Date: November 14, 2023

Docket Log: 23-SB-100

RE: Green Hydrogen Coalition Responses to the SB 100 Analytical Framework Workshop

I. INTRODUCTION.

The green hydrogen Coalition (GHC)[1] is an educational 501(c)(3) non-profit organization. GHC was formed in 2019 to recognize the game-changing potential of "green hydrogen"[2] to accelerate multi-sector decarbonization and combat climate change. GHC's mission is to facilitate policies and practices that advance green hydrogen production and use in all sectors of the economy to accelerate a carbon-free energy future. Our sponsors include foundations, renewable energy users and developers, utilities, and other supporters of a reliable, affordable green hydrogen fuel economy for all.

The GHC appreciates the California Energy Commission (CEC), California Public Utilities Commission (CPUC), and California Air Resources Board (CARB) (together the "Joint Agencies") for hosting the joint workshop on October 31, 2023, to present and discuss the analytical framework for the Senate Bill 100 (SB 100) Joint Agency Report. We echo President Alice Reynold's comment that "it's critical that we get the [SB 100] analytical framework right" since it helps enable the "protection of the planet and reduction of climate change."[3] Additionally, the GHC supports staff's focus on finding solutions that are "ambitious, yet feasible," recognizing that progress cannot actualize if the steps to get there are not sustainable.

II. GHC'S COMMENTS.

1. The GHC supports the inclusion of various technologies and alternative fuels in the proposed scenarios for the 2025 SB 100 Report, namely green hydrogen.

The GHC appreciates the staff and dais' focus on clean, reliable energy with the inclusion of green hydrogen since it can help decarbonize important hard-to-abate sectors. Hydrogen – when produced from non-fossil fueled derived pathways – is a carbon-free, renewable resource that can replace fossil fuels in some of the heaviest polluting economic sectors, including the power sector. It can thereby help California achieve its SB 100 targets since it can fill the state's need for clean, firm power and long-duration energy storage and thereby provide grid reliability. Currently, however, California relies on natural gas-fueled power plants to achieve grid reliability — and will

[1] https://www.ghcoalition.org/
[2] The GHC defines "green hydrogen" according to Assembly Bill 209.
[3] SB 100 Analytical Framework Workshop presentation. October 31, 2023.

continue to until at least 2045.[4] Therefore, without access to hydrogen, the state will continue to rely on natural gas.

Given that one of the stated opportunities of the 2025 SB 100 Report is to identify pathways to enhance state efforts, we are pleased to see the Joint Agencies working in tandem to plan for hydrogen's role in the state's energy transition.

Recommendation: A systems-level approach is needed to accelerate adoption of green hydrogen, as indicated in HyBuild™ findings.

When including green hydrogen in the 2025 SB 100 proposed scenarios, we urge the Joint Agencies to embrace a statewide systems-level approach with a long-term vision for hydrogen's role. As GHC's work architecting green hydrogen hubs at scale has found, it is possible to achieve less than $2/kg delivered mass-scale green hydrogen in Los Angeles with shared 100% green hydrogen pipeline transport connected to out of state geologic storage of hydrogen in salt caverns.[5]

HyBuild LA established a long-term vision (2030) at scale and demonstrated that a scaled green hydrogen economy for Los Angeles was commercially feasible and cost-competitive with fossil fuels. The analysis also found that aggregated demand in Northern California (Stockton area) could be cost-effectively served by a North/South green hydrogen transmission pipeline backbone. To achieve the lowest cost for green hydrogen year-round, California's green hydrogen pipeline infrastructure will need to be interconnected to an out of state salt dome, as California does not have any known geologic salt formations. HyBuild LA findings indicate that the Sierra Nevada Mountain range is a challenging geologic barrier for interstate pipeline connection with green hydrogen demand in northern California; therefore, to access out of state salt domes, northern California's green hydrogen pipeline system would ideally be interconnected through southern California. However, achieving this cost-competitive future for hydrogen requires taking a long-term vision for how hydrogen can scale quickly and efficiently.

