HYDROGEN FOR BUILDINGS

Prospects

TERRIBLE

This fact sheet is part of an Energy Innovation paper assessing clean hydrogen's value for cutting climate pollution from 12 end uses. The full report includes context, analysis, policy recommendations, and citations—see QR code or link at bottom.

Hydrogen has at best a negligible role to play in decarbonizing buildings.

CONTEXT: U.S. gas utilities have announced at least 22 proposals to blend hydrogen with natural gas in their pipelines, aiming to deliver lower-carbon fuels to homes and businesses for space heating, hot water, cooking, and clothes drying. Concepts for net-zero gas delivery vary from switching to a "clean fuels" portfolio—consisting of hydrogen, renewable natural gas (RNG), and synthetic natural gas—to enabling a 100 percent hydrogen system. Utilities find such approaches compelling for meeting (or anticipating potential) legislative requirements for decarbonizing their operations while continuing to use and invest in their gas delivery systems; however, superior alternatives exist that generally obviate the need for hydrogen.

INFRASTRUCTURE NEEDS: Today's pipelines and end-use appliances are not suited to handle a blend of more than 20 percent hydrogen by volume with natural gas. Even this may be an optimistic upper limit, requiring careful testing and targeted pipeline and appliance retrofits to lessen leakage and explosion risks. Exceeding a 20 percent blend carries extreme logistical and cost challenges, such as replacing all pipelines and appliances on a distribution system.

Gas utilities would also need to increase pipelines' size or pressure to provide similar service with hydrogen as natural gas, which would be costly or dangerous, respectively. Hydrogen carries about a third of the energy of natural gas by volume. This means any use of hydrogen would result in less delivered energy (e.g., a longer wait to boil water) with today's pipelines.

SOCIAL IMPACTS: Burning hydrogen in buildings carries risks related to public health, safety, climate, and consumer costs. Hydrogen burns hotter than natural gas, which can worsen emissions of nitrogen oxide—a pollutant that harms the respiratory system. Hydrogen's faster flame speed also increases the risk of "flashback," which can damage appliances.

As the smallest molecule, hydrogen leaks much more readily than natural gas, including through cracks that odorants (such as what is added to natural gas so leaks can be smelled) cannot travel through. This raises explosion risks, particularly since hydrogen is much more flammable than natural gas. It also worsens climate change, as hydrogen has approximately a 12 times greater warming impact than CO_2 over a 100-year period. In fact, leakage of hydrogen from its use in buildings can eliminate its climate benefits. Even assuming zero-carbon hydrogen and no leaks, a 20-80 blend of hydrogen and natural gas by volume would only cut climate pollution by 7 percent at most, due to its lower volumetric energy density.

Hydrogen's use in buildings poses a substantial risk of increasing consumer energy bills. Gas utilities would need to source hydrogen below approximately $0.50 per kilogram to break even with natural gas—an extremely low price that will rarely be possible without never-ending policy support. In the near term, hydrogen might look attractive due to steep federal subsidies, but costs could skyrocket once those expire. However, some gas utilities may be given authorization to recover these higher costs from their customers absent sufficient regulatory oversight. Any hydrogen use will also require tests and pipeline upgrades, adding more costs.

These cost impacts could be further worsened if hydrogen is part of a broader "clean fuels" strategy. RNG is scarce and will be needed to decarbonize other sectors, which will boost its price. Synthetic natural gas requires making methane (CH_4) from hydrogen and a net-zero source of captured carbon (e.g., from direct air capture)—an extremely expensive proposition.

Collectively, these risks are very likely to worsen equity outcomes. Rising energy costs from the use of hydrogen will compel higher-income households to switch to electric appliances (which have higher up-front costs but lower lifetime costs than gas-fired counterparts), thereby increasing the share of gas system costs borne by remaining lower-income customers.

COMPETING TECHS: Electric appliances are the clear winner over hydrogen for cutting emissions in buildings. **Electric heat pumps** use clean electricity three to six times more efficiently than electrolyzing hydrogen and burning it in a furnace, achieving this by moving—rather than producing—heat. New modern heat pumps also perform well in very cold weather. Similarly, **induction stoves** use clean electricity three times more efficiently than electrolyzing hydrogen and burning it in a gas stove. They can also boil water much faster than natural gas (and especially hydrogen) stoves and have better temperature control.

Unlike gaseous fuels, electric appliances have no adverse health, safety, or climate impacts. It is also far easier to gradually install electric appliances building by building relative to having to replace all pipelines and appliances before being able to achieve higher hydrogen blends.

Another competing technology is **thermal energy networks**, which use pipelines to exchange heat between buildings and the earth. These networks are highly efficient and can be especially helpful in colder climates where electrification may be relatively more expensive.

TAKEAWAY: Regulators should deny hydrogen-blending requests given their generally worse climate, health, safety, and cost outcomes relative to alternatives. Legislators should similarly avoid supporting hydrogen blending. A review of 54 independent studies finds that "at best hydrogen will play a niche role for heating buildings," such as to back up electric heat pumps in extremely cold climates. The prevalence of gas utility hydrogen blending proposals does not imply value as a climate solution—instead, these proposals allow gas utilities to profit from new infrastructure investments while delaying meaningful emissions reduction efforts.

FURTHER READING:

- Sara Baldwin, Dan Esposito, and Hadley Tallackson, "Assessing the Viability of Hydrogen Proposals: Considerations for State Utility Regulators and Policymakers," Energy Innovation, March 2022, https://energyinnovation.org/wp-content/uploads/2022/04/Assessing-the-Viability-of-Hydrogen-Proposals.pdf
- Jan Rosenow, "A meta-review of 54 studies on hydrogen heating," *Cell Reports Sustainability*, December 14, 2023, https://doi.org/10.1016/j.crsus.2023.100010
- Massachusetts Department of Public Utilities, "Order 20-80-B," December 6, 2023, https://www.clf.org/wp-content/uploads/2023/12/DPU-20-80-B-Order-12.6.2313.pdf, pages 59-72
- **Featured story:** Aaron Cantu, "A Tiny Farmworker Community is Eyed for California Hydrogen Experiment," Capital & Main, May 29, 2024, https://capitalandmain.com/a-tiny-farmworker-community-is-eyed-for-california-hydrogen-experiment
- **Full report:** https://energyinnovation.org/publication/hydrogen-policys-narrow-path-delusions-and-solutions