**Response of Clean Energy Group**
**to DOE Hydrogen Program Request for Information # DE-FOA-0002529**

Submitted Electronically to: HFTORFI@ee.doe.gov

by:
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Clean Energy Group (CEG) appreciates the opportunity to submit a response to the US Department of Energy (DOE) Hydrogen Program Request for Information (RFI) #DE-FOA-0002529 on viability of hydrogen demonstration and deployment projects that enable clean hydrogen production, infrastructure, and end use to reduce emissions, create jobs, and enable a net-zero carbon emissions economy by 2050.

CEG is a national nonprofit organization that has been advocating for clean energy solutions to climate change since 1998. Our work is focused on ensuring that the benefits of the clean energy transition are equitably distributed and accessible to people of color, low-income communities, and other historically underserved communities. To this end, CEG works to develop and disseminate innovative clean energy programs and deployment strategies that could be replicable across the country and bring our clean energy expertise to collaborations with a diverse array of partner organizations. Through these efforts, we are involved in multiple community-led initiatives to replace polluting fossil-fuel infrastructure, such as peaker power plants, with renewable generation and energy storage alternatives. This work has led us to perform extensive research and engage academic and industry experts on the topic of hydrogen use in the power sector.

CEG's response to this RFI focuses on three of the requested input categories: Greenhouse Gas and Pollutant Emissions Reduction Potential; Diversity, Equity, Inclusion (DEI), Jobs, and Environmental Justice; and Science and Innovation Needs and Challenges, as well as a general response raising concerns about the development of hydrogen demonstration projects in underserved communities.

## Introduction: Hydrogen Concerns

CEG is responding to this RFI primarily to voice concerns about the recent wave of support for "clean" hydrogen projects. While CEG is responding to the RFI on its own behalf, the concerns we raise here are shared by many of the environmental justice and community-based partners we collaborate with through our work.

There has been a rush to portray hydrogen as an emissions-free solution for multiple areas of the energy system. Unfortunately, industry support for hydrogen has gotten ahead of policy and regulations to ensure a socially responsible path forward for hydrogen. While there may be a role for hydrogen as a potential solution for some difficult to decarbonize applications, such as heavy transportation, the combustion of hydrogen—particularly in power plants—could result in a new source of pollution impacting the public health of already overburdened and disproportionately impacted frontline communities.

The most pressing concern is that hydrogen combustion produces *up to six times* the level of nitrogen oxide (NOx) emissions as burning methane. Due to the elemental differences between hydrogen and methane, existing power plant NOx emissions control technologies are only effective at low levels of hydrogen blending with natural gas. This is an issue that has been publicly confirmed by industry researchers, see Hydrogen substitution for natural gas in turbines: Opportunities, issues, and challenges by Electric Power Research Institute and Georgia Institute of Technology. Even if adequate NOx control technologies are developed for higher hydrogen blends or 100 percent hydrogen combustion, the end result is still no better than the NOx emissions of newer gas power plants, which are currently impacting the lives of hundreds of thousands of predominantly low-income people and people of color across America.

Hydrogen combustion is already being proposed in dense urban communities disproportionately impacted by harmful emissions from fossil-fuel infrastructure, industrial processes, and transportation. These include regions currently in nonattainment for criteria pollutants, such as New York City and Los Angeles. The introduction of hydrogen combustion in these environmental justice communities runs counter to policies aimed at reducing pollution burdens and the stated intent of the Biden Administration's Justice40 Initiative.

In addition to creating a significant new source of NOx emissions, the use of hydrogen in the power sector introduces new pressures on strained water resources, creates public safety concerns that have not been addressed by updated codes and standards, and would require massive investments in pipeline and gas storage infrastructure to ensure hydrogen can be transported and stored safely. Furthermore, green hydrogen production and conversion back to energy through combustion is extremely inefficient, with a round trip efficiency of around 30 percent. The high renewable energy demands this process represents could threaten advancements the U.S. has made in renewable energy development and derail the achievement of clean energy goals by diverting renewable generation that would otherwise directly offset fossil-fuel emissions. We expand on many of these concerns in the following sections.

## Pollutant Emissions and Environmental Justice

- **When hydrogen gas (H2) is combusted, as in a power plant, it is not emissions-free**. While H2 does not generate carbon dioxide when combusted, it can lead to nitrogen oxide (NOx) emissions at rates up to ***six times that of methane*** (source 1, source 2).

