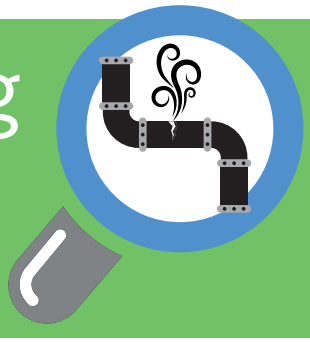
Potential Dangers of Blending Hydrogen and Natural Gas in Pipelines



Proposals to blend hydrogen (H_2) with natural gas are being promoted by utilities and gas companies, claiming that this would help decarbonize the natural gas supply chain. However, injecting hydrogen into gas pipelines raises significant climate and safety concerns that must be thoroughly understood and addressed before these projects can move forward. In addition to the fact that hydrogen is an indirect greenhouse gas and is primarily produced from fossil fuels, the proposals fail to account for serious safety risks. These include hydrogen's negative effects on pipeline materials, its tendency to leak, and its highly explosive nature.

Hydrogen Causes Pipelines to Crack and Degrade

- Natural gas transmission pipelines in the US are comprised mainly of steel. Large diameter pipelines transport gas from production to distribution sites at high pressure. Gas distribution pipelines are made from steel, iron, and/or plastic and transport gas in smaller pipelines at a lower pressure to its end use.
- When hydrogen comes into contact with steel, it diffuses into the alloy and combines with carbon to form methane (CH_4), which then creates cracks in the metal. This process is called **hydrogen embrittlement (HE)**. **Exposure to hydrogen can result in a decreased resistance to fracture and an exacerbation of the existing flaws in steel** (source). An increase in hydrogen concentration and gas pressure further worsens the adverse effects of hydrogen on steel (source).
- Iron pipelines are also susceptible to HE, which poses a considerable risk as they are some of the oldest in the country and already prone to leakage and cracking (source 1, source 2).
- Plastic (polyethylene) pipelines are a more recent addition to gas infrastructure. While they are not impacted by HE, **hydrogen can permeate through polyethylene at a rate six to seven times higher than methane**, the main component in natural gas, increasing the risk of hydrogen accumulation and ignition outside of the pipeline (source 1, source 2). Hydrogen also permeates through the elastomeric sealing used in distribution systems at an even higher rate (source).
- Besides increasing the likelihood of fracture through HE, hydrogen can also accelerate the degradation of iron and steel through a passive process known as lattice dilation (source).

Hydrogen Will Leak through Pipelines

- Natural gas leaks throughout US pipeline systems have been historically undercounted (source). **Hydrogen's small size and low density makes it more prone to leaks when compared to the larger methane molecule.** This high leakage rate is exacerbated by phenomena like HE and hydrogen permeation.
- Hydrogen will not only leak out of cracks and failures in iron and steel pipes, **it will also flow out of the connection points in both metal and plastic pipelines** (source).
- Due to hydrogen's low density compared to methane, pipelines containing any levels of hydrogen would have to maintain a higher pressure, increasing gas flow and gas loss through existing and newly created leakage points (source).

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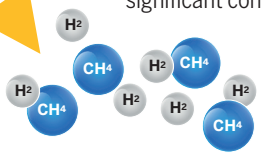
Blending Hydrogen with Natural Gas in Pipelines Could Be Disastrous

As an indirect greenhouse gas, **hydrogen leads to 35 times more climate warming than CO_2** during its first 20 years in the atmosphere. Hydrogen leaks could be a significant contributor to climate change.

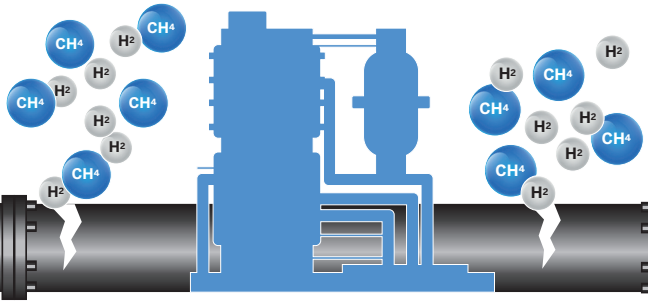


Hydrogen burns hotter, faster, and ignites more easily than natural gas. Blending hydrogen into the natural gas that is flowing into homes would lead to **increased residential explosions**.

