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Comments on the Connecticut Green Bank Hydrogen Power Study Task Force - response to request for public comments to the Connecticut Hydrogen Task Force for December 9, 2022.

Comments submitted by Cary Lynch, Climate and Energy Policy Manager, The Nature Conservancy, Connecticut Chapter. Thank you for the opportunity to present comments on behalf of The Nature Conservancy regarding the Connecticut Hydrogen Task Force. TNC is committed to promoting actions and policy that reduce our energy needs while also increasing the reliability and security of our energy grid.

<u>Defining Clean Hydrogen</u>

1. **Based on Federal guidance in the Infrastructure Investment and Jobs Act and the Inflation Reduction Act, clean hydrogen is defined as hydrogen that is produced through a process that results in a lifecycle greenhouse gas emissions rate of not greater than 4 kilograms of CO2e per kilogram of hydrogen and with less than 2 kilograms of CO2e per kilogram of hydrogen at the point of production. Do you believe that Connecticut should pursue a more stringent definition for clean hydrogen than the one that has been established by the Federal government? If so, why? If not, why not?**

Yes, we believe that Connecticut should pursue a more stringent definition for clean hydrogen than has been established by the Federal government. A clean hydrogen definition should be limited to hydrogen produced from non-fossil resources with zero-carbon energy. Moving away from the hydrogen color coding system, the definition should be explicit that there be no carbon content from the hydrogen source material nor carbon emissions from the process to make it. The federal definition would allow for reclaimed fossil[1] and/or biofuels[2] to be used as the source material potentially requiring carbon capture and storage (CCS) technologies, all of which would increase local and cumulative emissions. In practice, CCS requires large amounts of energy to operate, transport, and store, all of which create substantial additional emissions[3]. Captured carbon, if not in long-term storage is often used in fertilizer production[4] and oil recovery[5], which increases downstream GHG emissions.

A more stringent definition would not preclude Connecticut from obtaining federal funding, despite concern expressed in several Hydrogen Task Force working group meetings. The Clean Hydrogen Production Standard (CHPS) sets the initial, minimum requirements to meet "clean hydrogen" standards, and the Department of Energy (DoE) "may expect stakeholders to reduce emissions across the supply chain as aggressively as technologically and economically feasible, and preference may be given to funding applicants on the basis of their emissions alongside other selection criteria[6]."

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[1] EPA Landfill Methane Outreach Program, https://www.epa.gov/lmop/basic-information-about-landfill-gas
[2] EPA Economics of Biofuels, https://www.epa.gov/environmental-economics/economics-biofuels
[3] Schmelz W. J., Hochman G. and Miller K. G. 2020, Total cost of carbon capture and storage implemented at a regional scale: northeastern and midwestern United States Interface Focus.102019006520190065, http://doi.org/10.1098/rsfs.2019.0065
[4] Fertilizer Europe pamphlet, 2019, Carbon Capture and Utilization in the European Fertilizer Industry, https://www.fertilizerseurope.com/wp-content/uploads/2019/10/Carbon-Capture-def-version-1.pdf
[5] Kolster, C., et al, 2017. CO2 enhanced oil recovery: a catalyst for gigatonne-scale carbon capture and storage deployment? Energy & Environment Science 10: 2594-2608, https://doi.org/10.1039/C7EE02102J
[6] U.S. Department of Energy Clean Hydrogen Production Standard (CHPS) Draft Guidance, 2022, https://www.hydrogen.energy.gov/pdfs/clean-hydrogen-production-standard.pdf

Hydrogen End-Uses

2. **The Hydrogen Task Force has been exploring hydrogen end uses including: critical facilities, aviation, cargo ships, material handling equipment, long-haul heavy duty trucks, fuel cells for peak power generation, high heat industrial processes, buses, ferries, rail, hydrogen blending in pipelines, and light-duty vehicles. How should the state address differing stakeholder perspectives about hydrogen end use prioritization? Which specific end uses are of greatest concern, and why? What actions can or should the state take to continue to solicit stakeholder feedback?**

The need to move rapidly towards sector-wide decarbonization, electrification, and energy efficiency does not allow any potential energy options to be ignored. However, there is a need to establish the right priorities for hydrogen use, rather than planning for its use in all sectors. Targeting hard to electrify sectors, hydrogen fuels can help decarbonize industrial processes, international shipping, long-haul transport, aerospace, and aviation[7]. Beyond those aforementioned uses, we believe it is not cost-effective, environmentally friendly, nor safe to utilize hydrogen fuels as a means to mitigate climate change.

