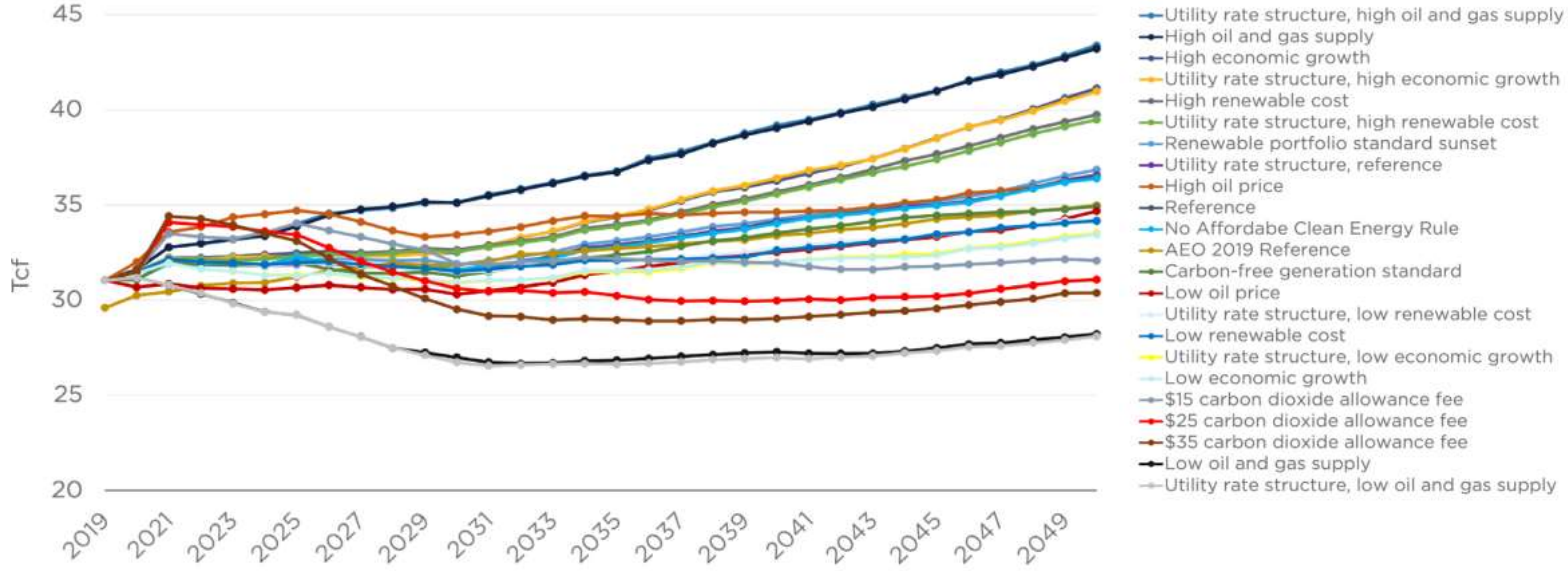


It will be more complicated to move the US economy off of natural gas than it has been to move away from coal

Note: Preliminary data for 2019.
Source: US EIA monthly energy review

EIA (the bull): Almost all scenarios project continued gas consumption at today's levels or higher

