Clean Energy Group Response to RFI on
Regional Clean Hydrogen Hubs Implementation Strategy
Request for Information # DE-FOA-0002664

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Clean Energy Group (CEG) is pleased to provide this response to the U.S. Department of Energy (DOE) Energy Efficiency and Renewable Energy (EERE) Hydrogen and Fuel Cell Technologies Office (HFTO), Office of Fossil Energy and Carbon Management (FECM), the Office of Nuclear Energy (NE), and the Office of Clean Energy Demonstrations (OCED) regarding RFI No. DE-FOA-0002664. These comments reflect the position of CEG, a national nonprofit focused on accelerating an equitable and inclusive transition to a resilient, sustainable future. These comments do not necessarily reflect the positions of CEG's partner organizations or funders.

For the past two years, CEG has worked extensively with environmental justice and community-based partners on topics intersecting with hydrogen production, demonstration, and storage. Through its national Hydrogen Information and Public Education initiative, CEG is working to counter hydrogen misinformation by developing a repository of research and information on the viability of and issues related to the production and use of hydrogen, in addition to supporting the efforts of frontline organizations challenging hydrogen development that may negatively impact their communities. These comments respond to several provisions in DOE's Regional Clean Hydrogen Hubs Implementation Strategy, as outlined below.

Category 1: Regional Clean Hydrogen Hub Provisions and Requirements

Subcategory 3: Feedstock Diversity: "To the maximum extent practicable– (i) at least 1 regional clean hydrogen hub shall demonstrate the production of clean hydrogen from fossil fuels; (ii) at least 1 regional clean hydrogen hub shall demonstrate the production of clean hydrogen from renewable energy; and (iii) at least 1 regional clean hydrogen hub shall demonstrate the production of clean hydrogen from nuclear energy."

As much as is possible within the stipulations of the Infrastructure Investment and Jobs Act (IIJA), DOE should give priority to funding and support for green hydrogen. CEG is strongly opposed to the production of clean hydrogen from fossil fuels, or so-called "blue hydrogen." Multiple peer-reviewed analyses of blue hydrogen emissions have found that, even with carbon capture and storage (CCS), the production and combustion of hydrogen derived from natural gas produces more climate damaging greenhouse gas (GHG) emissions than directly burning natural gas.[1][2] This is partially due to the ineffectiveness of current CCS technology, which most estimates find can only capture about 55 percent of carbon emissions in the hydrogen production and combustion cycle.[3] CCS reduces CO^2 emissions of fossil fuel-based power plants, but increases life-cycle indicators for particulate matter up to 60 percent.[4] Given that the electrolysis technology to produce hydrogen from renewable energy, also known as green hydrogen, already exists, extending the use of fossil fuels through hydrogen production hubs is counterproductive to combating GHG emissions and the severe impacts of climate change. DOE's Hydrogen Hub Implementation Strategy should place no special priority on the production of clean hydrogen from fossil fuels beyond what is required by Section 813 of the IIJA.

Subcategory 3d: "Should DOE prioritize the repurposing of historic fossil infrastructure in the regional hub(s) focused on production from fossil fuels and if so, over what time frame? If yes, should DOE incentivize an eventual transition from fossil fuels to another fuel source? What conditions should DOE place on the carbon intensity of the fossil fuels (with CCS) used in this hub other than what is already specified in the BIL?"

CEG recommends that DOE consider the following:

- Hydrogen should not be developed in ways that have the effect, whether intended or unintended, of extending the life of fossil fuel infrastructure. In the first place, most fossil fuel infrastructure is ill-suited to transporting, storing, or combusting hydrogen. If steel is exposed to hydrogen at high temperatures or high pressure, hydrogen will diffuse into the alloy and combine with carbon to form tiny pockets of methane.[5] This methane does not

[1] Howarth, Robert W., and Mark Z. Jacobson. "How Green Is Blue Hydrogen?" *Energy Science & Engineering* 9, no. 10 (2021): 1676–87. https://doi.org/10.1002/ese3.956.