Cost

Creating hydrogen from natural gas or water will require large amounts of energy. Recognizing that CT ratepayers already pay more for electricity than any other state in the Lower 48, paying more to produce a new energy source that does not yet have a market is not economically sensible.

Using the most energy efficient technology available to convert natural gas to make 1 kg of hydrogen requires 5 kWh of electricity[8]. Hydrogen produced through this method will cost approximately 3 times the cost of natural gas per unit of energy produced. Using electrolysis of water to make hydrogen requires even more energy (1kg of hydrogen requires 50-55 kWh) which can be translated to even higher costs[9] to CT ratepayers.

Hydrogen is also not without an environmental cost. If using natural gas as the source of hydrogen, carbon dioxide is created in the steam-reform process. Producing 1 kg of hydrogen is associated with about 9 kg of carbon dioxide[10]. If using electrolysis of water to produce hydrogen, a byproduct is not carbon dioxide, but it will require substantial solar, wind, or nuclear energy. We currently do not have enough renewable energy resources to produce the requisite amount of hydrogen to decarbonize any sector.

Once created, due to its relatively low volumetric energy density, transportation, storage and delivery of hydrogen can represent significant costs and energy inefficiencies.

It should be recognized that the unique properties concerning hydrogen energy density make the transport of hydrogen different from that of the other fuels and energy carriers and will likely require entirely different infrastructure. Storing and transporting hydrogen under atmospheric conditions is highly inefficient, so hydrogen is almost always liquefied or put under very high pressure. In effect, utilization

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[7] Geopolitics of the Energy Transformation: The Hydrogen Factor (irena.org)
[8] 2020 US DoE, Office of Fossil Energy, HYDROGEN STRATEGY: Enabling A Low-Carbon Economy, https://www.energy.gov/sites/prod/files/2020/07/f76/USDOE_FE_Hydrogen_Strategy_July2020.pdf

[9] 2020 DoE Cost of Electrolytic Hydrogen Production with Existing Technology, https://www.hydrogen.energy.gov/pdfs/20004-cost-electrolytic-hydrogen-production.pdf

[10] https://greet.es.anl.gov/publication-smr_h2_2019

of current natural gas infrastructure is not sufficient. Large capital investments in new infrastructure for hydrogen transport through pipeline will be needed. To retrofit the current 590 miles of natural gas transmission pipeline in Connecticut for hydrogen would cost ~$367 million ($.621 million/mile). To build new transmission lines for hydrogen would cost ~$1.28 billion ($2.17 million/mile)[11]. Given the statutory requirements of the CES, this is not yet a suitable pathway for lowering Connecticut ratepayer costs.

If Connecticut were to move forward with hydrogen production and inject it into the natural gas pipeline as a blend, the maximum percentage of hydrogen is between 15-20%[12]. A 15-20% blend would still require extensive pipeline upgrades and various new safety procedures for venting and flaring. Such blending would only continue to prop up the natural gas industry in the state, leaving ratepayers on the hook for indefinite upgrades to the aging and expensive infrastructure.

Hydrogen storage systems will also need large capital investments. Finding locations that will be both safe and cost effective while also efficiently helping meet energy load represents a problem that will require planning and stakeholder input. Storage system capital costs range from $15-20/kg of liquid hydrogen[13] depending on scale and size of tanks. Storing or using hydrogen at atmospheric pressure and temperature requires a substantial amount of space and energy[14], which will contribute to ongoing costs.

Safety

At present, most pipelines that transport gaseous hydrogen in the US are owned and operated by merchant hydrogen producers, located where large hydrogen users, such as petroleum refineries and chemical plants, are concentrated, mainly around the Gulf Coast. The feasibility to retrofit current natural gas pipelines to incorporate hydrogen blends and pure hydrogen is extremely uncertain.

Under the DoE, federal pipeline safety is overseen by the Pipeline and Hazardous Materials Safety Administration (PHMSA). PHMSA has recognized there are major research gaps for safely using existing pipelines for potential hydrogen transport[15]. Hydrogen is corrosive to steel and will embrittle metal joins, gauges, and welds along the pipeline[16] as well as corrode plastic and rubber seals. It is also a much lighter gas that methane, and as such is far more prone to leakage, which is concerning given the high leakage rate of methane through pipelines/gauges currently[17]. Then there is the issue of flammability. Hydrogen has a very broad flammability range, especially if mixed with oxygen. It requires only 0.02 millijoules of energy to ignite a hydrogen–air mixture, which is less than 7% of the energy needed to ignite natural gas. Even if states were to invest in new infrastructure for hydrogen transport and storage, issues of safety are still concerning.

