November 11, 2020

The Honorable Richard Corey, Executive Officer
California Air Resources Board
1001 I Street
Sacramento, CA 95814

Re: Comments on CARB's October 14-15, 2020 Public Workshop to Discuss Potential Regulatory Revisions to the Low Carbon Fuel Standard

Dear Mr. Corey:

The Green Hydrogen Coalition **("GHC")** is pleased to submit these comments on the CARB's Public Workshop to Discuss Potential Regulatory Revisions to the Low Carbon Fuel Standard (LCFS), held on October 14-15, 2020. GHC is a 501c3 educational non-profit organization formed in 2019 in recognition of the game-changing potential of green hydrogen to accelerate multi-sector decarbonization and combat climate change. The GHC's mission is to facilitate policies and practices that advance green hydrogen production and use in all sectors of the economy where it will accelerate a carbon-free energy future. Our sponsors include both renewable electricity users and providers and those in the renewable natural gas space.

WHY GREEN HYDROGEN IS A GAMECHANGER IN FIGHTING CLIMATE CHANGE

As a mainstream commodity, hydrogen can be utilized for many applications across sectors of the economy, including displacing the use of fossil fuels in existing pipeline infrastructure. Hydrogen is widely used today for many industrial processes, however, more than 99% of the hydrogen used today is produced from fossil fuels, which produce greenhouse gas emissions ("GHGs").

Green hydrogen, in contrast, is commercially produced today from zero carbon electricity by electrolysis, from biogas by steam reforming, and from biomass through thermal conversion. Green hydrogen is a clean and safe energy carrier that can be used as a fuel for transportation

and electricity production, as well as a means for multi-day and seasonal dispatchable renewable energy storage. It can also be used as a feedstock for industry, displacing millions of metric tons of hydrogen made from fossil fuels today (grey hydrogen)[1]. Green hydrogen, once scaled, has the potential to be *lower* cost than hydrogen made from fossil fuels. It will not only displace grey hydrogen in multiple current industrial uses, but also serve to decarbonize the most challenging sectors of the economy such as heavy industry, heavy-duty transport, shipping and aviation.

Today, hydrogen is transported by ships, trucks, and dedicated pipeline infrastructure. It is also blended into existing natural gas pipelines to displace methane and reduce its carbon content, cutting short-lived climate pollutant emissions and helping to decarbonize many gas end-uses, including thermal electric generation.

The fundamental challenge for all commercially viable pathways to produce green hydrogen today is how to achieve scale and reduce cost. Globally, production and use of green hydrogen are currently being pursued at the gigawatt-scale for multiple applications to help get to scale, accelerate decarbonization, and to meet climate goals.

The LCFS is nationally recognized as one of the most successful programs to date in its demonstrated impact in accelerating transportation fuel decarbonization. It is directly driving innovation and investment in many new pathways for lower carbon fuels, and holds great promise for opening potential new pathways to create and use green hydrogen. The LCFS is well positioned, with appropriate reforms, to help drive scale and reduce cost for green hydrogen to accelerate the decarbonization of transportation fuels and many other sectors simultaneously. The GHC appreciates this opportunity to comment on potential regulatory

[1] The definition of Renewable and Green Hydrogen proposed by the GHC is consistent with the green hydrogen definitions as adopted by the European Commission - Link

revisions to the LCFS that would help amplify the impact of the LCFS in our fight against climate change. The GHC has three primary recommendations:

1. Update the LCFS's definition of Renewable Hydrogen to ensure technology neutrality
2. Expand LCFS beyond the transportation sector
3. Establish sector-specific decarbonization targets to further drive focus and near term project development and procurement particularly for hard to abate applications

1. **UPDATE THE "RENEWABLE HYDROGEN" DEFINTION IN THE LCFS: Develop a technology-neutral, emissions-based definition for green hydrogen, and update the current definition of "Renewable Hydrogen" to "Green Hydrogen" in the LCFS regulations to reflect all technology solutions available and to encourage innovation and development of new green hydrogen production solutions.**

