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March 3, 2025

Katie O'Shea, Project Manager
Office of Clean Energy Demonstrations
U.S. Department of Energy
1000 Independence Ave SW
Washington, D.C. 20585

Re: Comments by Clean Energy Group regarding Notice of Intent to Prepare an Environmental Impact Statement (EIS) for the Pacific Northwest Hydrogen Hub; Department of Energy (DOE) Docket DOE-HQ-2024-0094.

Dear Ms. O'Shea,

Clean Energy Group (CEG), a national nonprofit organization that works to provide innovative technical, economic and policy solutions to enable communities to participate equitably in the clean energy transition, is pleased to provide these comments in response to the Department of Energy's (DOE) notice of intent to prepare an Environmental Impact Statement (EIS) for the Pacific Northwest Hydrogen Hub, also known as The Pacific Northwest Hydrogen Association (PNWH2). These comments reflect the position of CEG and do not necessarily reflect the positions of CEG's partner organizations or funders.

For the past four years, CEG has worked extensively with environmental justice and community-based partners on hydrogen issues. Through its national Hydrogen Information and Public Education initiative, CEG is working to counter misinformation regarding hydrogen by developing a repository of research and information on the viability of issues related to the production and use of hydrogen. In addition, through this initiative, CEG supports the work of frontline organizations to understand and critically evaluate how hydrogen production may benefit or harm their communities.

The development of the Pacific Northwest Hydrogen Hub and the scope of this environmental impact statement will have wide ranging implications for the evaluation of federally funded hydrogen projects moving forward. Ensuring that the environmental impact of PNWH2 is accurately evaluated is crucial in developing a hydrogen economy that supports, rather than hinders, vital decarbonization efforts, and minimizes harm to environmental justice communities. An analysis of the chemical properties of hydrogen and how it interacts with surrounding materials and the atmosphere, as well as an examination of production methods and end uses proposed by PNWH2, will be necessary in determining the best path forward for this regional hub.

EIS Comment Deadline

First and foremost, we urge DOE to extend the deadline for comments on the proposed scope of the EIS by another 60 days. PNWH2 has provided limited information on the scope and locations of the proposed projects, leading to a lack of community knowledge and awareness of the potential environmental impact of the development of this hub. Extending the comment period would allow more time for crucial information to be released that would inform community engagement and education around the environmental impact statement.

Both in person scoping meetings for this EIS process have been cancelled, one scheduled for February 11th in Oregon and one scheduled for February 13th in Washington. These meetings would have provided an opportunity for community members to provide input, an important step in the process. Extending the deadline for comments would be a step in the right direction to ensure that all voices be heard and incorporated into the scope.

Hydrogen's Global Warming Potential

While hydrogen does not produce carbon dioxide (CO2) when combusted, the rapid expansion of a hydrogen economy could still exacerbate global warming. Hydrogen interacts with the atmosphere in four main ways: 1) it extends the lifetime of methane in the atmosphere; 2) it increases the production of ozone; 3) it increases the production of stratospheric water; and 4) it alters the production of certain aerosols. These atmospheric effects culminate in an extreme global warming potential, nearly 12 times that of CO2 over 100 years after release. When looking at a time scale of 20 years, hydrogen contributes to climate warming 35 times more than CO2.[1] Venting hydrogen is part of standard industry safety practices during the production, transportation, and storage of this gas, and understanding the effects of introducing hydrogen into the atmosphere through these practices is imperative to analyzing the climate impacts of increased hydrogen production and use through the Pacific Northwest Hydrogen Hub.

In addition to purposeful venting of hydrogen into the atmosphere, hydrogen will be introduced into the atmosphere through unintentional leakage. Due to its small molecular size and low density, hydrogen gas is highly prone to leakage. While exact data on leakage is limited, many models have pointed to the necessity for leakage rates to be kept at a minimum as hydrogen production and use increases to mitigate the climate warming effects.[2] Leak detection for