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[11] https://www.statista.com/statistics/1220856/capex-new-retrofitted-h2-pipelines-by-type/#:~:text=For%20one%20kilometer%20of%20distribution,million%20U.S.%20dollars%20per%20kilometer.
[12] https://www.energy.gov/eere/fuelcells/hydrogen-pipelines
[13] https://www.hydrogen.energy.gov/pdfs/review20/st100_houchins_2020_o.pdf
[14] https://www.sciencedirect.com/science/article/pii/S0360319919310195#:~:text=Being%20the%20lightest%20molecule%2C%20hydrogen,storage%20density%20must%20be%20increased.
[15] https://primis.phmsa.dot.gov/rd/mtgs/020707/GlynHazelden_Hydrogen.pdf
[16] https://www.sciencedirect.com/science/article/pii/S2452321618302683
[17] https://blogs.edf.org/energyexchange/2021/10/28/new-research-shows-boston-methane-emissions-continue-despite-pipe-replacement-efforts/

Additionally, there is also no federal permitting process for underground hydrogen storage facilities, which will leave communities without basic regulatory oversight to protect public health and safety. A federal permitting regime to cover underground hydrogen storage facilities must also be developed based on tested and known safety requirements.

Hydrogen Supply

5. **If local (in-state) hydrogen supply is expected to limit in-state hydrogen end use applications, should the state consider the role of hydrogen imports in meeting supply needs?**

Currently, Connecticut does not have the resources (infrastructure, storage, renewables) to meet projected hydrogen supply. Such resources will take years to develop and require both substantial federal and in-state investment. Even with federal aid, hydrogen produced in state will likely be costly (as compared to other fuels) and could put undue financial burden on residents.

At this time, it is premature to determine whether imported hydrogen would be more cost-effective, but imports may not fit within future Connecticut "clean" hydrogen standards. As hydrogen demand increases, the state should be cautious of importing hydrogen. Instead, the state should prioritize creating clean hydrogen workforce development opportunities for populations that face systemic discrimination and/or are underrepresented in the workforce.

Hydrogen Infrastructure

6. **What additional processes should the state consider to ensure that use of pipeline infrastructure for hydrogen transport is implemented safely, and supports community and climate goals?**

As stated above, there are considerable safety concerns with the production, transport, storage, and use of hydrogen, and federal guidelines are still being developed[18]. Given these safety concerns, following best practices and establishing stringent regulatory requirements will be critical. Federal and state safety requirements should be established and regularly updated based on the best available science. In addition, the state should provide a robust public engagement process to ensure that community concerns are heard and discussed prior to the buildout of any hydrogen infrastructure project.

7. **What enabling infrastructure do you believe is highest priority for the state to pursue to support the development of Connecticut's hydrogen economy, and why?**

For reasons of cost, safety, efficiency, and environmental preservation[19], deployment of hydrogen should be limited to hard-to-decarbonize applications that cannot easily or cost-effectively be electrified and any build out of infrastructure should focus on those applications. Enabling infrastructure to support hydrogen should focus solely on these hard-to-decarbonize applications.

Hydrogen Funding and Policy Activities

10. **What are the best mechanisms for state agencies to gain visibility into federal funding opportunities pursued by individual commercial actors or other organizations? What actions can the state take to support these applications?**

[18] U.S. Dept. of Energy, Hydrogen and Fuel Cell Technologies Office, *Regulations, Guidelines, and Codes and Standards*, https://www.energy.gov/eere/fuelcells/regulations-guidelines-and-codes-and-standards.

[19] Amanda N Ullman and Noah Kittner 2022 *Environ. Res. Commun.* **4** 055003, **DOI** 10.1088/2515-7620/ac68c8

To increase transparency and public awareness of federal funding opportunities, the state should create a publicly accessible, searchable database with information on federal funding opportunities and the status of projects that have applied for or received funding. Additionally, a mapping tool should also be developed so people can see where projects are or will be located. It would be valuable for state agencies, other interested stakeholders, and the general public to easily access this information.

By providing information about hydrogen funding opportunities and transparency around projects, stakeholders and the public can better engage in the development of clean hydrogen projects in Connecticut. This will reflect the states commitment to DEIJ and alignment with state climate goals.

11. **What federal funding opportunities have stakeholders applied to? Are these formula grants or competitive? Are these opportunities hydrogen-related? Do stakeholders have lessons learned to share based on the application or implementation process?**

It is unclear what entities in Connecticut are pursuing federal funding and as such the status of potential projects is unknown. If it is legally possible that the state can obtain and publicly share this information, we encourage the state to do so.

We would like to thank you for the opportunity to submit our comments.