Scaling the production and use of green hydrogen is key to decarbonizing hard-to-abate sectors of the economy. In order to help scale the market CARB should update the current definition of "Renewable Hydrogen" in the LCFS regulations to "Green Hydrogen" to support new technology developments, encourage new investments in a diverse array of green hydrogen solutions and to align more closely with climate goals. For example, the current definition of "Renewable Hydrogen" in the LCFS incorrectly limits electrolytic hydrogen to only hydrogen made from RPS-eligible renewable electricity and unnecessarily limits renewable hydrogen's production utilizing the electricity grid and zero carbon non RPS-eligible resources. This reduces the potential for other non-carbon producing electrolytic hydrogen pathways, including curtailed solar and wind and grid electricity, for example. Grid supplied electricity can and should also be a candidate for producing green hydrogen so long as it is supplied from zero carbon sources. It is critical at this early stage in the market development to encourage multiple pathways to produce green hydrogen; and in particular, to encourage multiple pathways to leverage available capacity and infrastructure in the power sector to displace carbon emissions in the transportation and other sectors.

The GHC recommends that CARB develop a technology-neutral definition for renewable hydrogen and also recognize the benefits of green hydrogen in the LCFS regulations. The new definition should afford the widest access to and use of all zero-carbon energy resources and to encourage hydrogen production from all renewable sources including non RPS eligible zero carbon sources, biogas and organic matter.

The specific definition that the GHC recommends is 'Green Hydrogen' and it should be considered synonymous with 'renewable hydrogen' for the purposes of LCFS regulations as follows:

> *Green hydrogen is hydrogen that does not produce incremental carbon emissions during its production; and is a hydrogen gas that is not produced using steam reforming or any other conversion technology that produces hydrogen from a fossil fuel feedstock.*

Furthermore, CARB should establish clear accounting mechanisms that facilitate the utilization of zero carbon curtailed power and other zero carbon electricity to generate electrolytic hydrogen. This will help optimize the utilization of existing electricity grid infrastructure and current and planned renewable resources such as solar and wind toward achieving additional greenhouse gas reductions in hard-to-abate sectors.

2. **EXPAND LCFS BEYOND THE TRANSPORTATION SECTOR TO COVER ALL FOSSIL FUEL USE: CARB can and should expend the LCFS to decarbonize other hard-to-abate sectors; including industrial applications, gas sector and applications in the power sector that require long duration energy storage and dispatchable green capacity subject to SB 100, including use of green hydrogen to displace fossil fuels for emergency power backup**

As a proven program that has yielded tremendous demonstrable decarbonization results for transportation fuels, CARB should expand the LCFS program to decarbonize fuel use in other

sectors, particularly hard-to-abate sectors such as fossil natural gas, mobile and stationary emergency backup generation, industrial, chemical, aviation, maritime transport and even agriculture. In all of these sectors, green hydrogen can be used to displace fossil fuels as a drop-in fuel replacement or to displace gray hydrogen used as a feedstock. Moreover, commercially available solutions exist today to safely produce and store green hydrogen in small, modular quantities as well as in large-scale, vast underground cavern and pipeline quantities.

Expanding the LCFS will provide a needed market signal and value proposition to green hydrogen innovators, developers and investors that California is serious about decarbonization and use of green hydrogen as an unlimited and scalable potential zero carbon fuel alternative. Expansion of the LCFS will also serve as a helpful template for how other states in the western region can similarly follow suit, encouraging regional collaboration and needed multi-state regional infrastructure development. The urgency to provide this market signal has never been greater.

3. **Establish decarbonization targets to replace natural gas to further drive focus and near term project development and procurement particularly for hard to abate applications**

California has the world shown multiple times the importance and impact achievable via appropriate goal-setting for clean energy. California's renewable portfolio targets and energy storage procurement targets, for example, have propelled California to a globally-leading position in the deployment, active use and related industry and employment associated with these game changing technology classes. More recently, CARB's targets for reducing emissions from medium and heavy duty vehicles will not only ensure decarbonization will be achieved in this important sector, but also will stimulate more rapid investment and innovation.

