Recent Hydrogen Studies focusing on Environment Considerations

The latest (Sept 15, 2022): New York Hydrogen Demonstration Confirms Environmental Justice Concerns. The New York Power Authority (NYPA) released the results of a collaboration with EPRI and General Electric (GE) designed to test the blending and combustion of green hydrogen with fossil gas at NYPA's Brentwood Power Station in Long Island. The findings confirm concerns expressed by Clean Energy Group and other advocates and energy experts, that burning hydrogen in power plants increases emissions of nitrogen oxides (NOx). NOx emissions have serious health impacts on surrounding communities, leading to severe respiratory and cardiovascular conditions and exacerbating existing inequities. The demonstration found that NOx emissions steadily increased as hydrogen blending levels were increased, raising NOx emissions rates by as much as 24%. The only way that power plant operators were able to keep NOx air emissions within permitted levels was by significantly increasing water injection at the site, which raises additional sustainability concerns.

Is heating homes with hydrogen all but a pipe dream? An evidence review. The paper reviews 32 independent studies and finds that the widespread use of hydrogen for heating (space and water heating) is not supported by ANY. The evidence suggests that, compared to other alternatives such as heat pumps, solar thermal and district heating, hydrogen use for domestic heating is less economic, less efficient, more resource intensive, and associated with larger environmental impacts.

"Assessing the Viability of Hydrogen Proposals: Considerations for State Utility Regulators and Policymakers", Energy Innovation

- The report concludes that hydrogen should play a limited role in supporting a carbon-free economy, reserved for the hardest-to-decarbonize end-uses for which no alternatives exist
- The report summarizes the existing body of research on blending hydrogen with natural gas for use in buildings or for power generation and finds it is highly inefficient and does little to reduce GHG emissions. Instead, it might thwart more viable decarbonization pathways while increasing consumer costs, exacerbating air pollution, and imposing safety risks.
- It includes a one pager that outlines the climate, cost, health and safety risks of hydrogen and points to efficient electrification as an alternative.
- The report delves into the limits on hydrogen blends in pipelines and home appliances, costs of using green hydrogen for buildings vs electrification and greater efficiency of electric appliances compared to hydrogen burning appliances. (According to one estimate, it takes approximately five times more wind or solar electricity to heat a home with green hydrogen than it takes to heat the same home with an efficient electric heat pump)

"Low-Carbon Fuels Have a Limited Role to Play in New York's Buildings", Rocky Mountain Institute (RMI)

- The report examines the challenges that make hydrogen, biomethane, and synthetic methane impractical for playing any significant role in heating buildings in New York, a state that has become a national leader in climate action in the buildings sector.
- It found that hydrogen is inefficient as a fuel in buildings. For the same amount of heating, you need 4 times as much clean electricity to create the green hydrogen as compared to heat pumps.
- Almost double the renewable power would be needed by 2050 to power buildings with green hydrogen
- The report identified practical issues with hydrogen: hydrogen embrittles steel pipes (using PHMSA data) & limitations of existing appliances that cannot function on hydrogen

"Hydrogen Pipe Dreams: Why Burning Hydrogen in Buildings is Bad for Climate and Health", Physicians for Social Responsibility. The report offers the following policy recommendations:

- Promote and expand the direct use of renewably generated electricity to heat buildings. Support options such as promoting efficient electric appliances like heat pumps through point-of-purchase rebates; emissions performance standards for buildings; all-electric building codes; renewable requirements for electricity production, and expanded energy storage to enhance grid resilience and performance.
- As part of the process for considering permits for hydrogen projects, require an Environmental Impact Assessment, Comprehensive Health Impact Assessment, and a cost-effectiveness analysis comparing burning hydrogen with lower-pollution options including energy efficiency, renewable energy, and energy storage options.
- Require accounting of the full-lifecycle greenhouse gas emissions of producing hydrogen. Greenhouse gas emission inventories must take all those emissions into account.
- Require certification of “green” hydrogen to assure it is produced using truly renewable, and 100 percent renewable, energy sources.
- State public utility commissions and state legislatures should not allow gas utilities to raise ratepayer rates to purchase hydrogen for blending, nor should they allow hydrogen to qualify for “clean heat” credits.