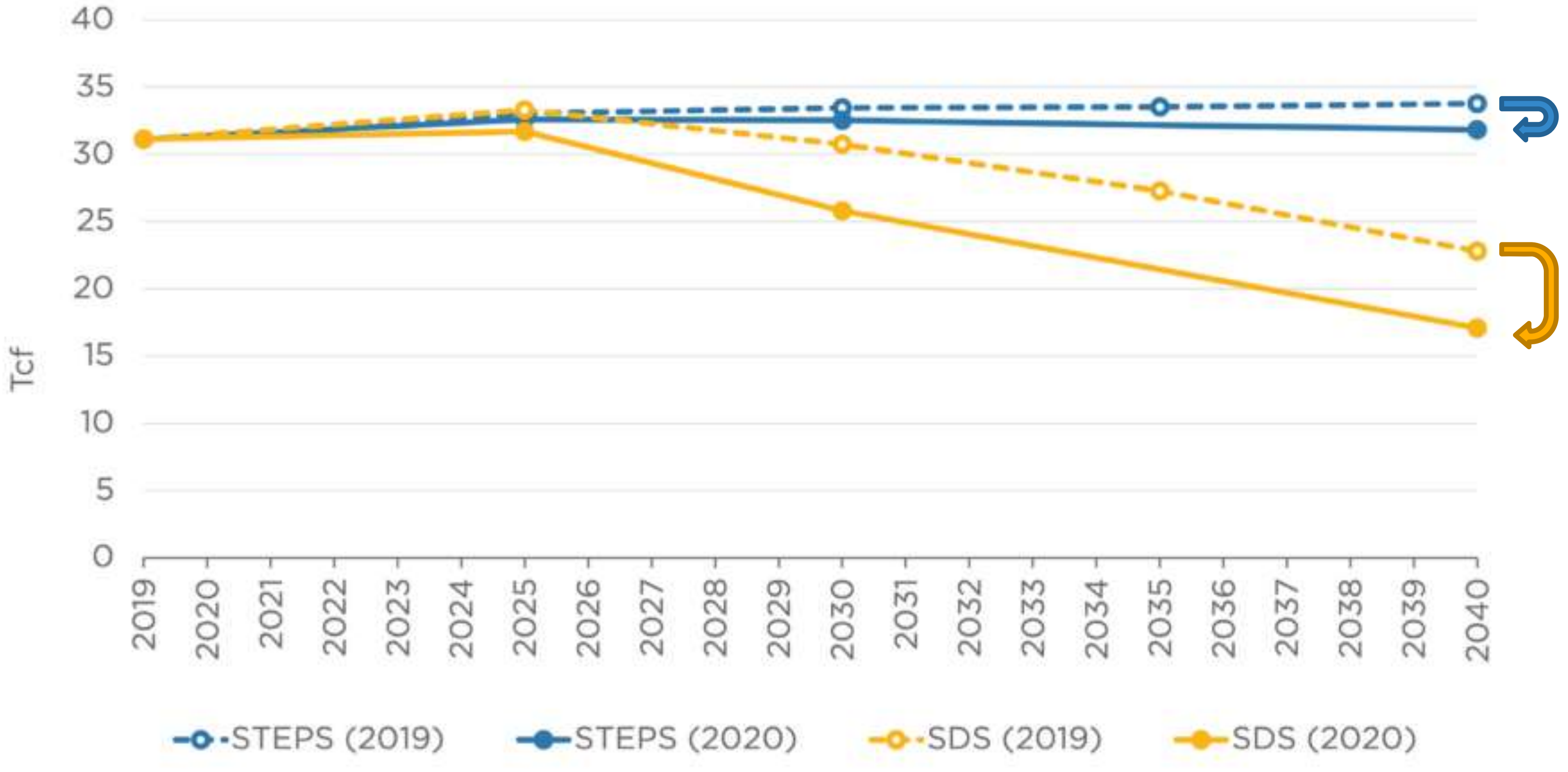
EIA AEO 2020 total US natural gas consumption by scenario



Source: US EIA Annual Energy Outlook 2020, https://www.eia.gov/outlooks/archive/aeo20/

IEA (the bear): Downward revisions in 2020 from the 2019 projections but still significant gas use to 2040

