DOCKETED	
Docket Number:	19-SB-100
Project Title:	SB 100 Joint Agency Report: Charting a path to a 100% Clean Energy Future
TN #:	236058
Document Title:	Green Hydrogen Coalition Comments on SB 100 Draft Final Report Workshop
Description:	N/A
Filer:	System
Organization:	Green Hydrogen Coalition
Submitter Role:	Public
Submission Date:	12/18/2020 4:34:52 PM
Docketed Date:	12/18/2020

Comment Received From: Green Hydrogen Coalition
Submitted On: 12/18/2020
Docket Number: 19-SB-100

Green Hydrogen Coalition Comments on SB 100 Draft Final Report Workshop

Additional submitted attachment is included below.

December 18, 2020

Email to: docket@energy.ca.gov
Docket Number: 19-SB-100
Subject: GHC's SB 100 Draft Final Report Workshop Comments

Re: Comments of the Green Hydrogen Coalition (GHC) following the December 4, 2020 Senate Bill 100 Draft Final Report Workshop

Overview

The Green Hydrogen Coalition ("GHC")[1] appreciates the opportunity to provide comments on the Draft Final Report Workshop, conducted with the scope of the Senate Bill (SB) 100 Joint Agency Report. GHC seeks to offer insights on the benefits and opportunities green hydrogen represents for California's state-wide decarbonization efforts and provide actionable recommendations to improve upon the SB 100 Joint Agency Report.

GHC is a California educational non-profit organization founded in 2019 to facilitate policies and practices to advance the production and use of green hydrogen at scale in all sectors to accelerate a carbon free energy future. GHC defines green hydrogen as hydrogen made from non fossil fuel feedstocks and does not produce incremental carbon emissions during its primary production process. Such pathways can include but are not limited to: electrolysis of water, steam methane reforming, autothermal reforming or methane pyrolysis of renewable gas and thermochemical conversion of biomass. GHC believes that the prioritization of green hydrogen project deployment at scale is fundamental to reduce cost and to meet California's climate and carbon goals. By including green hydrogen as a foundational resource toward achieving the zero carbon power sector goals articulated in SB 100, California will enable at-scale production, transport and storage of green hydrogen necessary to benefit the power sector and also to accelerate decarbonization in multiple hard-to-abate sectors such as transportation, heavy industry and even shipping and aviation.

Accelerated deployment of green hydrogen to achieve carbon goals can be realized through an initial focus on the power sector. Given the size of this sector and the abundance of intermittent renewable power in the State, the power sector offers significant opportunity to quickly scale green hydrogen. Large-scale green hydrogen production and use opportunities in the power sector today include using curtailed and purpose-built renewable electricity to make hydrogen through electrolysis; as well as using the resulting hydrogen in an existing thermal electricity generation plant to produce dispatchable, carbon free reliable power. In sum, green hydrogen gives Californians a way to 'bottle' zero carbon resources

[1] https://www.ghcoalition.org/

like sunshine and wind; effectively taking abundant renewable power and making it dispatchable across time.

Green hydrogen is the pathway to electrify fuels of all types:

- Production of green hydrogen can leverage abundant low-cost renewable energy to derive a flexible renewable molecule that can displace natural gas, diesel, gasoline, and other fossil fuels.
- Green hydrogen can displace the current global use of gray hydrogen, which is made from fossil fuels – if treated as a country, the GHG emissions from global gray hydrogen production would surpass the emissions of Germany.[2]
- Green hydrogen can be combusted in existing turbines so progresses achievement of SB 100 goals with use of existing infrastructure
- Green hydrogen is a carbon free fuel that can ensure reliability and affordability, particularly for California's most vulnerable communities.

In these comments, GHC urges the Joint Agencies to seriously consider and incorporate into the Joint Agency Report the transformative capacity of green hydrogen for the achievement of SB 100 goals. GHC recommends the Joint Agencies consider the following observations and recommendations as described in the subsequent sections:

Recommendations

1) The GHC recommends advancing planning for and utilization of green hydrogen production and storage to achieve SB 100 goals as part of SB 100 modeling efforts to enable full replacement or retirement of natural gas from the fuel mix.

