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**Green Hydrogen Coalition Comments on SB 100 Draft Results  
Workshop**

*Additional submitted attachment is included below.*



September 15, 2020

Email to: [docket@energy.ca.gov](mailto:docket@energy.ca.gov)

Docket Number: 19-SB-100

Subject: GHC's SB 100 Draft Results Workshop Comments

**Re: Comments of the Green Hydrogen Coalition (GHC) following the September 2, 2020 Senate Bill 100 Draft Results Workshop**

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### Overview

The Green Hydrogen Coalition (“GHC”)<sup>1</sup> appreciates the opportunity to provide feedback on the Draft Results 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.

The GHC is a California 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. The GHC defines green hydrogen as hydrogen made from eligible renewables and/or carbon free energy sources, such as large hydro or curtailed renewables. The GHC believes that the prioritization of green hydrogen project deployment at scale is fundamental to reduce the cost and to meet California's climate and carbon goals. Lower cost solutions will enable green hydrogen 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, because the size of this 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 and using the resulting hydrogen in an existing thermal electricity generation plant to produce dispatchable, carbon free reliable power.

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

- Production of green hydrogen can leverage abundant, very low cost solar and wind energy and convert electrons into a flexible renewable molecule that can displace natural gas, diesel, gasoline and other fossil fuels.

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<sup>1</sup> <https://www.ghcoalition.org/>

- Green hydrogen can displace the current global use of gray hydrogen made from fossil fuels – if treated as a country, the GHG emissions from global gray hydrogen production would surpass the emissions of Germany.<sup>2</sup>
- Green hydrogen can be combusted in existing turbines so progresses achieving 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.

Today, the Los Angeles Department of Water & Power (“LADWP”) is advancing the use of green hydrogen as a resource to meet carbon goals in California and achieve the benefits of. Clean, reliable resource. With their plan to convert Intermountain Power Project (“IPP”) from an 1,800 MW coal plant to a combined cycle gas turbine initially running on a green hydrogen blend and increasing that blend to 100% on or before 2045, LADWP will achieve a robust power and thermal solution to support an affordable zero-carbon energy future. The GHC supports that this and other projects for production, use, and storage of green hydrogen are fundamental to realizing a future clean energy economy for everyone.

In these comments, the GHC urges the Joint Agencies to acknowledge the transformative capacity of green hydrogen for the achievement of SB 100 goals. By thinking expansively regarding the role green hydrogen, the GHC believes that California will be positioned to meet zero-carbon solutions for the State’s power, transportation, agricultural and industrial sectors. As the subsequent sections describe in further detail, GHC recommends the Joint Agencies consider the observations and recommendations in its scoping and planning to meet our climate goals.

### **Recommendations**

The benefits of green hydrogen can be realized most quickly via scale. The GHC recommendations are based on creating the pathways to achieve scaled, multi-sector production and utilization of green hydrogen. – which

- 1) The GHC recommends that CARB, in conjunction with the Joint Agencies, consider approaches to Demand Aggregation for Green Hydrogen in its scoping and planning to meet California’s carbon reduction goals.

Scale of green hydrogen can be achieved by aggregating demand in a given location, starting with thermal electric generation and adding demand that may exist from other applications, including oil refining, green hydrogen transportation fueling stations, or microgrid solutions. Once demand is effectively aggregated, it will be possible to scale

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<sup>2</sup> See Wood Mackenzie, “CO2 and other Greenhouse Gas Emissions”, May 2017. Available at <https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions>.

production, driving down cost and enabling the development of low-cost green hydrogen storage facilities.

Aggregating demand for green hydrogen in a given location is essential to supporting cost-effective infrastructure development needed to site new production facilities, and transport and store the resulting green hydrogen from areas of low cost production to where it is being used.

*As a strategy for co-locating end-use applications, the GHC recommends that the Joint Agencies focus efforts to identify thermal electric generation location(s) where green hydrogen can be used as a fuel source. Iterative analysis can then identify and cumulatively account for demand from other applications such as H2 fueling stations for transportation.*

2) 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 retirement of natural gas from the fuel mix.