IEA WEO 2020 total US natural gas consumption by scenario

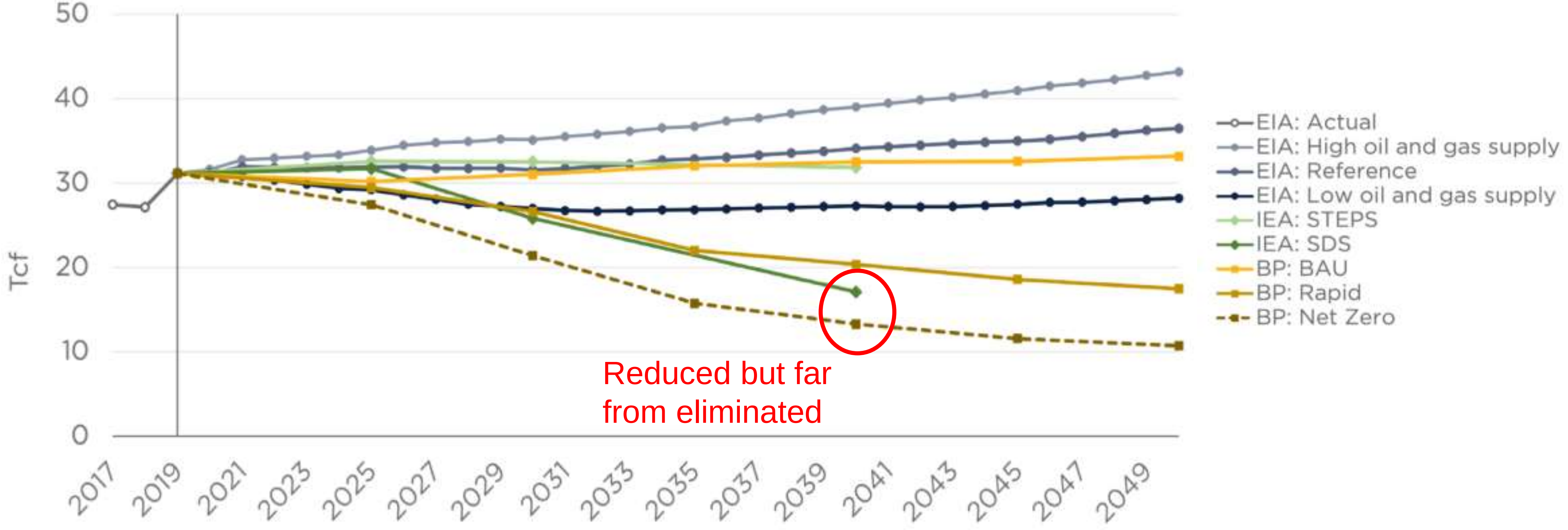


~80 percent of the reduction in gas demand between the 2020 and 2019 SDS scenarios comes from decreasing consumption in the power sector

Source: IEA World Energy Outlook 2020, https://www.iea.org/reports/world-energy-outlook-2020

In 2040, there is still at least 13 to 17 TCF of natural gas flowing through the system, 50 percent of current volumes

Total US natural gas consumption under the EIA, IEA, and BP 2020 scenarios



Source: IEA World Energy Outlook 2020, https://www.iea.org/reports/world-energy-outlook-2020

All deep decarbonization scenarios rely on the deployment of CCS/CCUS and reduced methane flaring and leakage

Carbon Capture, Utilization and Storage

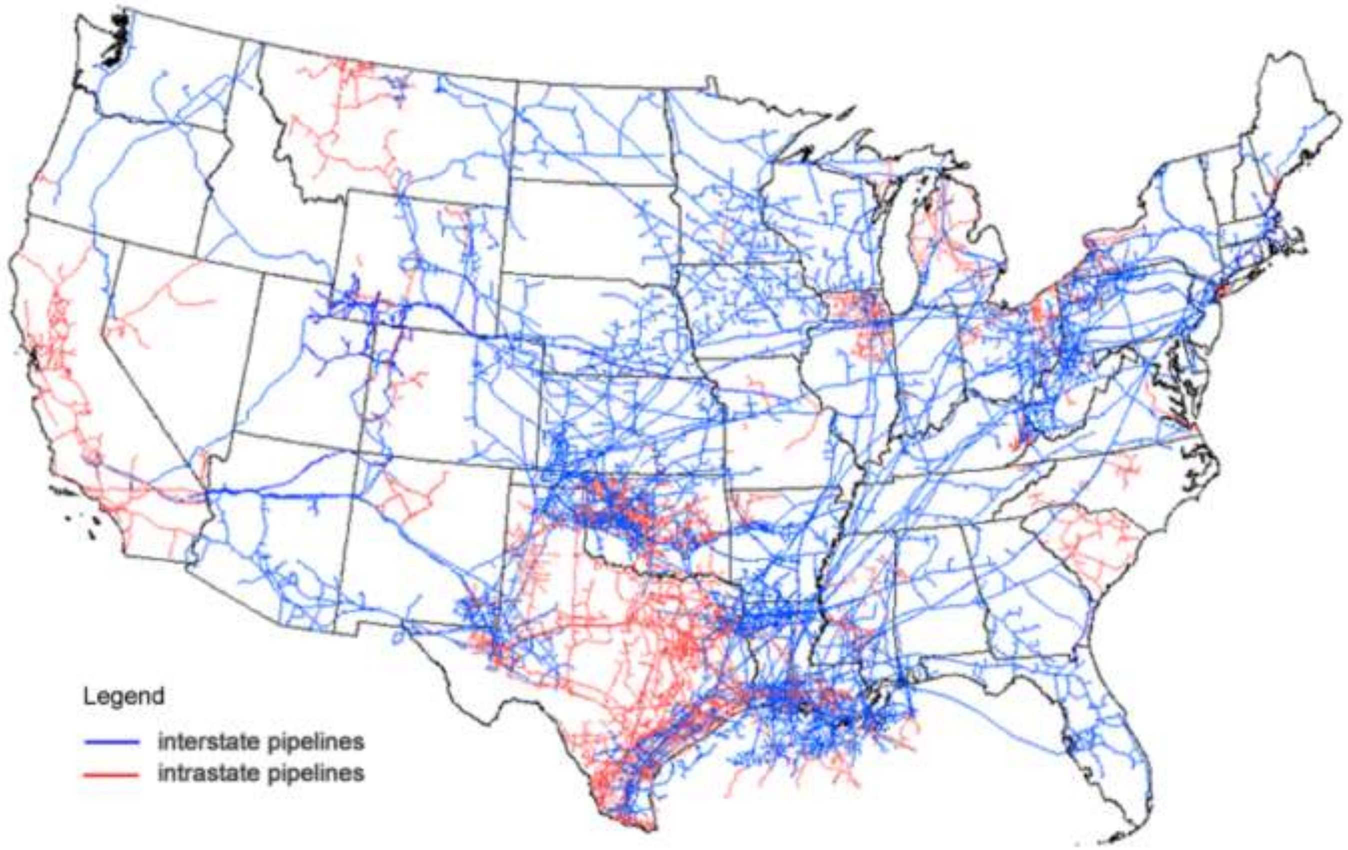
- CCS opportunities exist at large coal and natural gas-fired plants, major industrial sources such as cement plants and synthetic fuel plants, and fossil-based hydrogen production facilities
- Existing CCS technology can capture approximately 80-90 percent of CO_2 produced during power generation
- Some newer systems produce pure CO_2 streams ready for use or permanent geological disposal that would effectively result in 100 percent CO_2 capture rates