Transformational change requires effective alignment of broad stakeholders across multiple industries. To take full take advantage of the massive potential of green hydrogen as a locally produced, carbon-free, abundant versatile energy resource, CARB, in collaboration with sister agencies such as the California Energy Commission (CEC) and the California Public Utilities Commission (CPUC) and the California Independent System Operator (CAISO) can develop multi-sectoral decarbonization targets and roadmaps that include the use of green hydrogen to achieve the necessary stakeholder alignment and impact.

Decarbonize the Gas Sector

While much attention has been paid of late to decarbonization targets for the electricity sector, less work has been done to proactively decarbonize the existing natural gas sector. Gas pipelines represent a low-cost way to transport and store very large quantities of green hydrogen and have the ability to connect regions of very low-cost supply with areas of high demand.

Recommendations to support decarbonization of the gas sector by blending green hydrogen into the gas pipeline can include:

- Determine safe and appropriate green hydrogen blending and injection limits
- Establish a decarbonized fuel mandate or standard for the natural gas pipeline that includes green hydrogen as part of a broader renewable gas portfolio.
- Create tariffs for gas pipeline injection and market incentives that assure green hydrogen storage access for every kilogram of green hydrogen produced.
- Consider modifications to planned gas pipeline upgrades
  when performing scheduled pipeline upgrades and maintenance to enable increased green hydrogen pipeline content

In some cases, sufficient demand can be aggregated to justify the immediate development of a 100% green hydrogen pipeline. For example, a 16 inch pipe would require daily offtake of approximately 60,000 kg. It is worth exploring the concurrent multi-sectoral aggregation of green hydrogen demand in disadvantaged communities. This maybe possible in highly industrialized areas by displacing natural gas use for thermal electric generation, industrial gray hydrogen use and FCEV fleet refueling at ports and other areas of concentrated diesel use. The GHC recommends that CARB collaborate with the CEC to study the potential for multi sector decarbonization, aggregating green hydrogen demand, utilizing existing and potential new pipeline infrastructure and ensuring green hydrogen is SB 100 eligible.

Recommendations to support decarbonization of the gas sector via dedicated hydrogen pipelines include:

- Repurpose retired gas pipelines, where appropriate, to 100% hydrogen pipelines that can connect low cost sources of green hydrogen production at scale with high volume demand centers
- Alternatively, find ways to leverage right of ways of existing gas pipelines to build new 100% green hydrogen pipelines adjacent to existing gas pipelines where possible

<u>Decarbonize Critical Power Supplies</u>

In California, multi-day electric power outages are increasingly common, either from public safety power shutoffs which are needed to reduce the risk of wildfires or from Stage 3 rolling blackouts during heat waves. As a result, sales of polluting backup diesel and gas generators have reached all-time highs. However, locally stored green hydrogen and onsite fuel cells can provide an alternative, zero-emission, multi-day critical backup power solution.

Utility resource planning for service interruption events should consider the use of green hydrogen with fuel cells for emergency critical backup power. Programs for consumer

education and incentives for purchasing clean alternatives to diesel and gas should be developed, guided by targets to reduce diesel and gas for emergency back up use.

It should be noted that hydrogen fueled back up generation fuel cells are already being deployed at telecom stations, traffic signals and other remote power applications. With appropriate market design, green hydrogen powered fuel cells could also be routinely used to provide safe, clean emergency backup for grid tied applications.

Decarbonize Transportation

Leadership and focus will be critical to accelerating the use of green hydrogen for a wide section of various transportation applications from on/off road road vehicles, to marine vehicles and even aviation. CARB's zero emission vehicle mandate has been particularly effective in aligning stakeholders around a common achievable goal. Attention should be paid to not only the adoption of hydrogen-fueled vehicles but also the investment and support for green hydrogen fueling infrastructure.

Importantly, roadmaps to decarbonize transportation applications with green hydrogen should consider opportunities to concurrently decarbonize multiple uses (eg.light, medium and heavy duty on /off road transportation, maritime shipping as well as aviation) as well as consider multiple pathways to produce the green hydrogen to supply this network, including on site electrolysis and resulting green hydrogen storage at refueling stations and airports.