The Draft Final Report adequately states that the results presented are directional in nature and require further, iterative analysis in order to reduce the overall costs related to decarbonizing the electric sector.[3] GHC considers the issue of overall system costs relates directly to the need for firm dispatchable resources. In fact, it is this very need that results in the economic retention of natural gas generation by 2045.[4] In this context, the potential of green hydrogen must not be ignored. Green hydrogen is a scalable, proven solution that can place California on the path toward economy-wide decarbonization as supported by the goals of SB 100. It is also commercially viable and scalable alternative to natural gas as a carbon free drop-in fuel replacement and as a means to achieve multi day and seasonal renewable energy storage.

[2] *See* Wood Mackenzie, "CO2 and other Greenhouse Gas Emissions", May 2017. Available at https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions.
[3] Draft Final Report, at 10.
[4] Draft Final Report, at 25.

Unfortunately, the Joint Agencies have overlooked the transformative potential of green hydrogen. While the Draft Final Report correctly acknowledges green electrolytic hydrogen is gaining breakthroughs and cost reductions as a drop-in fuel, it clearly states that drop-in renewable fuels have been excluded from this initiative's modeling since these technologies are "not yet commercially available in California" and/or they have "inadequate cost and supply data".[5] GHC considers both these statements are deficient as reasons to exclude hydrogen from modeling analysis.

First, green hydrogen is currently commercially available. LADWP, one of the state's largest load-serving entities (LSEs), is leading the way in using green hydrogen in thermal generation through the Intermountain Power Plant (IPP). LADWP plans to convert IPP from an 1800 MW coal plant to a combined cycle gas turbine initially running on a green hydrogen blend, and ultimately increasing that blend to 100% on or before 2045. This closely follows the European model, where large LSEs are supporting the transition of thermal generation to green hydrogen. As such, LSEs in both California and other geographies are actively leveraging the benefits of green hydrogen today.

Second, the Joint Agencies have overlooked recommendations to fully consider the potential of hydrogen in the context of SB 100. GHC previously commended the Joint Agencies' determination to include hydrogen fuel cells as candidate resources; nevertheless, this inclusion does not fully represent the transformational potential of green hydrogen. However, further advancing modeling that is inclusive of green hydrogen must consider additional applications and use-cases. In fact, E3 has already studied this issue and identified a potential market size of 10 GW for hydrogen in the power sector in California; and even more if the state were to replace all of the natural gas with drop-in zero carbon fuels like green hydrogen.[6]

GHC strongly encourages the Joint Agencies to consider the role green hydrogen can play in fully decarbonizing dispatchable thermal generation. The GHC reiterates its proposal to have green hydrogen modeled as a drop-in fuel alternative within the E3's RESOLVE model by using biomethane as a proxy for green hydrogen and adjusting the cost inputs accordingly. It is worth noting that the limitation cited for biomethane within the Draft Final Report does not cite limited cost data, but inadequate supply potential.[7] Thus, it is reasonable to employ the biomethane cost estimates and modify them accordingly to represent green hydrogen. Existing research indicates that $2/kg may reflect a sensible green hydrogen fuel replacement cost input by 2030 or earlier.[8] GHC acknowledges that Joint Agencies' lack of consideration of green hydrogen as a drop-in fuel alternative may

[5] Draft Final Report, at 18.
[6] https://www.ethree.com/e3-evaluates-hydrogen-opportunities-in-a-low-carbon-future/
[7] Draft Final Report, at 18.
[8] James Thornhill. *Cost of Hydrogen From Renewables to Plummet Next Decade: BNEF.* Bloomberg News. August 21, 2019. *https://www.bnnbloomberg.ca/cost-of-hydrogen-from-renewables-to-plummet-next-decade-bnef-1.1304507*; Gerson Freitas Jr and Chris Martin. *Cheap Wind Power Could Boost Green Hydrogen, Morgan Stanley Says.* Bloomberg Green. July 24, 2020. https://www.bloomberg.com/news/articles/2020-07-23/cheap-wind-power-could-boost-green-hydrogen-morgan-stanley-says

be due to the fact these costs extend beyond fuel cost and into associated supply and storage infrastructure costs. In order to mitigate these concerns and effectively advance the consideration of green hydrogen, GHC recommends the Joint Agencies utilize one of the planned yearly SB 100 convenings as a forum for the advancement and incorporation of drop-in fuels for subsequent iterations of the Joint Agency Report.[9] This convening should include, among other speakers and experts, a presentation from the LADWP and the National Renewable Energy Laboratory (NREL) describing how their LA100 initiative included green hydrogen in every modeling scenario.