[2] Longden, Thomas, Fiona J. Beck, Frank Jotzo, Richard Andrews, and Mousami Prasad. "'Clean' Hydrogen? – Comparing the Emissions and Costs of Fossil Fuel versus Renewable Electricity Based Hydrogen." *Applied Energy* 306 (January 15, 2022): 118145. https://doi.org/10.1016/j.apenergy.2021.118145.

[3] Howarth and Jacobson.

[4] Hertwich, Edgar G., Thomas Gibon, Evert A. Bouman, Anders Arvesen, Sangwon Suh, Garvin A. Heath, Joseph D. Bergesen, Andrea Ramirez, Mabel I. Vega, and Lei Shi. "Integrated Life-Cycle Assessment of Electricity-Supply Scenarios Confirms Global Environmental Benefit of Low-Carbon Technologies." Proceedings of the National Academy of Sciences 112, no. 20 (2015): 6277–82. https://doi.org/10.1073/pnas.1312753111.

[5] Murakami, Yukitaka. "21 - Hydrogen Embrittlement." In *Metal Fatigue (Second Edition)*, edited by Yukitaka Murakami, Second Edition., 567–607. Academic Press, 2019. https://doi.org/10.1016/B978-0-12-813876-2.00021-2.

diffuse out of the metal and cracks the steel. This process, called "hydrogen embrittlement," means that a blend of more than 20 percent hydrogen to natural gas by volume could not be safely stored or transported via existing steel fossil fuel infrastructure.

- Due to these issues, as well as the upstream methane emissions of hydrogen production from fossil fuels, a study found that adding a blend of 20 percent green hydrogen to the natural gas network would increase industry costs by an average of 23.8 percent and would only lower greenhouse gas emissions by 6-7 percent.[6]

- DOE should prioritize transitioning hydrogen hubs focused on hydrogen production from fossil fuels to fossil fuel-free production as quickly as possible. It should be noted that there is no "glide path" from carbon-intensive hydrogen production to carbon-free hydrogen, even with CCS. As stated in our earlier response under Subcategory 3, hydrogen made from fossil fuels, even when paired with CCS, is not "clean." It continues to produce GHG emissions at highly concerning levels, and any hydrogen hubs that utilize fossil fuels should be evaluated as GHG producing assets that will never transition to being GHG-free. Therefore, any investment in prolonging the use of fossil fuel infrastructure or fossil fuels to produce hydrogen is not contributing to lowering GHG emissions or creating a carbon-free energy transition.

Subcategory 4: End-Use Diversity
END-USE DIVERSITY: "To the maximum extent practicable– (i) at least 1 regional clean hydrogen hub shall demonstrate the end-use of clean hydrogen in the electric power generation sector; (ii) at least 1 regional clean hydrogen hub shall demonstrate the end use of clean hydrogen in the industrial sector; (iii) at least 1 regional clean hydrogen hub shall demonstrate the end-use of clean hydrogen in the residential and commercial heating sector; and (iv) at least 1 regional clean hydrogen hub shall demonstrate the end-use of clean hydrogen in the transportation sector."

4d: "The climate value of displacement may vary across end uses. How should the climate benefit of different hydrogen end uses be considered?"

Although green hydrogen has the potential to be useful in difficult-to-electrify industrial and heavy transportation sectors, any vetting of hydrogen for power generation should be weighed against the efficiency losses of production versus the direct displacement of existing sources of emissions.

[6] Collins, Leigh. "'Expensive, Wasteful, Limited CO2 Reduction: Blending Hydrogen into Gas Grid Should Be Avoided.'" Recharge, January 26, 2022. https://www.rechargenews.com/energy-transition/expensive-wasteful-limited-co2-reduction-blending-hydrogen-into-gas-grid-should-be-avoided/2-1-1156262.