Key challenges

- **Geographic limits:** Requires dedicated CO2 storage sites
- **Infrastructure limits:** Many existing plants are not near pipelines, and many of the existing pipelines are at full capacity
- **Financing:** Since CCS does not create new generation (it reduces emissions and actually reduces the amount of electricity that is produced per unit of fuel burned), conventional power project financing does not support CCS retrofits

The US has 2.5 million miles of pipeline infrastructure, making it 6.5x longer than the interstate highway system

Map of U.S. interstate and intrastate natural gas transmission pipelines as of 2020



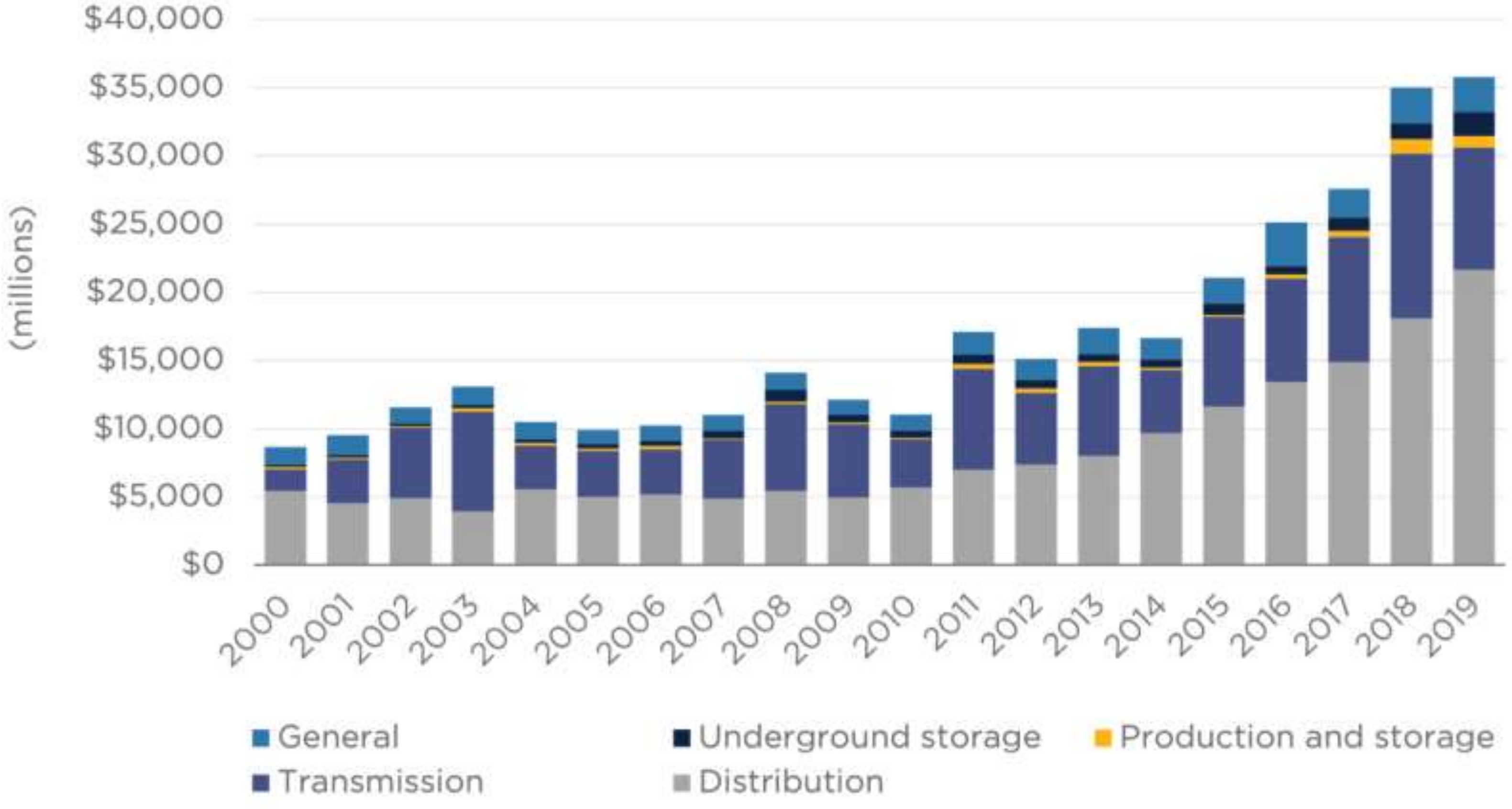
Existing pipelines currently transport natural gas to approximately:

