CALIFORNIA HYDROGEN BUSINESS COUNCIL

Hydrogen Means Business in California!

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Comments by California Hydrogen Business Council on Public Workshop to Discuss *Achieving Carbon Neutrality in California: A Report by E3*

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I. INTRODUCTION

The California Hydrogen Business Council (CHBC) [1] appreciates the California Air Resources Board (CARB) hosting the August 19, 2020 public workshop to discuss *Achieving Carbon Neutrality in California: A Report by E3* (Draft Report) and welcomes the opportunity to share these comments. We applaud CARB and E3 for initiating this critical conversation on significant issues and questions related to how California should implement the state's goal to achieve carbon neutrality economy-wide by 2045. We wholly agree with CARB that it is also best not to wait until the next Scoping Plan update to begin sending market signals to industry investors about how California envisions its carbon neutral future, especially as priorities for investment are being made for recovering from the pandemic-driven economic downturn.

We are glad to see the Draft Report include key roles for hydrogen in all the scenarios considered, and especially the widespread use of hydrogen in the Balanced Scenario and Zero Carbon Scenario. The CHBC agrees that based on a growing body of analysis, hydrogen can be a cost competitive solution to decarbonize the applications laid out in the report within the time frames given, if not earlier, and believe that the potential extends to additional applications as well. This, moreover, presents a prime opportunity to retain jobs in the gas and industrial sectors and create a massive number of new green jobs across the hydrogen supply chain, from production to distribution to end use.

[1] The CHBC is comprised of over 100 companies and agencies involved in the business of hydrogen. Our mission is to advance the commercialization of hydrogen in the energy sector, including transportation, goods movement, and stationary power systems to reduce emissions and dependence on oil. The views expressed in these comments are those of the CHBC, and do not necessarily reflect the views of all of the individual CHBC member companies. Members of the CHBC can be found here: https://www.californiahydrogen.org/aboutus/chbc-members/.

Our specific comments are summarized as follows and discussed further in the Comments section below.

A. **We agree with the Draft Report's premise that achieving carbon neutrality will necessitate zero carbon fuels and that the falling cost of renewable electricity and hydrogen technology point to the potential for hydrogen to become an especially cost-effective fuel for decarbonizing several applications.**

B. **The Draft Report rightly points out that California is a prime location to advance renewable hydrogen production and use.**

C. **We appreciate the Draft Report considering hydrogen as a zero carbon resource for firm power generation and storage and urge state electricity resource planning and modeling to draw from this and other examples and do so as well.**

D. **The Draft Report's cost estimates for decarbonizing firm power to achieve a 100% zero carbon electricity portfolio in California are very high compared to other analysis.**

E. **The Draft Report's limit of 5% hydrogen in the pipeline should be considered a near term starting place, not a long term ceiling.**

F. **Future energy planning in California must take into account the state's vulnerability to severe weather and natural disasters and prioritize managing these challenges to maintain reliability, while also meeting state greenhouse gas and air quality goals.**

G. **We strongly support the Draft Report's proposed expanded use of low and zero carbon hydrogen in industrial applications and encourage deeper consideration of other potential applications, including for process heating and industrial feedstock.**

H. **We strongly support the report's inclusion of hydrogen fuel cell electric technology as the solution for a large share heavy duty vehicles (HDVs), although the omission of hydrogen fuel cell technology for Medium Duty and Light Duty vehicles is premature in nascent market**

conditions and risks unfavorable impacts.

I. Limiting building decarbonization strategies to 100% directly electrified end uses for all buildings is suboptimal, and we urge the state to take a more diversified approach.

J. We generally agree with the further areas of study and next steps proposed in the Draft Report, with specific policy recommendations.

II. COMMENTS

A. We agree with the Draft Report's premise that achieving carbon neutrality will necessitate zero carbon fuels and that the falling cost of renewable electricity and hydrogen technology point to the potential for hydrogen to become an especially cost-effective fuel for decarbonizing several applications.