In addition, GHC recommends that the Joint Agencies work towards allocating CEC EPIC funding to identify and analyze in detail optimal scenarios for the role of green hydrogen production, transmission, distribution, and storage in supporting cost effective attainment of California's carbon targets in the electric and linked sectors. Such a study should evaluate the potential of repurposing retired natural gas and oil pipelines and underground storage caverns to instead store and distribute green hydrogen for multiple large offtake applications, and particularly to displace natural gas use in the power sector. Moreover, EPIC funding should be directed towards green hydrogen RD&D. While many innovative green hydrogen technologies are commercially available today, additional research, development, and demonstration (RD&D) is needed. Research, development and demonstration in material sciences, controls, and system platforms will transform the performance, diversity, and cost profiles of green hydrogen solutions. Areas for research include feasibility studies for the repurposing of existing natural gas pipelines and depleted oil and gas fields for hydrogen storage; advanced research on electrolysis for seawater; and software development to study the use of green hydrogen in support of ongoing integrated power and gas sector resources planning and modeling efforts.

2) The GHC recommends that the Joint Agencies consider resiliency needs across the State and include green hydrogen as an alternative to diesel, gasoline and propane powered back up generation.

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. Despite the growing relevance of these previously extraordinary conditions, California has yet to determine a workable definition of resilience as well as a plan to attain it, particularly for loads deemed as critical. The Draft Final Report recognizes the need to consider and study this factor, citing resilience as one of the key non-economic benefits (NEBs) meriting further analysis.[10]

In this context, GHC is concerned the analysis relative to resiliency needs defaults to consider only carbon-emitting assets and/or fuels. Recent heat storms in California and public safety power shutoffs ("PSPS") to avoid wildfires highlight the need to have

[9] *See* Draft Final Report, at 28.
[10] Draft Final Report, at 119.

dependable and dispatchable generation on-site. This has spurred customers to increase their reliance on diesel, gasoline, or natural gas generators. However, dispatchable, clean multi-day generation is possible going forward. A green hydrogen solution for use in fuel cells or microturbines for back-up generation can displace carbon-based fuels, protecting the environment, and enhancing resilience on the system, providing safer, cleaner outcomes for all Californians. In essence, green hydrogen provides an "insurance" against power disruptions and a protection for the climate by displacing fossil-based back up generation fuels.

As a result, the reliance on natural gas and diesel solutions poses a risk to meeting California's policy goals and can result in inefficient planning, high levels of pollution, and negative outcomes. Grid resilience issues are urgent, and the state and Joint Agencies should make efforts to support immediate deployment of green hydrogen resilience solutions that can provide clean air benefits now. In order to properly capture the potential of hydrogen for resiliency applications, GHC recommends the Joint Agencies, either collectively, or individually to the extent of their jurisdictions, study the potential of green hydrogen as a resiliency resource for back-up generation and resilient microgrid solutions. Moreover, GHC considers it essential to have LSEs evaluate the use of green hydrogen as an alternative fuel to provide zero-carbon dispatchable capacity, and in local constraint areas in conjunction with fuel cells for emergency critical backup power. With these studies, 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 remaining thermal electric generation plants and local area emergency backup.

3) The GHC recommends that the Joint Agencies consider the myriad of benefits – beyond SB 100 compliance – associated with scaling the production and use of green hydrogen.

Green hydrogen is a resource that can uniquely advance economy-wide decarbonization. Scaling green hydrogen production and use will facilitate deep decarbonization of other sectors, including but not limited to: agriculture, aviation, shipping, transportation, mining, and industrial processes/heating.[11] While unlocking the potential of green hydrogen will bring decarbonization benefits to a series of currently fossil-based supply chains, the first steps to do so is to properly represent these solutions within ongoing modeling efforts and supporting this needed solution through policy.

The Draft Final Report recognizes that SB 100 sits at the intersection of a host on related efforts to reduce climate risks and air pollution emissions across the State.[12] Moreover, the Draft Final Report acknowledges the need to evaluate a series of NEBs, as mentioned in the recommendations above. In this context, the GHC recommends the Joint

[11] *See Green Hydrogen Guidebook* https://www.ghcoalition.org/guidebook at 17-25.
[12] Draft Final Report, at 14.

Agencies consider the cross-sectoral benefits associated with green hydrogen and the potential NEBs related to its deployment.