- 70 million households
- 5.5 million commercial customers,
- 182,000 factories and manufacturing facilities, and
- 1,800 power plants

Source: US EIA, Natural gas explained: Natural gas pipelines, [https://www.eia.gov/energyexplained/natural- gas/natural-gas-pipelines.php](https://www.eia.gov/energyexplained/natural-gas/natural-gas-pipelines.php)

Since 1972, more than half a trillion dollars has been invested in US natural gas pipeline infrastructure

Construction expenditures by type of facility



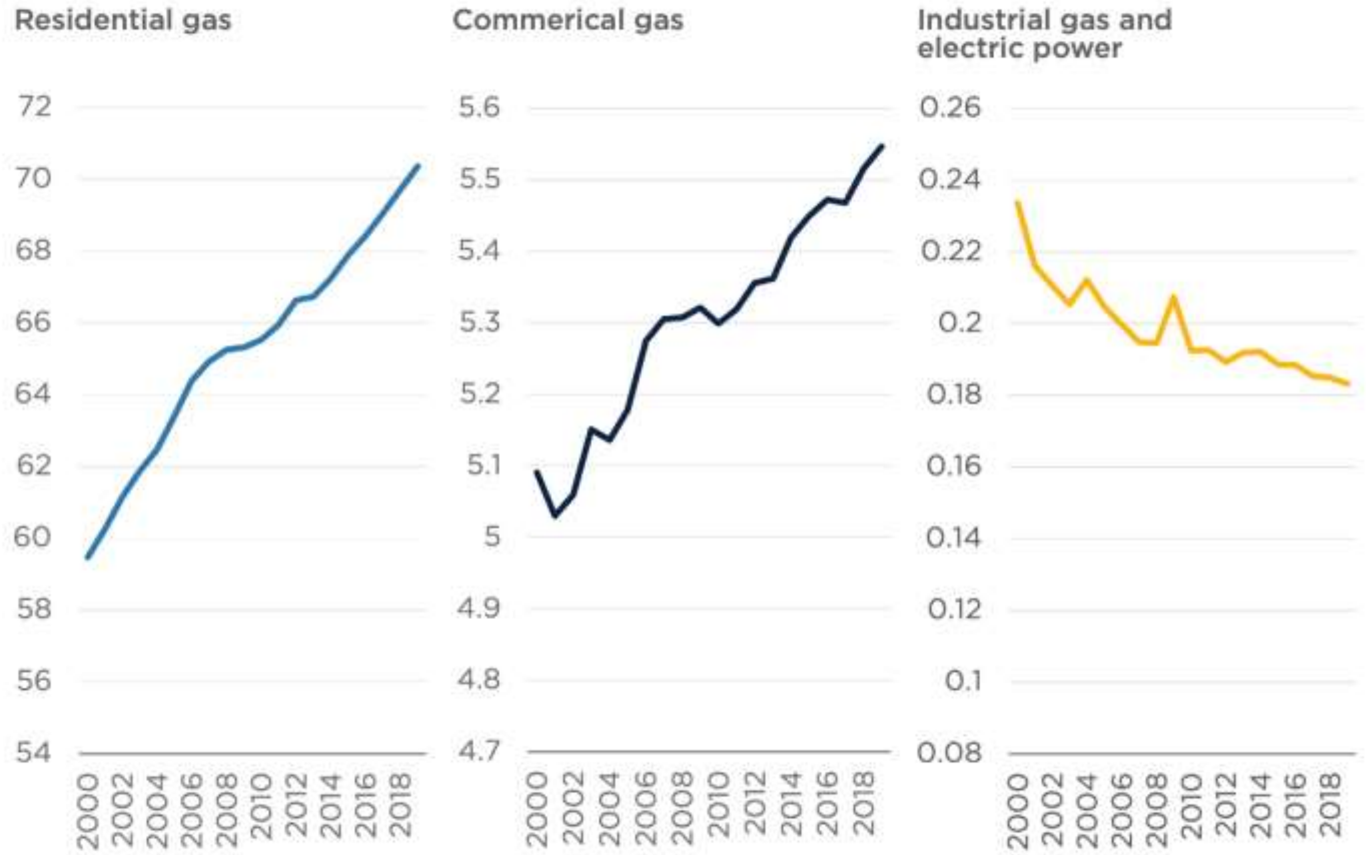
Investment in distribution infrastructure has been driven by three key areas:

1. Mandated expenses
2. Reliability expenses
3. New customer connections

Source: AGA 2020, https://www.aga.org/contentassets/5d9888f793ad4508bb35cb6b5f2c1865/table12-1.pdf

The total number of gas users has increased steadily by 11.4 million since 2000

Natural gas end users (millions)

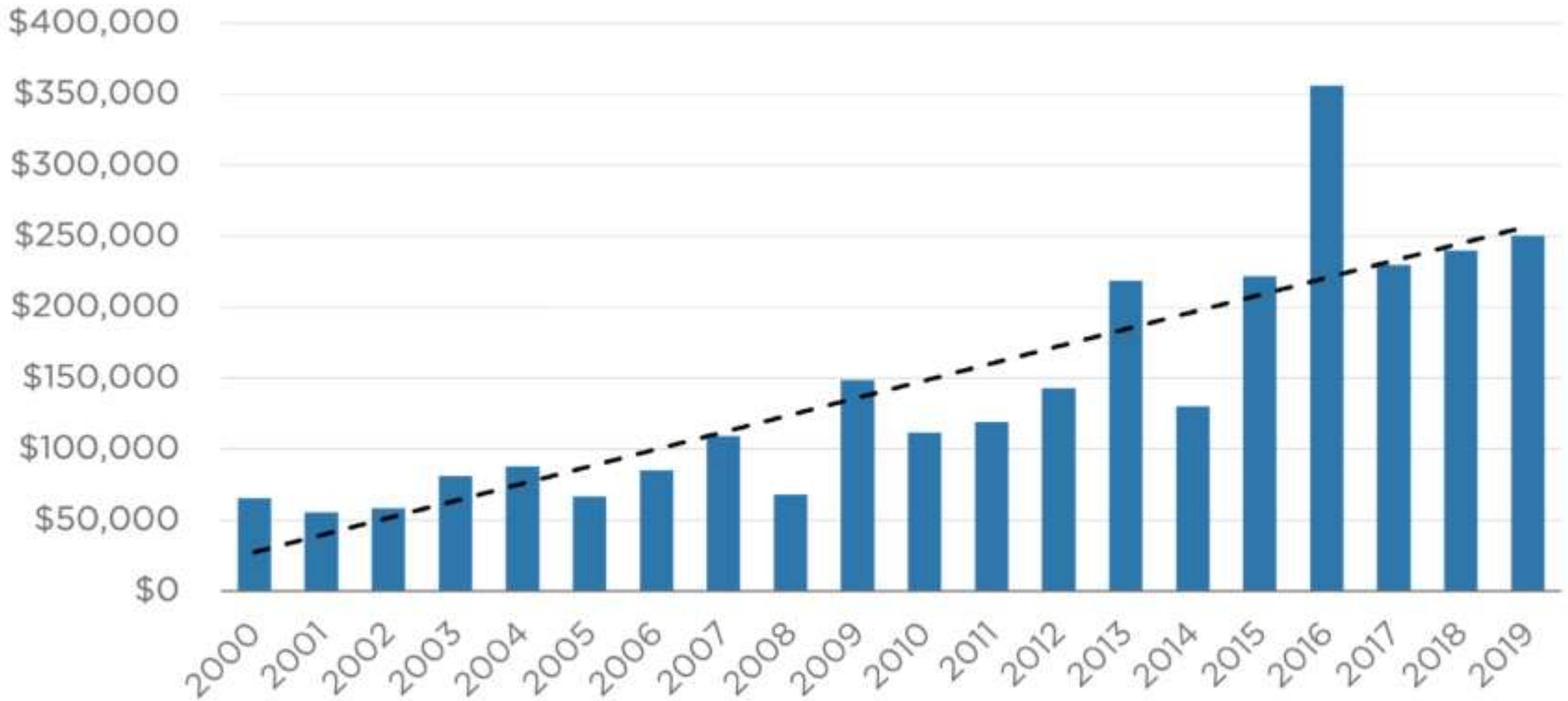


A rapid transition to zero-carbon supplies **will likely require strong policy changes** to drive market choices to low-carbon alternatives (e.g., low- or zero-carbon hydrogen or electric heating)