E3 points out in the Draft Report that "most published decarbonization pathways show a significant reliance on low-carbon (or zero carbon) liquid and/or gaseous fuels," including hydrogen based fuels, "across all sectors of the economy (buildings, industry, transportation, and electricity) in order to meet climate goals, and in particular when targeting net zero emissions."[2] Downward cost curves for renewable power and hydrogen production costs are raising the economic prospects for decarbonized hydrogen. As the Draft Report states, "As the cost of wind and solar decline, the cost of renewable hydrogen production is also falling," making renewable hydrogen cost competitive compared to other low carbon options. [3] As the presenter remarked during the workshop discussion, E3's recent analysis for Mitsubishi Hitachi Power Systems, also confirmed that electrolyzer costs are quickly going down at a pace not previously anticipated by E3.

In addition to electrolytic technology, there are also other pathways to producing decarbonized hydrogen that can play important roles in achieving carbon neutrality. Converting organic waste to hydrogen either through biogas or gasification pathways can help to both manage issues like short-lived climate pollutants and fire risk caused by increased forest residuals , while making a high value greenhouse gas free fuel in the form of zero carbon hydrogen. A recent study by Lawrence Livermore

[2] ibid, p. 27
[3] ibid, p. 11

National Laboratory finds that hydrogen made by gasifying woody biomass from forest waste is the most cost effective means of achieving carbon neutrality and net carbon negativity in California.[4] Gasification is still on the way to being commercialized, but demonstrating that some bio-energy pathways are already commercial ready, $150 million is being invested into a project that will produce renewable hydrogen from biogas to serve the California transportation market.[5]

B. The Draft Report rightly points out that California is a prime location to advance renewable hydrogen production and use.

California's abundance of natural resources and long history of clean technology innovation make the state an ideal launching pad for the decarbonized hydrogen industry. As the Draft Report mentions, "large amounts of solar and wind in California and in neighboring regions can provide an excellent source of renewable energy for electrolysis to produce hydrogen. The West is also endowed with salt caverns and geological storage sites that can serve to store hydrogen in interim periods when renewable energy production and demand are not temporally aligned."[6] This echoes the opinion shared by other experts at the last carbon neutrality workshop, including UC Irvine[7] and Energy Futures Initiative.[8] The state is also rich in organic waste resources, for example, from its large agricultural operations.

California has also been an epicenter of numerous landmark clean energy technology breakthroughs, from catalytic converters to wind and solar to efficiency solutions to batteries and zero emissions vehicles. The state has also been a leader in forward thinking clean energy policies that have been a role model for the nation and the world. Time and again California has proven that pioneering green energy solutions is good for the environment, public health and the economy. Advancing decarbonized hydrogen is a logical next step in this tradition.

C. We appreciate the Draft Report considering hydrogen as a zero carbon resource for firm power generation and storage and urge state electricity resource planning and modeling to draw from this and other examples and do so as well.

[4] https://www-gs.llnl.gov/content/assets/docs/energy/Getting_to_Neutral.pdf, p. 5
[5] https://www-gs.llnl.gov/content/assets/docs/energy/Getting_to_Neutral.pdf
[6] Ibid, p. 30
[7] https://ww2.arb.ca.gov/sites/default/files/2020-07/nfcrc_cn_fuels_infra_july2020.pdf, Slide 20
[8] https://ww2.arb.ca.gov/sites/default/files/2020-07/efi_cn_fuels_infra_july2020.pdf, Slide 4

The Draft Report estimates that to maintain reliability in a zero carbon electricity future, which both the Balanced and Zero Carbon scenarios call for, approximately five percent of the state power portfolio will need to be supplied by zero carbon fuels to provide firm capacity. Hydrogen is among the zero carbon fuels the report considers.[9] This is similar to the Los Angeles 100% Renewable Energy Study, which includes green electrolytic hydrogen used in fuel cells or thermal generation in every scenario, and includes an "LA Leads" scenario that deploys green electrolytic hydrogen to replace all fossil natural gas to achieve a 100 percent zero-carbon electricity system for Los Angeles by 2035.[10]