GHC understands that the need for firm dispatchable resources has been one of the determining factors that results in the economic retention of natural gas generation by 2045 within the Draft Results. In this context, the potential of green hydrogen must not be underestimated. 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.

The current scoping study and draft results do not consider applications of green hydrogen production and storage. Production and storage of green hydrogen provides an unlimited and sustainable alternative fuel source that can be used to meet reliability and resilience objectives with a zero- carbon fuel. If produced from electrolysis and using clean energy from the grid, it will also increase demand on the power sector.

There are a wide range of hydrogen production and storage possibilities in California. On the production side, in addition to producing green hydrogen via electrolysis from an abundance of low cost wind and solar, and reformation of biogas, implementation of SB 1383 could enable the production of significant quantities of green hydrogen via gasification of organic matter. SB 1383 requires 75% of organic waste to be diverted from landfills by 2025 to either create compost or energy.<sup>3</sup> Thus, achieving the goals of SB 1383 could also assist with achieving those of SB 100. The SB 100 modeling work should also consider other statutory compliance activities underway in California in adjacent sectors that can provide a cost effective supply of green hydrogen. Together, these three green hydrogen production pathways reflect domains in which California is uniquely positioned to not only produce green hydrogen, but also to store it cost-effectively. There are a wide range of green

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<sup>3</sup> California Health and Safety Code (HSC) § 39730.6.

hydrogen storage possibilities in California, ranging from extension of existing 100% hydrogen pipelines<sup>4</sup>, to hydrogen injection into existing gas pipelines to repurposing underground natural gas/oil caverns, to a variety of commercially available above ground pressurized container options. GHC notes that further study may be needed to better understand and quantify the potential of these storage options in combination with large scale applications such as using green hydrogen as a drop-in fuel replacement for existing thermal plants, and we recommend systematic study of these storage options as a needed near-term analysis that could be coordinated by the Joint Agencies.

*The GHC recommends that the production and storage options be combined with large scale aggregated green hydrogen demand applications, such as using green hydrogen as a drop-in fuel replacement for existing thermal plants and providing multi day and seasonal renewable energy storage, be comprehensively and systematically included in the evaluation of pathways to realize California's clean energy future. In particular, in the SB 100 report, the Joint Agencies should identify the role that hydrogen can play in achieving a fully decarbonized power sector, levels of curtailed power, and how curtailed renewables can be stored on a seasonal basis as green hydrogen.*

GHC commends 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. Advancing modeling that is inclusive of green hydrogen can support setting a clear path to ensure SB 100 compliance while maintaining affordability and reliability. 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 natural gas with drop-in zero carbon fuels like green hydrogen.

The GHC acknowledges the complexity of ensuring both SB 100 compliance *and* reliability. The August 2020 heat wave rolling blackouts provide a stark reminder of the challenges we face and underscore the critical need for multi-day dispatchable power. Retaining utility-scale natural gas generation to meet this need may provide a near-term solution but is inconsistent with longer term decarbonization goals. Additionally, peaker plants often disproportionately harm low-income communities. Displacing natural gas peaking capacity with green hydrogen can maintain reliability during times of peak demand and supports environmental justice within the energy system.

The GHC notes that displacing natural gas in power plants is possible and, as noted above, LADWP, one of the state's largest load-serving entities (LSEs), is leading the way in using green hydrogen in thermal generation through the 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

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<sup>4</sup> The U.S. has about 1,600 miles of dedicated hydrogen pipelines. See *Hydrogen Pipelines*. U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, <https://www.energy.gov/eere/fuelcells/hydrogen-pipelines>.

closely follows the European model, where large LSEs are supporting the transition of thermal generation to green hydrogen.<sup>5</sup>

The GHC strongly encourages the Joint Agencies consider the role green hydrogen can play in fully decarbonizing dispatchable thermal generation. The GHC offers that green hydrogen could be 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. Existing research indicates that \$2/kg may reflect a sensible green hydrogen fuel replacement cost input by 2030 or earlier.<sup>6</sup> The GHC acknowledges that Joint Agency consideration of costs for green hydrogen as a drop-in fuel alternative may extend beyond fuel cost and into associated supply and storage infrastructure costs. To mitigate concerns over potentially distorting the analysis in this regard, GHC recommends the Joint Agencies coordinate closely with related initiatives actively addressing these challenges, such as the CPUC's Biomethane and Hydrogen Injection Standards and Long-Term Gas Reliability proceeding, as well as CARB's AB 32 2022 Scoping Plan. Additionally, the Joint Agencies can learn from the modeling and planning experience of LADWP within its LA100 initiative, which includes green hydrogen in every scenario.