First, as a critical component of California's toolkit for economy-wide decarbonization, green hydrogen should be acknowledged and supported as a no-regrets investment in California's future. An expanded role for green hydrogen within SB 100 implementation and beyond may catalyze an economic development boon, and GHC believes the Joint Agencies are well-positioned to advance green hydrogen use and production without delay. To the extent California can catch up to Europe, Australia, and other markets, the state may also be able to realize significant economic benefits from green hydrogen as an export commodity. As a result, future iterations of the Joint Agency Report should consider the job-creation and economic benefits of green hydrogen utilization. As noted within the Draft Final Report, labor should be considered an investment rather than a cost, as a growing, diversified, and skilled workforce can positively affect returns on climate mitigation efforts.[13] In this sense, the benefits of transforming the natural gas infrastructure to a green hydrogen one cannot be understated or overlooked. Such a significant transformation would lead to thousands of jobs, future-proofing the careers of Californians currently associated to carbon-emitting assets or supply chains.

Second, the Draft Final Report recognizes that supporting a significant overhaul of the electric sector would represent considerable economic gains for the State. Currently, the Draft Final Report states, California is the leader in patent registrations across all major clean technology categories, with 3.5 times more patents than the next highest state, Texas.[14] If we consider energy storage, whose patents have increased by 65% in the 2017-2018 period,[15] as a viable proxy to green hydrogen due to its potential and wide array of applications, it is clear green hydrogen has the capacity to further California's position as a technological leader across the US and the world.

4) The GHC requests the Joint Agencies consider a dedicated research track to explore use of green hydrogen as a drop-in fuel replacement and multi day and seasonal renewable energy storage solution by addressing five guiding questions.

As stated above, GHC recommends the Joint Agencies utilize one of the planned yearly SB 100 convenings as a forum for the advancement and incorporation of drop-in fuels for subsequent iterations of the Joint Agency Report.[16] GHC considers this convening should serve as the kick-off of a dedicated research track. In recognition of the game-changing potential of green hydrogen, GHC recommends the Joint Agencies use the convening to

[13] Draft Final Report, at 127.
[14] Draft Final Report, art 39.
[15] *See* Draft Final Report, at 39.
[16] *See* Draft Final Report, at 28.

begin answering the following five questions to guide the necessary research to transition away from thermal peaking plants:

1. Where is thermal peaking capacity needed?

2. How can remaining thermal gas plants be fully converted to green hydrogen? Specifically, what amount of green hydrogen is needed, and what is the lowest cost method of storing green hydrogen?

3. What other end-use applications can be co-located to aggregate green hydrogen demand?

4. How can green hydrogen be used to displace growing demand for gas and diesel backup generation to mitigate rolling blackouts from heat waves and PSPS events?

5. How can green hydrogen molecules be cost effectively moved from areas of low-cost production to large, high value demand?

GHC considers a dedicated research track for hydrogen technologies and applications is warranted under Recommendation 2 of the Draft Final Report, which states the need to continue assessing the role and impacts of emerging technologies and non-generation resources.[17] This research track must be developed off a broad and technology-neutral definition of green hydrogen as to include all pathways to produce it. GHC envisions the research track would be carried out by a working group of dedicated stakeholders that would communicate their findings and recommendations to the Joint Agencies ahead of the definition of inputs and assumptions needed for the 2025 Joint Agency Report cycle. As such, GHC recommends the annual SB 100 convening on green hydrogen takes place in 2021 or 2022 in order for the research track to complete its assessments in time for the 2025 Joint Agency Report cycle.

5) GHC strongly encourages the Joint Agencies to explore and implement effective multi-sectoral targets to enable green hydrogen to meet California's decarbonization and affordability obligations.

Transformational change requires effective alignment of broad stakeholders across multiple industries. To take full advantage of the massive potential of green hydrogen as a locally produced, carbon-free, versatile energy resource, California can develop multi-sectoral decarbonization targets and roadmaps to achieve the necessary stakeholder alignment and impact.

California has effectively used targets for energy efficiency, demand response, renewable generation and energy storage. Because of its silo-busting use in the power

[17] Draft Final Proposal, at 28.

sector (production of green hydrogen can look like load, a fuel for generation, and deliver transmission and distribution benefits) as well as decarbonization benefits in many other sectors, green hydrogen is an excellent candidate for similar establishment of sector specific targets and roadmaps.