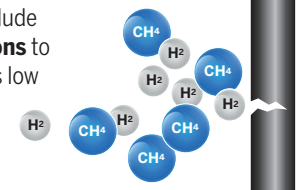
Hydrogen is incompatible with common natural gas pipelines materials. It creates cracks in steel and iron and permeates through plastic pipelines.

Hydrogen is a very small and leak-prone molecule. It would readily **leak through existing and new cracks in natural gas pipelines** as well as at connection points.

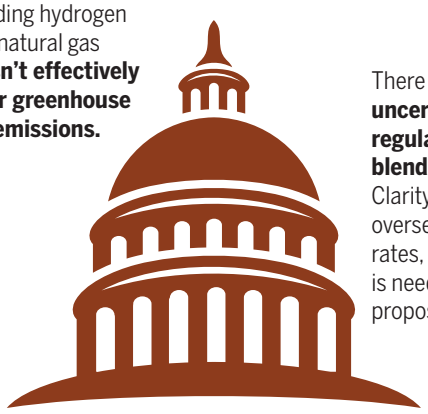
When combusted, **hydrogen produces six times more NO_x emissions when compared to natural gas**. Burning hydrogen in natural gas appliances like furnaces and stoves would have dangerous health impacts for utility customers.



Natural gas infrastructure would need to be built out to include **more compressor stations** to accommodate hydrogen's low density.

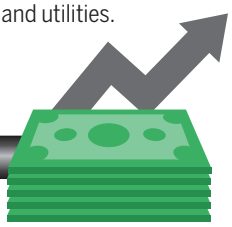


Blending hydrogen with natural gas **doesn't effectively lower greenhouse gas emissions.**



There remains **uncertainty over the regulation of hydrogen blending proposals**. Clarity over who is overseeing safety, siting, rates, and data collection is needed before proposals proceed.

Hydrogen is expensive to produce and would require costly infrastructure upgrades. These extra costs would be passed on to rate-payers from gas companies and utilities.



Utilities are proposing to blend hydrogen into the natural gas pipelines as a false solution for their decarbonization efforts. These proposals will not reduce emissions, but they will allow these utilities to continue selling fossil fuels and profiting from gas infrastructure. Injecting hydrogen into natural gas pipelines will lead to more cracks and leaks in the pipelines, increased venting of methane and hydrogen into the atmosphere, higher risk of explosions, elevated nitrogen oxide (NO_x) emissions, and more money coming out of ratepayers' wallets.

Source: Clean Energy Group

- **Natural gas blended with hydrogen results in faster leakage rates from cracks and connection points than in pipelines with natural gas alone** due to its decreased density and increased gas velocity (source 1, source 2, source 3). Hydrogen's harmful effects on pipeline materials not only allow for more hydrogen leakage, but also more methane leakage when blended with natural gas.
- Hydrogen leaks are critically important to prevent. **Hydrogen in the atmosphere prolongs the lifetime of methane and can produce 35 times more climate warming impacts than carbon dioxide in the first 20 years** (source). For more information about hydrogen's global warming impact, see Clean Energy Group's 2023 fact sheet on hydrogen's global warming impacts.

Hydrogen Presents an Increased Safety Risk

- Hydrogen burns hotter and faster and ignites more easily than natural gas (source).
- Gas appliances in residential structures, like stoves and boilers, are designed for the specific properties of natural gas. Introducing hydrogen into distribution pipelines and subsequently into homes, even at low percentages, would increase the safety risks associated with its differential properties (source).
- Safety features, like sensors used to detect flames or failures in natural gas appliances, may not be able to effectively identify the same risks in blended gas with a higher hydrogen content (source).
- Hydrogen's faster flame speed would lead to an increased risk of flashback in blended gas when used in residential appliances, where the flame travels back into the gas line. This could result in gas build up, damage to appliances, and potential gas leaks in enclosed spaces. Increased risk of flashbacks may occur in blends as low as 10 percent hydrogen (source).
- **Completely replacing natural gas with hydrogen in the home would result in a four-fold increase in residential explosions** (source).
- **Hydrogen produces six times more nitrogen oxide (NO_x) emissions when burned than natural gas**, and exposure to NO_x emissions has severe respiratory health implications. Combusting hydrogen in homes would affect the long-term health of residents (source).