Green hydrogen produced from renewable energy relies on electrolyzers. With current electrolyzer technology, converting renewable energy into hydrogen, then converting that energy back into electricity for the grid through combustion, has a roundtrip efficiency of about 30 percent.[7] This already low roundtrip efficiency is further exacerbated by fugitive hydrogen emissions during storage and transport, due to the embrittlement issues mentioned in our response under Subcategory 3d.

In addition to climate value, public health and environmental justice risks should be factored into hydrogen end uses. For example, New York City is projected to realize 4.5 GW of offshore wind capacity by 2035. All this capacity will be required to replace the heavily polluting peaker plants currently operating in the city, many of which are high emitters of the harmful air pollutants nitrogen oxides (NOx) and sited in environmental justice communities.[8] If one of these peaker plants were to convert to green hydrogen, due to inefficiencies in the green hydrogen production process, much of New York's planned offshore wind capacity would need to be diverted to produce enough green hydrogen to power this plant. This diversion is doubly concerning because when combusted, either alone or in a natural gas blend, hydrogen produces high levels of NOx.[9] Furthermore, the production and use of hydrogen in fossil fuel assets could delay the retirement of legacy plants, encourage new investment in fossil fuel infrastructure, and undercut the market for renewable energy and battery storage. Diverting renewable energy to produce green hydrogen, especially if that green hydrogen is to be combusted, doubly condemns environmental justice communities to decades of more harmful pollution.

Category 3: Equity, Environmental, and Energy Justice (EEEJ) Priorities

EEEJ benefits will be a high priority as the H2Hubs are developed. For the purposes of this RFI, DOE has identified the following non-exhaustive list of policy priorities as examples to guide DOE's implementation of Justice40 in DACs: (1) decrease energy burden (2) decrease environmental exposure and burdens (3) increase access to low-cost capital; (4) increase the clean energy job pipeline and job training for individuals (5) increase clean energy enterprise creation (e.g., minority-owned or diverse business enterprises); (6) increase energy democracy, including community ownership; (7) increase parity in clean energy technology access and adoption; and (8) increase energy resilience.

Question 29: "What measures should H2Hub project developers take to ensure that harm to communities with environmental justice concerns, including local pollution, are

[7] Deign, Jason. "The Reality Behind Green Hydrogen's Soaring Hype." *Green Tech Media*, November 28, 2019, sec. Energy Storage. https://www.greentechmedia.com/articles/read/the-reality-behind-green-hydrogens-soaring-hype.

[8] UPROSE, The POINT CDC, New York City Environmental Justice Alliance, New York Lawyers for the Public Interest, and Clean Energy Group. *The Fossil Fuel End Game.* Accessed February 28, 2022. https://www.cleanegroup.org/wp-content/uploads/Fossil-Fuel-End-Game.pdf.

[9] 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 (2018): 1194–1207. https://doi.org/10.1016/j.ijhydene.2017.05.107.

mitigated?"

First and foremost, H2Hub project developers should consult with environmental justice communities located in or near potential project sites prior to the design process and regularly throughout development. Environmental justice communities do not all have the same priorities, so the only way to ensure that these projects truly benefit communities is through regular and responsive dialogue.

However, given that not all environmental justice communities have access to information regarding the potential harms of hydrogen, developers should also keep in mind the following:

- No H2Hub project should be used to extend the life of fossil-fuel power plant assets, which disproportionately harm environmental justice communities. Historically, the most polluting fossil fuel projects, such as peaker plants, have been sited in and near environmental justice communities, leading to disproportionate health outcomes in those communities, such as higher rates of respiratory and cardiovascular conditions.[10]

- One of the biggest harms caused by fossil fuel combustion is from resulting NOx and particulate matter emissions. Hydrogen, when combusted, produces six times the level of NOx emissions as methane.[11] The chemical differences between hydrogen and methane mean that dry low NOx burner designs, which are created to limit NOx emissions, are not effective at controlling emissions for hydrogen combustion or hydrogen and natural gas blends above a nominal level.[12]

- Therefore, any H2Hub project that plans to utilize existing fossil fuel infrastructure, particularly infrastructure located near environmental justice communities, to burn hydrogen will be condemning those communities to decades of additional exposure to harmful pollution. Combusting hydrogen, either made from renewable energy or fossil fuels, will only further exacerbate, and entrench, inequalities in the power sector.[13]