- **NOx does significant damage to the respiratory system over time**. In areas affected by smog resulting from NOx emissions, symptoms including coughing, increased rates of asthma, and comorbidities with other respiratory illness develop (source). This impact is readily apparent in many frontline communities dealing with heavy NOx emissions emitted by nearby high-polluting peaker power plants and other sources. These communities have developed stark health disparities as a result of elevated NOx exposure.

- **Air pollution controls to limit NOx emissions in gas turbines do exist, but none of these systems have been proven to work with a significant hydrogen blend or 100% hydrogen fuel.** To comply with Clean Air Act regulations, most power plants limit their NOx emissions either through a catalytic reaction, dilution of the fuel mix with water or steam, or using newer low-NOx technology such as a dry low NOx (DLN) combustion system. Due to differences between hydrogen and methane, these methods are only effective at controlling NOx at in a hydrogen blend of approximately 30 percent or less.

- **Even when dry low NOx methods can be applied effectively a project using this technology produces NOx levels similar to those of a newer natural gas plant** (source).

- **By the industry's own admission, hydrogen *cannot* be used as a "drop-in" fuel because of its elemental differences to methane.** To safely combust a hydrogen/natural gas blend, power plant operators would have to replace all their existing emissions controls (source).

## Science and Innovation Needs and Challenges

***Pipelines and storage:***

- **Due to a process called "hydrogen embrittlement," hydrogen cannot simply be stored and transported with existing gas infrastructure** (source). If steel is exposed to hydrogen at high temperatures, hydrogen will diffuse into the alloy and combine with carbon to form tiny pockets of methane. This methane does not diffuse out of the metal and cracks the steel over time, impacting the feasibility of repurposing existing gas pipelines and storage tanks.

- **Any plans to use existing natural gas assets with hydrogen would require replacement of extensive networks of pipelines** because of the embrittlement issue. Steel makes up nearly one third of natural gas transmission systems in the U.S.

- **Pipeline replacement is expensive**. Plans currently underway in the City of Chicago to replace all its natural gas pipes will cost each utility customer $750 per year by 2040 (source).

- **The storage infrastructure needed for a hydrogen revolution does not yet exist**. Hydrogen's competitiveness and value in a clean energy future resides in its ability to be stored and readily available to deploy at any given time. While storage methods such as salt caverns have been proposed, these are geographically limited and are not viable solutions in most areas (source).

- If natural gas were to be replaced with hydrogen**, all end user appliances would have to be replaced as well**. Appliances currently built to run on natural gas, such as stoves and dryers, would not be able to safely operate on hydrogen (source).

***Water usage:***

- **Electrolysis for the production of green hydrogen requires up to 9 tons of water per ton of hydrogen produced** (source). With the current reality of rising temperatures and prolonged drought, water scarcity is a major issue.

- **Because electrolysis breaks down water into constituent elements, this water needs to be purified.** Most industrial water purification processes require, at minimum, a ratio of 2:1 wastewater to pure water, effectively doubling the amount of water required. This means each ton of green hydrogen produced requires 18 tons of water in total (source).

- Additionally, **most combined cycle natural gas plants currently use up to 300 gallons of water per megawatt-hour of electricity produced as a cooling fluid** (source).

***Efficiency losses:***

- **70 percent of the renewable energy put into producing green hydrogen is lost across the full cycle of production and use** (source). With current electrolyzers, green hydrogen's efficiency, from production back to energy through combustion, is around 30 percent. Next generation electrolyzers could have an efficiency cycle of 80 percent, which will only bring green hydrogen's total efficiency to around 45 percent. (source).

- **Switching from grey to green hydrogen is power intensive**. To replace all current industrial consumption of grey hydrogen with green hydrogen would require 3,500 TWh of renewable energy. This is equal to the amount of renewable energy currently produced by the entire European Union (source).

- **Green hydrogen production has the potential to divert renewable energy away from directly offsetting fossil fuel emissions** due to the massive inefficiency of electrolysis. This renewable energy diversion could undermine renewable deployment goals and emissions reduction targets.

**Conclusion**

For these reasons, and the potential harms that could result from widespread use of hydrogen, we encourage DOE to further evaluate the environmental, social, and public health impacts of hydrogen production and use before committing funding to support demonstration 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.

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

Respectfully submitted,

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