. *Source: AGA 2020, https://www.aga.org/research/data/end-users/*

The average real cost of a pipeline per inch mile has increased nearly 400 percent over the past 20 years

Pipeline cost per inch-mile

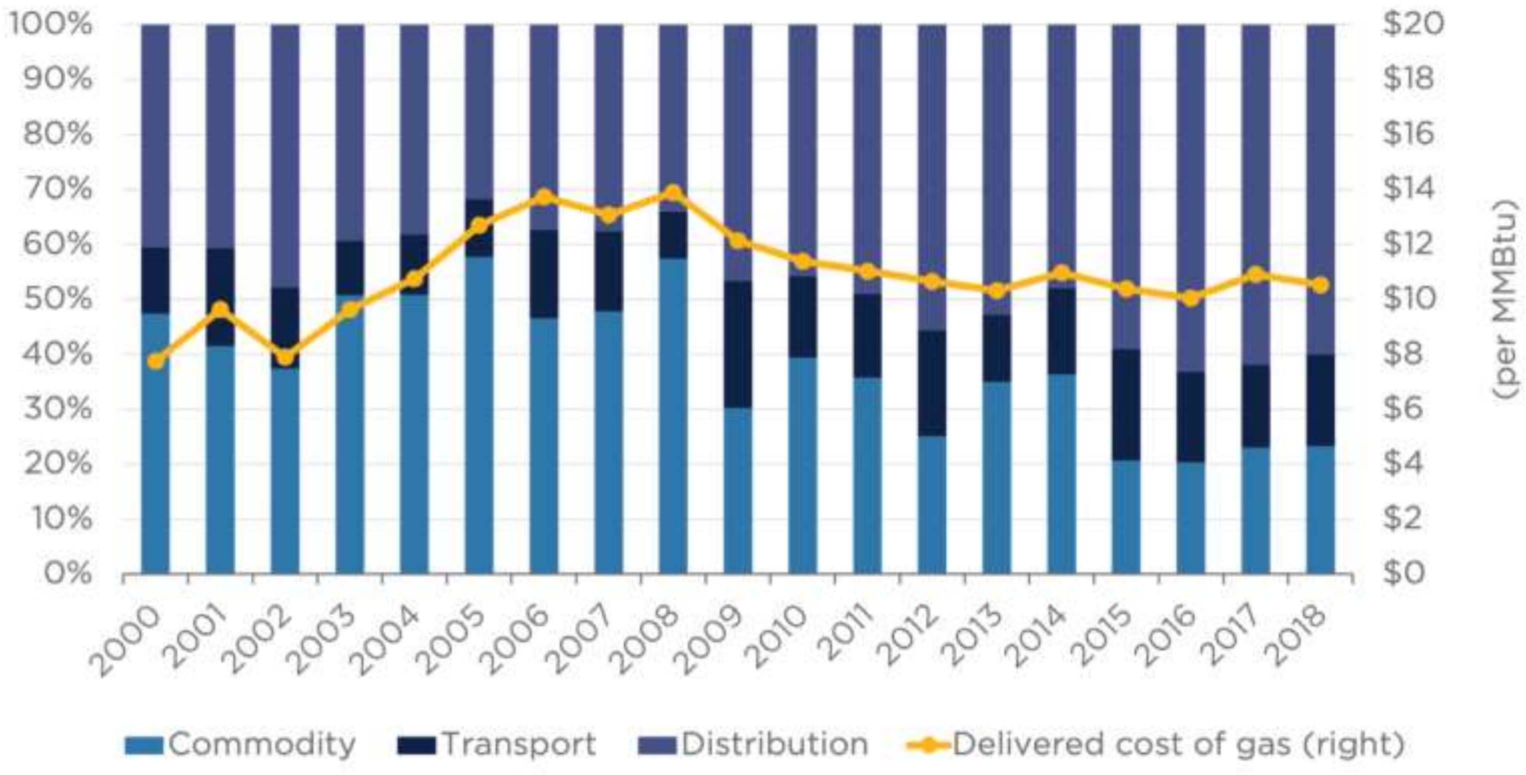


But the increase has been offset by other factors such as increased revenue from the sheer volume of gas that is being transported