Ultimately, while the Joint Agency staff discussed taking a statewide approach to SB 100, we further encourage expanding this to a systems-level approach as well. For the reasons stated above, the GHC believes it is integral to ensure that the upstream, midstream, and downstream segments of the hydrogen market are accounted for today and well into the future. This should encompass the entire hydrogen value chain, including production technologies, storage solutions, transport infrastructure, and efficient grid integration strategies. By delving into the technical and economic viability of different hydrogen pathways, California can develop a strategic roadmap for maximizing the benefits of renewable hydrogen.

2. **The GHC supports the inclusion of increased hydrogen under the "Resource Diversification" proposed scenario and suggests referring to various regulation, legislation, research, and funding opportunities to determine the hydrogen target**.

[4] https://www.energy.ca.gov/news/2021-03/californiareleases-report-charting-path-100-percent-clean-electricity
[5] https://www.ghcoalition.org/ghc-news/hybuild-la-phase-2-report

The GHC supports the inclusion of increased green hydrogen under the "Resource Diversification" scenario since it will be a key resource in helping achieve economy-wide decarbonization for the state. Within this proposed scenario, we recommend that the Joint Agencies adopt a clear target for hydrogen adoption that is consistent with existing energy policies and targets. Specifically, we encourage the modeling to align with the following key resources:

Category	Title	Significance / Notes
Regulation	**CARB's 2022 Scoping Plan**	California needs "1,700 times the amount of current hydrogen supply" as part of its transition to a clean energy system by 2045.[6]
Regulation	**CPUC's Integrated Resource Plan**	This "planning proceeding . . . consider[s] all of the Commission's electric procurement policies and programs and ensure[s] California has a safe, reliable, and cost-effective electricity supply."[7]
Administration	**ARCHES**	ARCHES is California's initiative to accelerate renewable hydrogen projects and the necessary infrastructure, which includes a heavy focus on the state's power sector.
Legislation	**California Senate Bill 1075**	Requires CARB to create a specified report on potential hydrogen uses by June 2024, and it requires the CEC to report on potential uses of hydrogen in the electric and transportation sectors in the 2023 and 2025 editions of the Integrated Energy Policy Report (IEPR). Given that the 2024 CARB report and the 2023 IEPR will be completed prior to the 2025 SB 100 Report, it is important to ensure that this research informs the 2025 SB 100 Report.
Research	**EDF: "California needs clean firm power, and so does the rest of the world"**	California will require between 25 to 40 gigawatts of clean and dependable power.[8]
Research	**SDG&E, Boston Consulting Group, and David Victor: "The Path to Net Zero"**	California needs 20 GW of dispatchable generation from 100% clean hydrogen generation by 2045.[9]

The GHC believes it is important to consider the abovementioned resources to help inform the targets set for hydrogen use within the 2025 SB 100 Report since the state needs a unified and cohesive strategy to reach our clean electricity goals. Without incorporating this existing research,

[6] https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf
[7] https://www.cpuc.ca.gov/irp/
[8] https://www.edf.org/sites/default/files/documents/SB100%20clean%20firm%20power%20report%20plus%20SI.pdf
[9] https://www.sdge.com/sites/default/files/documents/netzero2.pdf

the GHC worries this will be a lost opportunity to better understand the size and scale required to allow hydrogen to decarbonize the state.

It is important to note, however, that this approach should also be inclusive of the funding opportunities that are designed to jumpstart the state's hydrogen market. With billions of dollars set to flow into California's energy market, it is utmost importance that the 2025 SB 100 Report adequately reflects the anticipated funding, which will lead to increased adoption of hydrogen, project development, and market momentum:

- **Federal Funding | U.S. Department of Energy's H2Hubs program:** California has been selected for award negotiations for up to $1.2 billion.[10]
- **State Funding | CEC's Clean Hydrogen Program:** Provides $100 million to in-state hydrogen projects for the demonstration or scale-up of the production, processing, delivery, storage, or end use of hydrogen.[11]

Ultimately, the energy transition required to achieve SB 100 goals will require well-defined milestones to guide the adoption of renewable hydrogen technologies. Collaborative efforts between state agencies and stakeholders should lead to the establishment of clear and attainable targets. Setting these milestones will help establish a trajectory towards realizing the full potential of hydrogen. In doing so, it is important to utilize the existing analysis that has been (or will be) performed by relevant stakeholders to set clear and realistic milestones and thereby provide a tangible trajectory towards achieving SB 100 goals.

