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Blue Hydrogen Has Weak Case When It Comes to Emission Reductions

Methane From Natural Gas Used for Blue Hydrogen Undermines Clean Tech Claims

Many private investors and potential end-use customers will look beyond a plant's efforts to capture carbon from its on-site emissions. Most are highly likely to consider the full carbon footprint of a hydrogen product from feedstock extraction to its final use. Blue hydrogen's market appeal as a greenhouse gas (GHG) reduction tactic is weak due to the upstream emissions from extracting, processing and moving natural gas.

Natural gas is a mixture of gases extracted from underground reserves of fossil fuel. Between two-thirds and 77 percent of unprocessed natural gas is methane. After extraction, the gas travels through gathering pipelines to processing plants that remove certain hydrocarbons and fluids. The methane then travels through feeder pipelines to distribution centers or storage sites, before arriving through another pipeline to its end use (such as a blue hydrogen plant). Harmful methane emissions escape into the atmosphere throughout this delivery system, as explained below.

Methane is 86 times more powerful as a GHG than CO_2 over a 20-year time frame,[1] accounting for an estimated 25% of net global warming in recent decades.[2] According to the United Nations Environment Programme (UNEP), global methane emissions must be cut at least 40% by 2030 to curb global warming to 1.5°C this century—the target set by the 2015 Paris Agreement.[3] The UNEP reports a transition to renewable energy and energy efficiency would "substantially contribute to methane mitigation over the next few decades."[4]

[1] Intergovernmental Panel on Climate Change (IPCC). Climate Change 2021. The Physical Science Basis. 2021. Also see: IPCC. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the IPCC. 2014, p. 87, Box 3.2, Table 1. Also see: Climate Change. Anthropogenic and natural radiative forcing. 2013.
[2] IPCC. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. 2013.
[3] United Nations Environment Programme (UNEP) and Clean Air Coalition. Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions. 2021, p. 6-ES and Section 4.1.
[4] United Nations Environment Programme, *op. cit.*, p. 11-ES and Section 4.3.

A. Aerial and Satellite Data Show the Amount of Methane Released From Natural Gas Extraction and Transport Is Higher Than EPA Estimates Suggest

For many years, natural gas had a reputation of being a better option to reduce GHG emissions than coal. An efficient natural gas plant emits 50 percent to 60 percent less CO_2 than a typical coal plant.[5] Drilling and delivering natural gas, however, releases substantial amounts of methane.[6]

The U.S. Environmental Protection Agency (EPA) model for estimating such methane emissions greatly underpredicts the impact. One study examined oil and gas production, processing, and transmission, before local distribution and end use. Using ground-based measurements validated by aircraft observations and recent atmospheric studies, it found methane emissions were roughly 60 percent more than the EPA's model would estimate.[7] To assess the impact of local distribution and end use of natural gas, a subsequent academic study directly observed methane emissions in research flights over six major urban centers on the U.S. East Coast. The methane emissions were more than double the amounts estimated by the EPA inventory in four of the six areas observed.[8]

Relying on these two studies and other information, researchers concluded that producing hydrogen from natural gas with carbon capture and storage (CCS) can release more greenhouse gases than directly burning natural gas.[9]

Since then, researchers who conducted the municipal impacts study have expanded the scope of their work and included satellite data. In the aggregate, total methane emission rates were 2.8 times greater than the EPA inventory estimated.[10] A subsequent analysis found that using "best case CCS technology," blue hydrogen would produce emissions that were only 17 percent less than burning natural gas with no CCS, and lower capture rates made blue hydrogen emissions equal to or higher than natural gas without CCS.[11]

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[5] U.S. Department of Energy, National Energy Technology Laboratory (NETL). Cost and performance baseline for fossil energy plants, Vol. 1: Bituminous coal and natural gas to electricity. November 2010.
[6] Natural gas venting and flaring in the United States more than doubled from 2017 to 2018. See: Energy Information Agency. Natural Gas Gross Withdrawals and Production. Accessed November 28, 2021.
[7] Ramon A. Alvarez et al., Assessment of methane emissions from the U.S. oil and gas supply chain, Science 361:186-88, 2018.
[8] Genevieve Plant, et al., Large fugitive methane emissions from urban centers along the U.S. east coast, Geophysical Research Letters 46 (14): 8500-8507, July 28, 2019.
[9] R. Howarth and M. Jacobson. How green is blue hydrogen? Energy Science and Engineering. 9: 1676-1687, 1683. July 26, 2021. The conclusion is based on the 20-year impact of methane.
[10] Genevieve Plant, *et al.* Remote Sensing of Environment. 268. January 2022 (made available online October 28, 2021).
[11] T. Longden, *et al.* Clean hydrogen? – Comparing the emissions and costs of fossil fuel versus renewable electricity-based hydrogen. Applied Energy. 306. January 2022, pp. 4 and 15.