*To support these considerations, the 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 in particular, to displace natural gas use in the power sector. Because of the diversity of these off take applications, this effort should be closely coordinated with ARB's 2022 Scoping Effort.*

- 3) The GHC recommends that green hydrogen be considered as an alternative to diesel, gasoline and propane powered back up generation to meet resiliency requirements on the grid and within the California energy system and decarbonize critical power supplies.

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 carbon and emissions emitting backup diesel, gasoline and propane powered generators have reached all-time highs.

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<sup>5</sup> See, for example, *Green Hydrogen Guidebook* <https://www.ghcoalition.org/guidebook> at Appendix A.

<sup>6</sup> 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>

Their frequent use under current conditions is also directly working against the goals of SB 100.

Recent heat storms in California and public safety power shutoffs (“PSPS”) to avoid wildfires highlight the need to have dependable, dispatchable, and clean multi-day generation going forward. The rolling blackouts associated with PSPS events create significant hardship for California’s citizens, businesses, and its environment. A green hydrogen solution for fuel cells or 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.

It should be noted that hydrogen-fueled backup generation fuel cells are already being commercially 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 – and provide another source of aggregated demand for green hydrogen as discussed in Recommendation #1, above.

Today, 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 take efforts to support immediate deployment of green hydrogen resilience solutions that can provide clean air benefits now. Ensuring California’s energy resilience can and should be carbon free. Moreover, existing dispatchable, back-up natural gas and diesel generation are disproportionately located near or within California’s most vulnerable communities. As such, the environmental and health impacts of fossil fuel combustion disproportionately fall on members of these communities. GHC believes transitioning to run green hydrogen for back-up generation can significantly reduce or eliminate these direct environmental and health impacts.

*The GHC recommends that the time to study the potential of green hydrogen to as a resiliency resource to back-up generations solutions is now. The sooner we initiate our planning and study, the sooner we can realize its benefits. extra insurance of sorts.*

*The GHC recommends that utility resource planning for service interruption events that consider 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. Together, these power applications of green hydrogen are fundamental for designing programs necessary to displace fossil based systems completely and achieve the goals of SB 100. 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.*



- 4) 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.<sup>7</sup> While it is clear that 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.

Furthermore, the Draft Results reflect an expected abundance of renewable generation resources as 2045 nears: under the SB 100 Core case, using the High Electrification load assumption, the system would experience the addition of approximately 130 GW of wind and solar generation resources.<sup>8</sup> This availability – and potential over-supply – of renewables can be leveraged to produce green hydrogen through electrolysis, which can behave as a flexible load on the grid. California may also be well-positioned to cost-effectively scale both biogas steam methane reformation and biomass thermal conversion (gasification), the latter being required by state law as noted above.

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.

*The GHC strongly recommends that the Joint Agencies to explore opportunities for close collaboration between the SB 100 modeling exercise and as a key focus activity of the Air Resource Board (“ARB”) AB 32 2022 Scoping Plan effort to advance green hydrogen as a cost-effective solution for multi-sector decarbonization.*

- 5) The GHC requests the Joint Agencies consider a dedicated Track within SB 100 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.

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<sup>7</sup> See *Green Hydrogen Guidebook* <https://www.ghcoalition.org/guidebook> at 17-25.

<sup>8</sup> See California Energy Commission (CEC), “SB 100 Draft Results”, September 2, 2020, p. 15.