Coastal ports are epicenters for concentrated fossil fuel use – including thousands of diesel fueled trucks, port operational vehicles, rail cars and ships. Often ports are located nearby airports and other municipal services. As such they are excellent candidates to aggregate demand for green hydrogen, and as Belgium's HYPORT of Oostende has shown, are also well situated to produce electrolytic hydrogen at GW scale from off shore wind.

Opportunities for such highly concentrated off take and production of green hydrogen present excellent opportunities for coastal cities to lead the way with green hydrogen, potentially even serving as a viable economic development opportunity as a commodity export in the future.

Decarbonize Industrial Applications

Hydrogen is a globally traded commodity that is currently used in large volumes in several key industrial applications; namely, oil refining and manufacturing ammonia. These applications are excellent targets to decarbonize with green hydrogen, as they represent very large off-take opportunities and currently produce significant GHG emissions. Special focus on these sectors, and ideally via setting specific decarbonization and green hydrogen utilization targets, is needed to encourage rapid transition to green hydrogen to displace current gray hydrogen use. New industrial applications of green hydrogen are also possible, such as displacing fossil fuels for mining operations.

Oil Refining

Oil refining represents the single largest use of gray hydrogen today. Setting targets to require oil refining operations in California to utilize increasing percentages of green hydrogen increasing to 100% green H2 by 2050 would establish a clear decarbonization pathway to this large industrial application.

Green Ammonia and Green Fertilizer

Today, after oil refining, ammonia production is the second largest industrial use of gray hydrogen as commodity feedstock. The majority of the ammonia manufactured today is used to make fertilizer.

California, as a significant global agricultural producer, is in a strategic position to accelerate the decarbonization of ammonia and fertilizer production. Because most of the ammonia used in

fertilizer production is made from fossil fuels, it is largely imported from the gulf coast. Ammonia can be produced locally. Setting decarbonization targets for the agricultural sector by requiring 100% green hydrogen for fertilizer used in California by 2050, will enable California to increase local value-add for its produce, create local skilled jobs and ultimately potentially create new green ammonia and fertilizer export opportunities to the Midwest and globally.

A focused effort involving a variety of ecosystem stakeholders can accelerate this progress:

a. Work with municipal recycling entities to produce green hydrogen and reduce organic waste in landfills
b. Work with state level agricultural agencies to develop low carbon food branding for consumers
c. Work with agricultural producers to stop open field burning of agricultural waste and instead utilize it as a valuable resource to produce local green hydrogen (for fertilizer and transport) to create local skilled jobs and establish a sustainable circular economy
d. Work with ammonia and fertilizer supply chain stakeholders to facilitate access to carbon markets and the development of local green hydrogen and ammonia and fertilizer production.

Mining

In 2009, California's 700 active mineral mines employed 5,300 people and ranked fourth nationally in the production of non fuel minerals [2]. Remote mining sites are another excellent candidate for green hydrogen, as they require Remote Area Power Systems (RAPS) which often rely on diesel fuel for their varied energy needs, from generating power to operating mining equipment such as drills, shovels, loaders, and material handling trucks. Emissions from underground usage of fossil fuels also creates significant health risks for workers.

[2] https://www.conservation.ca.gov/index/Pages/Californiaranksfourthinthenationinnon-fuelsmineralproduction.aspx

Green hydrogen provides a promising opportunity for mines to reduce operational costs, reduce health risks to workers, and to decarbonize their operations. Hydrogen has the value of being usable in a variety of different operational processes at a mine, including as fuel for trucks and other heavy equipment; as energy for heating and cooling systems; and as a primary fuel stock for electricity generation. Green hydrogen is particularly well suited for local production at mine sites with high solar penetration, such as in Southern California.

Setting targets to decarbonize mining operations and RAPS with green hydrogen can be an effective mechanism to rally the necessary ecosystem partners to commercialize effective solutions at scale and at a competitive price to status quo fossil alternatives.

Thank you for the opportunity to comment on the LCFS program update and regulation amendments. Updating the LCFS "renewable hydrogen" definition, expanding the LCFS to all fossil fuel uses and establishing sector specific targets will help to dramatically accelerate decarbonization in California. We look forward to working with you in these areas of the program and are enthusiastic about creating new, disruptive green economic growth opportunities, green jobs and continue to lead in climate goals.