B. Reducing Methane From the Drilling and Transport of Natural Gas Would Require Extensive, Vigorous Monitoring and Enforcement

Although measures to reduce methane emissions from the natural gas system could have some impact, they may take many years to implement effectively. The UNEP reports optimistically that leak controls and other measures could cut emissions between 29 million and 57 million tons per year (mtpa) worldwide.[12] The emissions come from so many sources, however, that achieving such results would require comprehensive controls throughout the industry.

Targeted measures to reduce vented and fugitive methane emissions may include leak detection/repair, recovery and use of vented gases, and improved control of fugitive releases. The recovery and use of vented gases alone can include capturing gas emitted from oil wells, blowdown capture, recovery and use of vented gas and installation of flares. Control of fugitive emissions can include action to detect and repair leaks; replace pressurized gas pumps and controllers with electric or air systems; replace gas-powered pneumatic devices and gasoline or diesel engines with electric motors; replace old devices earlier than necessary, replace compressor seals or rods; and cap unused wells.[13]

Achieving such measures throughout the gas industrial pathway, from drilling to end use, would require comprehensive rules coupled with extensive monitoring and enforcement.

The EPA has been ineffective at controlling vented and fugitive methane emissions. Regulations issued in 2012 and 2016 have had only minimal impact,[14] with an annual decline of only 0.3 percent.[15] The 2012 regulations only applied to sources built, modified or reconstructed after August 23, 2011; the 2016 regulations only applied to sources built, modified or reconstructed after September 18, 2015.

EPA recently proposed a new set of regulations to improve methane controls.[16] More than 280,000 comments on the proposal were submitted to EPA from industry, academic think tanks and public interest organizations.[17] The proposal

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[12] United Nations Environment Programme, *op. cit.*, p. 10-ES and section 4.2.

[13] United Nations Environment Programme, *op. cit.*, p. 13-ES.

[14] Emissions of volatile organic compounds (which include methane) from production, processing, transmission and storage operations were regulated in 2012 by 40 CFR 60, Subpart OOOO. The regulation was expanded to include greenhouse gases, specifically including methane, in 2016. 40 CFR § 60, Subpart OOOOa.

[15] Boston University Institute for Sustainable Energy and Columbia University Center on Global Energy Policy. Methane emission controls: Toward more effective regulation. June 4, 2021

[16] The new standards, when finalized and adopted, will be codified at 40 CFR § 60, Subpart OOOOb. EPA projected they would be finalized toward the end of 2022. See: EPA. Regulatory Impact Analysis for the Proposed Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review. November 2021, pp. 1-9.

[17] Energy Law 360. EPA methane proposal prompts tug-of-war over details. February 2, 2022.

also includes guidelines for states to regulate methane emissions from existing sources. This memorandum does not speculate on the likely effects of the final regulation, which may change significantly from the proposed version.

Downstream GHG emissions from CCS are less well-understood, but certainly three areas of concern exist.

- GHG impacts can result when the captured CO_2 is transported from the blue hydrogen plant. A CCS system requires compression and a pipeline to move the CO_2 to a storage area. The Petra Nova project in Texas, for example, required an 80-mile pipeline to reach an oil field for enhanced oil recovery (EOR),[18] resulting in more infrastructure with a carbon footprint.

- Concerns about the safety and security of underground storage of CO_2 exist. The Department of Energy is devoting almost $4 million for research and development projects to identify and reduce the risk of seismic disruptions of underground storage areas and contamination of groundwater supplies.[19]

- Finally, if the CO_2 is used for EOR—the most common use for captured carbon today—two questions arise. First, the value of EOR as a carbon sequestration method (from injection of the captured CO_2 into an oil well) depends on the amount of CO_2 retained underground, which can depend on the well's features and how well the injection area is capped when closed.[20] Second, EOR is designed to increase oil production, further undercutting GHG reductions associated with blue hydrogen projects.

All of these factors affect the carbon footprint of blue hydrogen, and undercut its value as a reputed clean technology for investors or customers.

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[18] Government Accountability Office. Carbon Capture and Storage: Actions needed to improve DOE management of demonstration projects. December 2021, p. 8.
[19] U.S. Department of Energy. DOE announces nearly $4 million to enhance the safety and security of CO2 storage. May 28, 2021.
[20] One study found the percentage of retained CO_2 decreases with the volume injected and is larger for carbonate reservoirs than sandstone reservoirs. See: R. Olea. CO_2 retention values in enhanced oil recovery. J Petroleum Science Engin. 129:23-28. 2015. https://www.sciencedirect.com/science/article/abs/pii/S0920410515001199

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Suzanne Mattei, an attorney (Yale Law School) and consultant with Lookout Hill Public Policy Associates, has over 30 years' experience in environmental policy. As Regional Director for the NYS Department of Environmental Conservation for four years, she led permitting and enforcement in New York City. Her widely cited recent report on a proposed fracked gas pipeline in New York found flaws in proponents' arguments. As NYC Executive for the Sierra Club, her research exposed federal mismanagement of the 9/11 response; her testimony to Congress helped lead to passage of the James Zadroga Act, providing healthcare to Ground Zero workers.