3. <u>The GHC supports the inclusion of increased hydrogen fuel cells for electricity generation but requests that the Joint Agencies reconsider the exclusion of hydrogen combustion turbines.</u>

In California's drive to electrify large segments of our economy, the power sector has become more important than ever. For the state to achieve its ambitious goal of attaining 100% clean electricity by 2045, a broad portfolio of clean energy technology is required. Therefore, the GHC appreciates the increase of hydrogen fuel cells for electricity generation within the "Combustion Resource Retirement" scenario since it can help shift the state away from fossil-fuel derived electricity for distributed energy needs. The GHC would like to note, however, that fuel cells alone are not likely to be sufficient to provide the reliable and affordable electricity that will be required as the effects of climate change further burden the state's grid.

<u>Recommendation: The GHC recommends the Joint Agencies reconsider the current exclusion of hydrogen combustion since it can provide two important benefits to the state: (1) grid reliability and (2) affordability.</u>

i) <u>Grid Reliability</u>

[10] https://business.ca.gov/california-awarded-up-to-1-2-billion-to-advance-hydrogen-roadmap-and-meet-climate-and-clean-energy-goals/#:~:text=California%20is%20one%20of%20seven,end%2Duse%20of%20clean%20hydrogen.
[11] https://efiling.energy.ca.gov/GetDocument.aspx?tn=247883

In the LA100 Study, it was found that green hydrogen turbines "are necessary infrastructure to ensure reliability of the grid" since they will be used "primarily during periods of peak demand or low output from wind and solar resources."[12] They can also be used "to bolster grid resiliency to ride through and recover from grid outages that can be caused by extreme events such as wildfires, earthquakes, heatwaves, and other types of unplanned events."[13] In this way, green hydrogen turbines can help provide backup and reliability in a way that fuel cells cannot at this size and scale required (gigawatts) for thermal generating facilities. They are therefore critical to helping the state achieve a 100% zero-carbon grid without compromising reliability.

While the topic of combustion often has emissions implications, research from the LA100 Study suggests that reliability does not have to come at the expense of emissions in the case of green hydrogen turbines. When switching to green hydrogen fueled turbines, it appears that this results in "emissions at rates equal to or less than the cleanest, state-of-the-art natural gas plant."[14] Specifically, the LA100 Study found that "when hydrogen is burned . . . emissions factors are cut to zero for CO, SOx, VOC (which includes most hazardous air pollutants, otherwise known as local toxics), and PM, whereas NOx and ammonia emissions are assumed to be emitted at the current regulatory limit.[15]" See the table below for greater detail.

Table 9. Annually averaged daily NOx and PM emissions in 2045 (metric tons per day) and percent reduction from the 2012 Baseline from LADWP power plants for the LA100 scenarios modeled for air quality impacts (excerpted from Tables 9 and 10 in Chapter 9)

	NOx	PM
2012 Baseline	0.54	0.24
SB100 – M	0.15 (-72%)	0.03 (-87%)
SB100 – H	0.15 (-72%)	0.03 (-87%)
Early/NoBio – M*	0.05 (-91%)	0.00 (-100%)
Early/NoBio – H*	0.04 (-93%)	0.00 (-100%)

*Early & No Biofuels only allows hydrogen combustion by 2045, which is assumed to have zero PM emissions.

ii) Affordability

Given that SB 100 requires the Joint Agencies to focus on affordability in addition to reliability, green hydrogen turbines offer important cost savings since they can repurpose existing infrastructure to achieve clean firm dispatchable renewable power. The use of green hydrogen in existing gas turbines is a strategic near-term pathway for helping to achieve scale since it allows the repurposing of valuable infrastructure at existing power plants – land, water infrastructure, and