Note: Dotted line shows trendline of average costs.
Source: AINGAA, https://www.ingaa.org/Foundation/FDNreports/Midstream2035.aspx

As commodity prices have fallen, distribution charges now make up 60 percent of a customer's delivered cost of gas

Expense share and delivered cost of natural gas



The $30.5 billion spent on transmission pipeline and distribution line infrastructure in 2020 equates to less than $1/MMBtu

This makes it easier for gas utilities to pass on the costs of upgrades and expansions to their systems without customers seeing an increase in the delivered price of gas

Source: US EIA, https://www.eia.gov/energyexplained/natural-gas/prices.php; Wellhead data post-2012 from S&P Platts (using average of regional production)

Using the existing natural gas system could accelerate wider adoption of hydrogen over time

Costs

- To achieve cost parity with natural gas, hydrogen must be produced at roughly $0.3 per kilogram.
- The most cost-effective way to transport hydrogen is via pipeline.

Type	Cost ($ per kilogram)
Gray (from $3.50/MMBtu gas)	*$1.00–$1.50*
Blue (at 60-90 percent CO_2 capture rates)	*$1.40–$2.10*
Green (from zero-carbon electricity)	*$4.50–$8.50*

Technical considerations

- Relatively low concentrations of hydrogen (5–20 percent by volume) appear to be feasible with very few modifications
- A number of pilot projects are testing how hydrogen interacts with existing pipeline materials
- Recent research has shown hydrogen leak rates are similar to that of natural gas
- Polyethylene (PE)—the most common plastic in use today—pipes have been shown to be compatible with hydrogen

Other potential future uses include biomethane and synthetic methane

Biomethane

- Biogas can also be upgraded into biomethane or renewable natural gas (RNG) by removing the CO_2 and other contaminants, and can be injected into the pipeline grid interchangeably with natural gas
- The key limit for biogas is supply, followed by cost. Even with greatly expanded production, biogas generation could provide only up to 3 to 5 percent of the total domestic natural gas market at a cost of $5–6/MMBtu by 2040

Synthetic methane

- The cost estimations of synthetic methane, also known as substitute natural gas (SNG), or synthetic natural gas, vary significantly but remain considerably higher than biomethane or hydrogen alone: for 2030 around $23-110/MMBtu and for 2050 around $15-60/MMBtu
- If SNG costs come down and projects scale up, its similarity to natural gas would make it particularly suited for use in the current US pipeline network.

Failing to invest in the US natural gas pipeline network ignores some critical US energy realities

There is no quick replacement for gas in the US energy mix

- Natural gas currently provides a huge volume of energy that can be stored for long durations
- Due to a lack of readily available zero-carbon fuel substitutes, the nation is likely to require natural gas in its energy mix for decades to come, even if the absolute amount declines as technology resolves those issues and accelerates the transition to zero-carbon gases
- Achieving zero emissions in this fuel constrained situation will require extensive use of carbon capture and sequestration (CCS) in power generation and industry

What can policymakers do?

How can the US natural gas pipeline network better limit its current greenhouse gas emissions and be adapted to transport increasing levels of lower-carbon fuels?

1. Change regulations on methane leak detection and repair to make the existing pipeline network as low emissions as possible.

2. Expand on existing regulatory authority to allow for retrofitting the transmission and distribution system for more hydrogen usage in the pipeline network, and increase R&D funding to test the integrity of the pipeline system with greater levels of hydrogen and other zero-carbon fuels.

Policy recommendations

1. Accelerate the pace to replace remaining cast-iron pipelines—which constitute a small percentage of the existing infrastructure but are responsible for an outsized percentage of methane leaks and are also incompatible with transporting hydrogen—and mandate replacement of aging pipelines

2. Adopt state-level methane reduction targets for gas utilities

3. Update federal pipeline standards to require annual inspections, change the criteria for which leaks need to be repaired, and require all leaks be reported

4. Conduct state-level inventories of the metallurgy in their pipeline infrastructure to identify parts most compatible with increased hydrogen usage, while questions surrounding how best to blend hydrogen and other zero-carbon fuels into the system undergo further study. Require that mains replacement programs use hydrogen-compatible plastic pipes

5. Consider specific rate add-ons that allow states to modify the system to accommodate hydrogen if those modifications can be made without an undue burden on ratepayers, especially lower income groups

Thank You

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