In recognition of the game-changing potential of green hydrogen, GHC recommends the Joint Agencies establish a dedicated Track within SB 100 to focus on the important issue of replacing natural gas generation with green hydrogen. The Joint Agencies should consider five primary questions to guide the necessary transition of thermal peakers:

1. *Where is thermal peaking capacity needed?*
2. *How can needed 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 the green hydrogen?*
3. *What other end-use applications can be co-located to aggregate green hydrogen demand? (see Recommendation #1)*
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?*

Given the abundant supply of renewable resources expected, California has several viable options for producing, storing, and moving green hydrogen molecules. As detailed above, existing 100% hydrogen pipelines can be extended and existing gas pipelines can be injected with green hydrogen. If sufficient demand can be aggregated in a particular location, it may be feasible and more cost effective to leverage natural gas pipeline right of ways and add an additional 100% green hydrogen pipeline. While these pipeline options, combined with the variety of commercially available above-ground pressurized container solutions, offer possibilities for delivery and on-site storage, GHC recommends on-site green hydrogen production strategies be explored as well. Facilitation of such strategies will require the development of new tariffs, for example, to encourage distributed electrolysis and injection into the existing gas pipeline.

- 6) 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 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 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. 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 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 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 HYPOR 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.

- c. The GHC recommends that consideration and modeling efforts are applied to option and opportunities to 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. GHC offers the following specific consideration related to decarbonization of industrial applications:

- i. Green hydrogen can provide a solution to reduce carbon emissions in the Refining Industry.

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 H<sub>2</sub> by 2050 would establish a clear decarbonization pathway to this large industrial application.*

- ii. The GHC advises that Green Ammonia and Green Fertilizer will be critical to decarbonizing the agricultural sector.

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. The GHC recommends that green hydrogen is a critical resource to decarbonizing the Mining Sector.*

In 2009, California's 700 active mineral mines employed 5,300 people and ranked fourth nationally in the production of non-fuel minerals.<sup>9</sup> 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.

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<sup>9</sup> 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.*

7) GHC offers several other policy recommendations to advance green hydrogen.

In addition to the targets and roadmaps outlined above, GHC respectfully recommends that the Joint Agencies consider the following additional policy recommendations with respect to green hydrogen:

- Define green hydrogen broadly to include all pathways to produce green hydrogen (technology neutral). This broad definition will enable robust innovation and competition for supply contracts.
- Establish emissions certification and tracking programs for green hydrogen and clarify its eligibility toward meeting California clean energy policy goals such as SB 100 implementation.
- Incorporate green hydrogen into power and gas system planning models and procurement processes. A key advantage of green hydrogen is its ability to decarbonize multiple sectors. Energy system planning models can consider its use accordingly and reflect the cost advantages of aggregating demand across sectors. Procurement processes can also account for the unique advantages of green hydrogen use. A single large project with a number of contracts and a variety of off takers will be lower cost and easier to finance.
- Reform Wholesale Markets to enable Green Hydrogen participation. Wholesale electricity markets can be adapted and updated to allow the participation of electrolytic hydrogen as a modifiable wholesale load. Such reforms are critical to enabling access to curtailed and low cost renewable electricity and other ancillary service products such as voltage/VAR support and spinning reserve. Additionally, California can lead the US in developing new market products that compensate for long hold, zero carbon reliability. Traditional capacity products in the 4 hour range fail to compensate for green hydrogen's ability to provide multi-day and seasonal clean

energy storage and reliability. Such compensation pathways are needed to displace the fossil fuel resource which currently provide this grid service.

- To enable efficient and smart power-gas sector integration, wholesale market reforms are also needed in the gas sector. Examples could include new gas standards for green hydrogen interconnection, and procurement pathways and tariffs are needed that enable the use of curtailed and purpose-built renewables for electrolytic hydrogen production and storage in the natural gas pipeline (and modular storage containers where there is no gas pipeline). Thus, coordinated integrated electric and gas sector resource planning is essential.
- Fund green hydrogen RD&D. Many innovative green hydrogen technologies are commercially available today. However, 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. State and national RD&D funding has played a critical role for all energy resources to date, and dedicated focus is also needed for green hydrogen.
- State RD&D dollars can be invested into green hydrogen project development, storage, and deployment. 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.

## Conclusion

In conclusion, GHC is supportive of the Joint Agencies and their work in the Joint Agency Report. GHC believes that further consideration of the cross-sectoral benefits of green hydrogen is warranted, 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 and via ARB's 2022 scoping plan and in collaboration with other key agencies such as CalRecycle to develop targets and roadmaps for the use of green hydrogen 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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