The GHC recommends that the Joint Agencies consider effective target for green hydrogen production and costs. For example, the Joint Agencies could set a "goal" for fully displacing natural gas for electric generation with green hydrogen, and fully displacing the use of diesel for emergency backup generation on or before 2045. Other goals that could be adopted include setting a $2/kg production costs for green hydrogen by 2030, deploying electrolyzer capacity over the near- and long-term at levels commensurate with needs to scale the market and reduce costs, increased RD&D investment into demonstrations, and smart investment into enabling infrastructure and commercial deployment programs. The following sector-specific targets can also be developed:

a. The GHC recommends that the Joint Agencies evaluate and plan for pathways to decarbonize the Gas Sector.

While much attention of late has been paid to decarbonization targets for the electricity sector, less work has been done to proactively decarbonize the existing natural gas sector. Recommendations to support decarbonization of the gas sector by blending green hydrogen into the gas pipeline include:

1. *Determine safe and appropriate green hydrogen blending and injection limits*

2. *Establish a decarbonized fuel mandate or standard for the natural gas pipeline that includes green hydrogen as part of a broader renewable gas portfolio.*

3. *Create tariffs for gas pipeline injection and market incentives that assure green hydrogen storage access for every kilogram of green hydrogen produced.*

4. *Consider that planned gas pipeline upgrades should include modifications to enable increased green hydrogen pipeline content when performing scheduled pipeline upgrades and maintenance.*

The GHC recommends that support for decarbonization the gas sector via dedicated hydrogen pipelines include: (1) Repurposing retired gas pipelines, where appropriate, to 100% hydrogen pipelines that can connect low costlow-cost sources of green hydrogen production at scale with high volume demand centers (2) Finding ways to leverage right of ways of existing gas pipelines to build new 100% green hydrogen pipelines adjacent to existing gas pipelines where possible

b. The GHC recommends that the Joint Agencies continue and expand planning for green hydrogen to decarbonize the Transportation Sector.

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 vehicles, to marine vehicles and even aviation. ARB'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 (e.g., light-, medium- and heavy-duty on-road transportation) as well as consider multiple pathways to produce the green hydrogen to supply this network.

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 are 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.

c. <u>The GHC recommends that consideration and modeling efforts are applied to options and opportunities to Decarbonize Industrial Applications.</u>

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. GHC offers the following specific considerations related to decarbonizing industrial applications:

i. <u>Green hydrogen can provide a solution to reduce carbon emissions in the Refining Industry.</u>

Oil refining represents the single largest use of gray hydrogen today. As such, *the GHC recommends setting targets to require oil refining operations 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.*

ii. <u>The GHC advises that Green Ammonia and Green Fertilizer will be critical to decarbonizing the agricultural sector.</u>

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. 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:

- *Work with municipal recycling entities to produce green hydrogen and reduce organic waste in landfills*
- *Work with state level agricultural agencies to develop low carbon food branding for consumers*
- *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*
- *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.*

iii. <u>The GHC recommends that green hydrogen is a critical resource for decarbonizing the Mining Sector.</u>

In 2009, California's 700 active mineral mines employed 5,300 people and ranked fourth nationally in the production of non-fuel minerals.[18] 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.

[18] California Department of Conservation. *California ranks fourth in the nation in non-fuels mineral production.* 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.

The GHC recommends that 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.

Conclusion

In conclusion, GHC is supportive of the Joint Agencies and their work in the Draft Final Joint Agency Report. GHC believes that further consideration of the cross-sectoral benefits of green hydrogen is warranted and imperative to decarbonization, as it could help regulators identify innovative paths that could lead to deeper and faster decarbonization in California and the rest of the Western grid. GHC encourages the CEC, CPUC, and ARB to recognize that green hydrogen is not an emerging technology but a mature solution that can enable the decarbonization of numerous sectors and processes *at scale*. Specifically, GHC urges the Joint Agencies to better incorporate green hydrogen into its modeling efforts, including its use as a drop-in fuel and multi day and seasonal renewable energy storage alternative that will enable the retirement of natural gas from the fuel mix. The GHC also respectfully urges the Joint Agencies to work together via SB 100 implementation to develop programs and studies that can further research, development, and demonstration of green hydrogen as to accelerate deep decarbonization.

GHC appreciates the opportunity to provide these comments and feedback, and looks forward to collaborating with the CEC, CPUC, ARB, and other stakeholders in this initiative.

Sincerely,

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