Recent preliminary analysis by UC Irvine shows green electrolytic hydrogen will also likely be an increasingly economical choice. Using the RESOLVE model, they show that at a price electrolytic hydrogen is likely to achieve by 2030, hydrogen is chosen as a cost-effective electricity resource, reducing the need for solar and batteries, as well as the need to retire thermal generation.[11]

An immediate opportunity to practically build on these propositions is to create a zero carbon electricity scenario in California's joint agency modeling for achieving SB 100 targets and to include hydrogen as a power generation and long duration storage solution in this model. This would align with the intent of SB 100, which calls for transitioning to a "zero carbon electric system," and was signed concurrently with the state's Executive Order B-55-18 that sets a goal of achieving climate neutrality statewide by no later than 2045 and maintaining net-negative greenhouse gas emissions thereafter.

D. The Draft Report cost estimates for decarbonizing firm power to achieve a 100% zero carbon electricity portfolio in California is very high compared to other analysis.

The Draft Report estimates that decarbonizing the last 5% of emissions from electricity generation in California "is estimated at an average cost of $380-$540/tCO2 based on prior analysis using E3's RESOLVE model, whereby either electricity generation with CCS or with a zero carbon fuel (e.g. biomethane, hydrogen) are available as firm capacity resources, to balance high levels of renewable generation." This is vastly higher than an assessment by Bloomberg New Energy Finance (BNEF), which estimates that over the long term, "a carbon price of $32/tCO2 would be enough to drive fuel switching

[9] Draft report, pp. 30, 56

[10] https://www.ladwp.com/cs/idcplg?IdcService=GET_FILE&dDocName=OPLADWPCCB726105&RevisionSelectionMethod=LatestReleased

[11] Slide 3, *Gas System Reliability Track 1B Workshop – July 21, 2020,* Dr. Jeff Reed, UCI APEPl https://cpuc.webex.com/recordingservice/sites/cpuc/recording/play/8f41736f0ab34b13aeb0a16dd3bb2329 Password: Gasplanning123; at Approx. 2:22

from natural gas to hydrogen, and generate clean, dispatchable power at a competitive price."[12] Notably, another study finds that by optimizing renewable electricity with electrolytic hydrogen and synthetic methane, California can achieve carbon neutrality five years ahead of the state's 2045 target, saving $8 billion and minimizing land use.[13] We urge the agencies to rigorously review cost assumptions of achieving zero carbon firm power to achieve carbon neutral electricity system wide.

E. The Draft Report's limit of 5% hydrogen in the pipeline should be considered a near term starting place, not a long term ceiling.

The Draft Report estimates the amount of hydrogen in the pipeline will be limited to a maximum of 5% by energy (as opposed to volume) through 2045[14] and presumably beyond that. The E3 presenter explained at the workshop that this is the amount they estimate will be able to be injected into the pipeline with no upgrades. This estimated blending limit is lower than the 7% limit projected in an earlier E3 study on the future of the gas system.[15]

It is understandable to be cautious at the beginning of a transformation of the gas system, but allowing such caution to limit vision for the future also risks inertia. When California began transitioning to renewable electricity, there were also warnings that the grid could not handle more than a few percent of wind or solar without the electric system breaking down. California ultimately chose to invest in increasingly high shares of renewables and the necessary grid upgrades, proving that this is not only possible, but also a boon to the state economy and green jobs. Today, the state has adopted a 100% renewable and zero carbon electricity target that seemed unthinkable not so long ago. We believe the same spirit of innovation and forward looking embrace of a clean energy transformation should be applied to decarbonizing the gas system.