[12] https://www.nrel.gov/docs/fy21osti/79444-10.pdf
[13] https://www.ladwp.com/cs/idcplg?IdcService=GET_FILE&dDocName=OPLADWPCCB794970&RevisionSelectionMethod=LatestReleased
[14] Chapter 10. Environmental Justice. LA100: The Los Angeles 100% Renewable Energy Study Chapter 10, page 67. https://www.nrel.gov/docs/fy21osti/79444-10.pdf
[15] Ibid.

electric interconnection – and enables an affordable transition to 100% renewable electricity. In this way, green hydrogen turbines offer a cost-effective means to scale its use while also achieving long duration storage for the state. We wish to note that the use of green hydrogen turbines is not going to be a large application in the future; rather, they will be used for strategic backup generation when intermittent renewables are not available or when the grid is constrained.

Furthermore, the cost trade-offs are echoed in LADWP's 2022 Strategic Long-Term Resource Plan (SLTRP) sensitivity analysis, which looked at the impact of replacing in-basin green hydrogen turbines with in-basin green hydrogen fuel cells. In this "no combustion" scenario, LADWP found that relying solely on fuel cells is not practical from an accountability perspective since they are "significantly costlier—roughly four times the capital cost assumed for green hydrogen turbines."[16] In this respect, there are a set of trade-offs that need to be considered when it comes to fuel cells versus green hydrogen turbines. As can be seen in the image below, for the specific use of thermal generating facilities, there are various categories under which green hydrogen turbines have a unique advantage over fuel cells.

	Hydrogen Turbines	Hydrogen Fuel Cells
Capital Cost	⬇	⬆
Operations & Maintenance Cost	⬇	⬆
Levelized Cost of Energy	⬇	⬆
Emissions	⬆	⬇
Operational Flexibility	⬌	⬌
Efficiency	⬌	⬌

LADWP ultimately concluded in its SLTRP that, "for fuel cells to be substituted for green hydrogen turbines at the massive scale required (gigawatts) in a land-constrained region such as the City of Los Angeles, several additional factors need to be thoroughly studied."[17] For this reason, it is important to take the following factors into account: **capital cost, operations and maintenance cost, levelized cost of energy, emissions, operational flexibility, and efficiency.**

iii) *Summary*

Limiting the use of hydrogen in this scenario to hydrogen fuel cells will not be sufficient to meet SB 100 goals in a reliable and affordable manner. While current technology offers another use for hydrogen in the power sector (i.e., hydrogen combustion in existing gas turbines), the current

16 https://www.ladwp.com/cs/idcplg?IdcService=GET_FILE&dDocName=OPLADWPCCB794970&RevisionSelectionMethod=LatestReleased

17 https://www.ladwp.com/cs/idcplg?IdcService=GET_FILE&dDocName=OPLADWPCCB794970&RevisionSelectionMethod=LatestReleased

proposed scenario excludes this pathway and thereby limits the state's ability to decarbonize our economy quicker and more cost-effectively.

As the GHC stated in our response to the Senate Bill 100 Kickoff Workshop on September 6, 2023,[18] we strongly advocate for the following: the inclusion of linear generators and combustion turbines fueled by renewable hydrogen as eligible resources within the SB 100 framework. Additionally, we encourage the CEC to formalize an official definition for "zero-carbon resources" that encompasses renewable hydrogen technologies. This approach will provide market certainty and pave the way for an effective integration of these innovative solutions.

III. CONCLUSION.

The GHC appreciates the opportunity to submit comments on the SB 100 Analytical Framework Workshop. We would like to thank the Joint Agencies for their leadership and look forward to continuing to collaborate with all other stakeholders.

Respectfully submitted,

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[18] https://efiling.energy.ca.gov/GetDocument.aspx?tn=252149&DocumentContentId=87152