Even for green hydrogen, the H2Hub project development should apply a set of rigorous criteria to ensure green hydrogen is only deployed in a least-regret capacity. Hydrogen should only be considered a potentially viable option if:

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[10] Mullendore, Seth. "Why We Must Shut Down Polluting Urban Power Plants." *US News & World Report*, May 27, 2020. //www.usnews.com/news/cities/articles/2020-05-27/its-time-to-shut-down-polluting-urban-power-plants.

[11] Cellek and Pınarbaşı.

[12] Goldmeer, Dr Jeffrey. "Fuel Flexible Gas Turbines as Enablers for a Low or Reduced Carbon Energy Ecosystem," February 2019, 19. https://www.ge.com/content/dam/gepower/global/en_US/documents/fuel-flexibility/GEA33861%20Power%20to%20Gas%20-%20Hydrogen%20for%20Power%20Generation.pdf

[13] Lewis, Alastair. "Pollution from Hydrogen Fuel Could Widen Inequality." *Nature*. July 13, 2021. https://www.nature.com/articles/d41586-021-01926-8.

- There are no other low-cost decarbonization strategies available;
- There are no electric technologies being developed that could take advantage of zero-emission technology directly;
- The logistics and costs of infrastructure for hydrogen transportation and storage can be contained;
- Technologies for using hydrogen fuel in the sector are or will be available; and
- Transitioning to hydrogen could measurably reduce air pollution.[14]

In addition to these criteria, H2Hub project developers should incorporate these seven principles, originally developed by three dozen environmental justice groups in response to New Mexico's initial hydrogen hub plan, to determine whether and how hydrogen should be deployed as part of the climate transition:

1. Developers must first put in place a comprehensive, durable, and enforceable climate policy framework before assessing whether hydrogen should be an element of the region's climate and energy transition
2. Equity and justice must shape and underpin hydrogen policy decisions
3. Hydrogen must neither divert nor delay a transition to a renewable energy future
4. Hydrogen must avoid adverse climate, environmental, public health, and community impacts
5. Policymakers must rigorously scrutinize the financial and economic prospects of hydrogen as a climate and energy transition tool, in particular fossil-fuel derived hydrogen which, given negative market expectations, risks wasted capital and stranded assets
6. Developers must provide a clear-eyed assessment of water availability, efficiency challenges, and constrained end-use markets for renewables powered green hydrogen
7. Developers must carefully consider hydrogen transport and storage safety challenges and risks[15]

In conclusion, due to the many concerns and uncertainty surrounding hydrogen production and use, CEG strongly encourages DOE to further evaluate the environmental, social, and public health impacts of hydrogen before committing funding to support hydrogen hub projects. There should be a pause in the development of large-scale hydrogen projects until the health and social equity ramifications have been independently studied and adequately considered and a regulatory framework has been implemented to ensure safety, transparency, and the establishment of public processes enabling communities and individuals to participate in the decision-making process. Particular attention and caution should be given to projects proposed in or near historically marginalized and environmental justice communities.

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[14] Saadat, Sasan, and Sara Gersen. "Reclaiming Hydrogen for a Renewable Future: Distinguishing Oil & Gas Industry Spin from Zero-Emission Solutions." Earthjustice, August 2021. https://earthjustice.org/sites/default/files/files/hydrogen_earthjustice_2021.pdf.

[15] Schlenker-Goodrich, Erik, Ben Shelton, Thomas Solomon, Mario Atencio, Rachel Conn, Aline Castelan, Kayley Shoup, et al. "Seven Guiding Principles To Evaluate Whether to Integrate Hydrogen into New Mexico's Climate and Energy Transition," October 5, 2021. https://westernlaw.org/wp-content/uploads/2021/10/NGO_NewMexicoHydrogenPolicyLtr_100521.pdf.

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

Respectfully submitted,

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