[1] Sand, Maria, Ragnhild Bieltvedt Skeie, Marit Sandstad, Srinath Krishnan, Gunnar Myhre, Hannah Bryant, Richard Derwent, et al. "A Multi-Model Assessment of the Global Warming Potential of Hydrogen." Communications Earth & Environment 4, no. 1 (June 7, 2023): 203. https://doi.org/10.1038/s43247-023-00857-8.
[2] Bertagni, Matteo B., Stephen W. Pacala, Fabien Paulot, and Amilcare Porporato. "Risk of the Hydrogen Economy for Atmospheric Methane." Nature Communications 13, no. 1 (December 13, 2022): 7706. https://doi.org/10.1038/s41467-022-35419-7; Ocko, I. B., and S. P. Hamburg. "Climate Consequences of Hydrogen Emissions." Atmospheric Chemistry and Physics 22, no. 14 (2022): 9349–68. https://doi.org/10.5194/acp-22-9349-2022.

hydrogen is a nascent technology, still being developed and refined, and relying on this limited data could underestimate the true climate warming effects of hydrogen production and use.[3]

PNWH2 has stated that it plans to produce 400 metric tons per day (mtpd) of hydrogen.[4] The impact of intentional and unintentional release of hydrogen into the atmosphere through industry standard venting and inevitable leakage while producing and offtaking this 400 mtpd of hydrogen could have far reaching consequences for the climate and must be included in the scope of the EIS.

Hydrogen Safety

Hydrogen's chemical properties increase the safety risks from leaks and ignition. Hydrogen has a wide ignition range and burns hotter than the most utilized and studied flammable gas, methane. When it ignites, hydrogen flames are invisible during the daytime.[5] Additionally, there are no commercially available odorants for hydrogen, an odorless gas, that could aid crucial leak detection, especially around workers and customers.[6] The properties of hydrogen flames paired with inadequate leak detection technology make the production and transportation of this gas of particular concern.

PNWH2 has proposed the use of hydrogen combustion for power generation in turbines in multiple project "nodes" including Ferndale, WA and Boardman, OR.[7] When combusted, hydrogen produces on average six times as much NOx as methane.[8] NOx pollution is a public health hazard that does significant damage to the respiratory system over time. Many frontline communities located near existing heavily polluting power plants or existing oil and gas production sites have developed serious health disparities due to overexposure to NOx. These impacts are not limited to areas where production or combustion takes place, and adverse health impacts are seen even when NOx emissions are within permitted limits.

Existing NOx emissions control technologies, such as using a catalytic reaction, diluting the fuel mix with water or steam, or using newer low-NOx technology such as a dry low NOx (DLN) combustion system, are not equipped to handle higher blends of hydrogen and natural gas. During a pilot hydrogen blending demonstration at NYPA's Brentwood facility, NOx emissions increased as much as 24 percent as the fraction of hydrogen increased. To keep NOx emissions

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[3] Qanbar, Mohammed W., and Zekai Hong. "A Review of Hydrogen Leak Detection Regulations and Technologies." Energies 17, no. 16 (August 15, 2024): 4059. https://doi.org/10.3390/en17164059.
[4] "Pacific Northwest Hydrogen Hub PNW Stakeholder Briefing" March 13, 2024. https://pnwh2.com/wp-content/uploads/2024/06/PNWH2-Environmental-Stakeholder-Briefing-Master-Deck.pdf
[5] Martin, Paul, Ilissa B. Ocko, Sofia Esquivel-Elizondo, Roland Kupers, David Cebon, Tom Baxter, and Steven P. Hamburg. "A Review of Challenges with Using the Natural Gas System for Hydrogen." Energy Science & Engineering 12, no. 10 (October 2024): 3995–4009. https://doi.org/10.1002/ese3.1861.
[6] Ibid.
[7] Pacific Northwest Hydrogen Association. "Projects." Accessed February 28, 2025. https://pnwh2.com/projects/.
[8] Cellek, Mehmet Salih, and Ali Pınarbaşı. "Investigations on Performance and Emission Characteristics of an Industrial Low Swirl Burner While Burning Natural Gas, Methane, Hydrogen-Enriched Natural Gas and Hydrogen as Fuels." International Journal of Hydrogen Energy 43, no. 2 (January 11, 2018): 1194–1207. https://doi.org/10.1016/j.ijhydene.2017.05.107.

within permitted limits, the plant had to significantly increase water consumption.[9] At best, in newer turbines developed to successfully combust 100 percent hydrogen while deploying NOx emissions control technologies, NOx emissions remain like that of a newer natural gas plant.[10] Environmental justice communities are already seeing adverse health impacts from NOx emissions at these levels, and introducing a new source of NOx emissions could have devastating effects.