“Reclaiming Hydrogen for a Renewable Future: Distinguishing Fossil Fuel Industry Spin from Zero-Emission Solutions”, Earth Justice. The report concludes the following about applications for green hydrogen:

- Least-regrets uses for green hydrogen: Displace fossil hydrogen in current uses as an industrial feedstock
- Sectors to explore with caution: Maritime shipping; Aviation; High-heat industrial processes; Long-haul trucks and trains; Long-term storage of renewable electricity paired; with fuel cells
- Sectors where hydrogen is not a solution: Combusting in fossil gas power plants; Gas-burning appliances in homes and commercial buildings; Cars, buses and regional trucks

Organizations submitted these joint comments to DEEP about the use of hydrogen in Connecticut. The key takeaways:

- Green hydrogen cannot be supplied in sufficient quantities to replace fossil gas in the buildings or power sector
- Alternatives to green hydrogen, including blue hydrogen, do not produce the requisite greenhouse gas emission reductions to support Connecticut's climate commitments
- There are a host of practical difficulties with reliance on green hydrogen that also would need to be addressed and satisfactorily resolved
    - Hydrogen production via electrolysis is inefficient and expensive
    - Hydrogen is leakable and is an indirect greenhouse gas
    - Hydrogen embrittles steel and cast iron pipelines, necessitating a costly replacement of existing pipeline infrastructure to accommodate hydrogen:
    - End-use appliances are not made to combust hydrogen and costly appliance replacement would be required to accommodate substantial hydrogen blends
    - Hydrogen has a substantially lower energy density than methane, which means that far greater quantities must be combusted to generate the same energy or heat
    - Hydrogen is explosive and storage issues must be resolved
    - Hydrogen combustion results in significant air pollution

Climate Impact of Methane and Methane Leakage Studies

Large Fugitive Methane Emissions From Urban Centers Along the U.S. East Coast: https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2019GL082635. Key points:

- Aircraft observations downwind of six major cities along the U.S. East Coast are used to estimate urban methane emissions
- Observed urban methane estimates are about twice that reported in the Gridded EPA inventory
- Methane emissions from natural gas (including end use) in five cities combined exceeds nationwide emissions estimate from local distribution

UN Global Methane Assessment: https://wedocs.unep.org/bitstream/handle/20.500.11822/35917/GMA_ES.pdf

Methane emissions and climatic warming risk from hydraulic fracturing and shale gas development: implications for policy: https://www.dovepress.com/methane-emissions-and-climatic-warming-risk-from-hydraulic-fracturing--peer-reviewed-fulltext-article-EECT

"Ideas and perspectives: is shale gas a major driver of recent increase in global atmospheric methane?" https://bg.copernicus.org/preprints/bg-2019-131/bg-2019-131.pdf

Methane doesn't get the attention CO2 gets – even though it's far more potent. It all comes down to bad math. Read more from @StanfordWoods' Sam Abernethy in the @SFChronicle:

https://www.sfchronicle.com/opinion/openforum/article/Why-don-t-people-realize-how-bad-methane-is-for-16998570.php

Rhetoric vs. Reality: The Myth of "Renewable Natural Gas" for Building Decarbonization: https://earthjustice.org/sites/default/files/feature/2020/report-decarb/Report_Building-Decarbonization-2020.pdf

Methane Gas Leaks from Pipelines in Hartford:
In 2016 and 2019, Sierra Club Connecticut conducted two research studies of methane gas leaks in Hartford. Both studies found active methane leaks throughout the city of Hartford. In 2016, a total of 716 distinct methane leaks over 225 road miles in Hartford was detected, resulting in a leak frequency of 3.2 leaks per road mile. The 2019 study covered fewer road miles, but found 4.3 leaks per mile. The leak frequencies found in 2016 and 2019 compare to 4.3 leaks per mile previously found in Boston, Massachusetts (MA) (Phillips, et al. 2013).

A preliminary estimate of methane leaks in Hartford from the 2016 study is 0.86 metric tonnes leaked per day (or 313 metric tons per year; a metric tonne is 2,204.6 pounds, a U.S. ton is 2,000 pounds), equivalent to 42,840 cubic feet per day of natural gas. This leakage rate represents an equivalent daily gas consumption of approximately 214 U.S. households.

Studies Confirm Widespread Gas Leakage From Pipelines:
In Boston, a 2021 study showed methane being released from the gas system into Boston's atmosphere is six times higher than estimates used by the Massachusetts Department of Environmental Protection. The Boston study showed total supply chain losses of 3.3 to 4.7% which significantly increases the climate impacts of fossil gas compared to Environmental Protection Agency estimates.

A study of gas leaks from pipelines commissioned by the DC government in 2021 identified 3,346 locations with methane at concentrations higher than ambient background levels. Neighborhood researchers in Washington DC found hundreds of methane gas leaks across the city in a citizen science project conducted in 2021 and 2022.

Methane and NOx Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes, Environmental Science & Technology, January 27, 2022. Stanford University researchers found that gas stoves leak significant amounts of methane, even when turned off. Methane gas leaks from stoves cause climate damage equivalent to that caused by about 500,000 gasoline-powered cars, according to the Stanford study. The Stanford researchers measured how much methane escapes from the moment a burner is turned on and when the flame ignites the gas. It also examined how much unburned methane is released during cooking and how much gas is leaked when the stove is off. The scientists from Stanford University conducted the study on gas cooktops in 53 California homes. The scientists found no relationship between the age or cost of a stove and its emissions. New and more expensive stoves leaked gas at similar rates to older and less expensive gas cooktops.