Hydrogen Blending is Inefficient and Costly

- Partially or fully replacing natural gas with hydrogen does not result in a 1-to-1 reduction of emissions. More hydrogen is needed by volume to replace the energy produced through natural gas combustion, because it has a lower energy density (source).
- Utilities proposals aim for blends of up to 20 percent hydrogen. In addition to being dangerous, this level of blending **would only lead to a 7.6 percent reduction in greenhouse gas emissions** (source).
- Blending hydrogen with natural gas would lower gas flow in pipelines and require the addition of new compressor stations to maintain gas pressure as well as an accompanying increase in the amount of energy needed to compress the blend (source 1, source 2).
- Materials currently used to build compressors are not compatible with hydrogen and would need to be replaced, adding to the cost of these projects (source).
- **A 30 percent blend of hydrogen into the natural gas system could almost double costs per megawatt-hour for power plants.** This increase in costs would likely be transferred to ratepayers (source).
- Given the incompatibility of hydrogen with the current materials used in pipelines, it may be necessary to build out new pipeline infrastructure to transport this fuel. **New hydrogen pipelines could cost over $1 million per mile to construct** (source).

There are Insufficient Regulations on Hydrogen in Pipelines

- Uncertainty about how hydrogen blending and pipelines will be regulated is growing as projects and proposals begin to pop up across the country. While the Federal Energy Regulatory Commission (FERC) oversees interstate natural gas pipelines through the Natural Gas Act, this does not extend to any potential interstate hydrogen pipelines. **There is no known regulatory authority for hydrogen pipelines, nor any regulatory guidance for a natural gas pipeline if it becomes a hydrogen pipeline and begins transporting a hydrogen blend** (source).
- Although FERC has rate-setting authority over natural gas, it has not established authority over rate-setting for hydrogen in interstate pipelines (source).

- While the Pipeline and Hazardous Material Safety Administration (PHMSA) regulates hydrogen pipeline transportation under its classification as a flammable gas, **there are limited regulatory differences between the treatment of hydrogen and natural gas, despite the chemical and physical property differences between these two molecules** (source).
- PHMSA forms do not currently collect data on the blending of hydrogen gas in pipelines but are considering a revision to increase the amount of information available. PHMSA is also working on a leak detection rule that will include hydrogen (source).
- Safety, siting, rate authority, and data collection regulations should be precursors to any blending proposals and not afterthoughts, given the climate and safety implications of hydrogen.

Blending Hydrogen into Pipelines Creates New Environmental Justice Issues and Exacerbates Existing Concerns

- Replacing methane with hydrogen either through blending or from the installations of new infrastructure would greatly increase costs for consumers. Energy costs already disproportionately burden low-income households (source).
- A higher density of natural gas pipelines is more likely to be found in environmental justice communities (source). Gas leaks have also been found to be concentrated disproportionately in communities of color and low-income neighborhoods (source). **Building new hydrogen pipelines would present environmental justice challenges if they follow the patterns of siting for natural gas pipelines** (source).
- Hydrogen blending in existing pipelines could increase the likelihood of leakage and pipeline deterioration. **Air pollution, water pollution, and safety risks could increase due to hydrogen's flammability and propensity to leak.**
- A large majority of rental homes do not adequately vent exhaust from natural gas cooking, resulting in increased indoor air pollution. Methane leaks and emissions from stoves have been undercounted, and it was recently found that the methane that leaks when a stove is turned off could account for 75 percent of methane emissions from stoves. Black, Indigenous, and people of color are statistically more likely to rent, leading to a disproportionate health burden from poor indoor air quality. **Introducing hydrogen to gas mixtures in the home would increase indoor air pollutants** (namely NO_x) and exacerbate this existing injustice (source 1, source 2).

So, Should Hydrogen Blending Be Part of the Clean Energy Transition?

Blending hydrogen with natural gas allows utilities to extend the life of gas infrastructure. It enables utilities to position themselves as part of the clean energy transition while still selling fossil fuels; and in some cases, it provides access to state and federal government incentives. Reducing natural gas use in the US is crucial to reach necessary emissions reduction goals, but hydrogen blending will only exacerbate climate change and increase costs, dangers, and inequities for ratepayers. Supporting proven clean energy alternatives to natural gas such as electrification paired with renewables should be the focus of government and utility-led initiatives for a cleaner energy future.

To learn more about other harms associated with hydrogen's production and use, visit www.cleanegroup.org/initiatives/hydrogen.