When combusting hydrogen in gas turbines, special consideration must be made to the interaction of hydrogen with typical turbine materials. Hydrogen corrodes metals through a process called hydrogen embrittlement (HE), where hydrogen diffuses into the alloy and combines with carbon to form methane, which then creates crack in the metal. Exposure to hydrogen can result in a decreased resistance to fracture and an exacerbation of the existing flaws in steel and other types of metal.[11] The nickel-based alloy that typically comprise gas turbine blades are particularly susceptible.[12] Corrosion of these components due to the introduction of hydrogen could result in safety failures and a decrease in turbine durability.

HE is an issue across the production, transportation, storage, and end use of hydrogen. Increased scrutiny must be paid to the types of metals and materials used throughout the hydrogen supply chain to prevent corrosion, decreased fracture resistance, and accelerated degradation. While plastic is not impacted by HE, hydrogen can permeate through polyethylene at a rate six to seven times higher than methane.[13] PNWH2 has proposed hydrogen pipelines to transport the fuel to various end uses, and the development of hydrogen storage facilities, making it imperative that the materials used for this infrastructure are not susceptible to hydrogen embrittlement, lattice dilation, or permeation. Negative interactions with these materials could lead to increased leakage, hazardous explosions, and decreased infrastructure longevity.

Hydrogen Production

PNWH2 intends to produce its proposed 400 mtpd of hydrogen through electrolysis with renewable energy, also known as green hydrogen. Electrolysis is a water-intensive process; for every kilogram of hydrogen produced through electrolysis, a minimum of 2.6 gallons of purified

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[9] Low Carbon Resource Initiatives, "Hydrogen Cofiring Demonstration at New York Power Authority's Brentwood Site: GE LM6000 Gas Turbine." Technical brief. 2022 LCRI-PG LCRI Program. EPRI, September 15, 2022. https://restservice.epri.com/publicdownload/000000003002025166/0/Product

[10] Kawasaki Heavy Industries, Ltd. "World's First Successful Technology Verification of 100 percent Hydrogen Fueled Gas Turbine Operation with Dry Low NOx Combustion Technology Improving Power Generation Performances to Realize a Hydrogen Society," July 21, 2020. https://global.kawasaki.com/news_200721 1e.pdf

[11] Raju, Arun SK, and Alfredo Martinez-Morales. "Hydrogen Blending Impacts Study." Prepared by: University of California, Riverside. Prepared for: The California Public Utilities Commission. https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M493/K760/493760600.PDF

[12] Zhang, Zhichao, Jurriaan Peeters, Vera Popovich, and Can Ayas. "Combined Effects of Stress and Temperature on Hydrogen Diffusion in Non-Hydride Forming Alloys Applied in Gas Turbines." *International Journal of Hydrogen Energy* 47, no. 71 (August 19, 2022): 30687–706. https://doi.org/10.1016/j.ijhydene.2022.07.006.

[13] Islam, Aminul, Tahrim Alam, Nathan Sheibley, Kara Edmonson, David Burns, and Manuel Hernandez. "Hydrogen Blending in Natural Gas Pipelines: A Comprehensive Review of Material Compatibility and Safety Considerations." *International Journal of Hydrogen Energy* 93 (December 3, 2024): 1429–61. https://doi.org/10.1016/j.ijhydene.2024.10.384.

water is needed. This water is transformed into hydrogen and cannot be recycled back to the source.[14] The water demand does not end there. Depending on end use, additional water is needed for cooling, making green hydrogen's water consumption a major area of concern especially in drought prone areas like the Pacific Northwest.[15]

The production of green hydrogen is also very energy intensive, and 60 percent of the energy put into electrolysis is lost.[16] The impact of energy use on Washington, Oregon, and Montana's grid and the potential diversion of renewable energy resources away from electrification needs to be further evaluated.

Producing hydrogen using electrolyzers powered by electricity from the grid could result in more emissions than hydrogen produced through fossil fuels, unless the electrolysis is matched with new hourly renewable generation.[17] The final guidance released by the Treasury regarding the 45V Clean Hydrogen Production Tax credit reflects this by requiring eligible facilities to match their production with new renewable generation. However, Washington is exempt from this requirement.[18] This makes it unlikely that Washington-based PNWH2 projects will match their hydrogen production with new renewable generation, even if the electrolyzers are grid connected. DOE must consider the implications for Washington's grid as these new sources of heavy demand come online, increasing reliance on dirtier forms of electricity generation.

Hydrogen End Use

Development plans proposed for PNWH2 include the production, storage, and transport of liquid hydrogen.[19] Hydrogen liquefaction is a very energy intensive process. Hydrogen transforms into a liquid from a gas at –253 degrees Celsius, a much lower temperature than other liquid fuels, so more energy is needed for the conversion and to maintain the liquid state of hydrogen. To convert ~12,000L of gaseous hydrogen into ~14L liquid hydrogen (both equaling 1kg), around 13.8 kWh of energy is used.[20]

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[14] Makhijani, Arjun, Thomas Hersbach, "Hydrogen: What Good Is It?," *Institute for Energy and Environmental Research,* January 2024. https://ieer.org/wp/wp-content/uploads/2024/01/What-Good-is-Hydrogen-IEER-report-for-Just-Solutions-January-2024.pdf
[15] Luhn, Alec "A Fifth of U.S. Green Hydrogen Projects Eyed for Water-Stressed Areas," *Floodlight* August 7, 2024. https://floodlightnews.org/green-hydrogen-projects-eyed-for-water-stressed-areas/; US Energy Information Administration, "Drought Conditions Reduce Hydropower Generation, Particularly in the Pacific Northwest - U.S. Energy Information Administration (EIA)." Accessed February 28, 2025. https://www.eia.gov/todayinenergy/detail.php?id=63664.
[16] Energy.gov. "Technical Targets for Proton Exchange Membrane Electrolysis." Accessed February 27, 2025. https://www.energy.gov/eere/fuelcells/technical-targets-proton-exchange-membrane-electrolysis.
[17] Ricks, Wilson, Qingyu Xu, and Jesse D Jenkins. "Minimizing Emissions from Grid-Based Hydrogen Production in the United States." Environmental Research Letters 18, no. 1 (January 2023): 014025. https://doi.org/10.1088/1748-9326/acacb5.
[18] Federal Register. "Credit for Production of Clean Hydrogen and Energy Credit," January 10, 2025. https://www.federalregister.gov/documents/2025/01/10/2024-31513/credit-for-production-of-clean-hydrogen-and-energy-credi
[19] Office of Clean Energy Demonstrations, "Pacific Northwest Hydrogen Hub (PNWH2) Awardee Fact Sheet", September 23, 2024. https://www.energy.gov/sites/default/files/2024-07/H2Hubs%20PNW%20Booklet_Factsheet_7.23.24.pdf?_hsenc=p2ANqtz--1tU942FEmnMQumvuFQhhEjSpnNCHne0wpGuRb-wMiLUIudW5KFZ3uVmpYAQRuvM_mwVSs
[20] Zhang, Tongtong, Joao Uratani, Yixuan Huang, Lejin Xu, Steve Griffiths, and Yulong Ding. "Hydrogen Liquefaction and Storage: Recent Progress and Perspectives." Renewable and Sustainable Energy Reviews 176 (April 1, 2023): 113204. https://doi.org/10.1016/j.rser.2023.113204.

Storing and transporting liquid hydrogen provides novel issues. Through the duration of time that the liquid hydrogen is stored and transported, one to five percent of the liquid will evaporate into gas per day. Allowing this expanded hydrogen gas to remain in storage containers with liquid hydrogen would lead to explosions, so it is industry practice to vent this hydrogen gas into the atmosphere.[21] This extensive venting practice will have major implications for the climate due to hydrogen's global warming effects and must be taken into consideration during an environmental evaluation.

The Environmental Impact Statement is an important step in evaluating the consequences of a fully developed PNWH2 hub. As the hydrogen economy proliferates, it is crucial that all environmental and social harms related to hydrogen production and use at PNWH2 be investigated.

In conclusion, CEG urges the DOE to analyze and evaluate impacts including but not limited to the global warming effects of venting and leaking hydrogen into the atmosphere, increased NOx emissions from hydrogen combustion, flammability of hydrogen, extreme water and energy intensity of green hydrogen production and hydrogen liquefaction, diversion of renewable energy away from electrification and towards hydrogen production, and the corrosive interactions between hydrogen and typical infrastructure materials. These issues could have grave consequences for the health and safety of citizens of Oregon, Washington, and Montana, and broader decarbonization goals within the region, and the EIS is an opportunity to ensure the most just and effective path forward.

We would welcome a conversation to discuss these issues further if that is of interest.

Respectfully submitted,

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[21] Ibid.