There will naturally be many challenges to understand and overcome. Safety must be the highest priority, and the CHBC strongly supports technical research to gain understanding of the concerns and how to best address them to ensure safe protocols for hydrogen injection into the gas system. The Draft Report warns that "Hydrogen is a high energy density fuel by weight but low energy density fuel by

[12] https://data.bloomberglp.com/professional/sites/24/BNEF-Hydrogen-Economy-Outlook-Key-Messages-30-Mar- 2020.pdf (pg. 7)
[13] https://www.pathto100.org/wp-content/uploads/2020/03/path-to-100-renewables-for-california.pdf
[14] Draft Report, p. 24
[15] *Natural Gas Distribution in California's Low- Carbon Future* (Draft), E3; October 2019, p. 33

volume and can easily leak from pipelines and valves."[16] At the last carbon neutrality workshop, UC Irvine's National Fuel Cell Research Center shared their findings that hydrogen actually leaks from the gas pipeline at the same rate as methane.[17] This is one example of an area where research is needed to ensure policy is based on up to date facts and not limited by a lack of understanding.

Notably far greater amounts of up to 100% hydrogen in existing pipelines are envisioned by European countries. Last month, for example, nine EU states announced their vision for a 23,000 kilometer pipeline network dedicated to 100% hydrogen, 75% of which is to consist of retrofitted existing pipeline. They project the pipeline upgrades to only add 10% to decarbonized hydrogen production costs.[18] German gas transmission operators are planning to create 1200 kilometers of hydrogen pipeline by 2030, nearly all of which will be conversion of the existing gas pipeline, with a vision of extending this to 5900 kilometers.[19]

We see no fundamental reason such envisioning cannot happen in California, perhaps in collaboration with other Western States that are showing increasing interest in hydrogen, and hope this will be part of California's carbon neutral planning going forward.

F. Future energy planning in California must take into account the state's vulnerability to severe weather and natural disaster and prioritize managing these challenges to maintain reliability, while also meeting state greenhouse gas and air quality goals.

The Draft Report leaves out highly significant discussions of the California context, which are how prone the state is to severe weather, natural disasters, the seasonal mismatch of heating and power demand with renewable generation, and the serious challenges to achieve regional grid integration compared to European countries, which enjoy the flexibility of regionally and internationally integrated grid operations. Recent rolling blackouts due to resource inadequacy during a heatwave and wildfire related power shutdowns are stark reminders of how underprepared the state is to maintain energy service reliability in the face of these challenges. The constraints are bound to getting far more severe, as the climate changes.

[16] ibid, p. 28
[17] Slide 16: https://ww2.arb.ca.gov/sites/default/files/2020-07/nfcrc_cn_fuels_infra_july2020.pdf
[18] https://www.euractiv.com/section/energy/news/gas-grid-operators-unveil-plan-for-european-hydrogen-infrastructure-backbone/
[19] https://www.rechargenews.com/transition/german-pipeline-operators-present-plan-for-world-s-largest-hydrogen-grid/2-1-810731

Hydrogen can play a key role in overcoming this hurdle. Hydrogen is particularly capable of supplying a long duration storage resource at mass scale, along with flexible, dispatchable generation as described above, to help manage the large and fast ramps needed for peak and seasonal demand. Hydrogen fuel cells are also a readily available technology that can provide 24/7, multi-day, zero emissions power for back up generation and microgrids, to help maintain reliability when regular grid power becomes unavailable. We hope that future iterations of carbon neutral energy planning for California will acknowledge these serious challenges and include hydrogen solutions as among those that should be deployed to overcome them.

G. We strongly support the Draft Report's proposed expanded use of low and zero carbon hydrogen in industrial applications and encourage deeper consideration of potential additional applications, including for process heating and industrial feedstock.

The Draft Report correctly concludes that decarbonized hydrogen deployed for use in industrial applications is a promising pathway to address greenhouse gas emissions in this hard-to-abate sector and, therefore, ought to be prioritized. This ought to include the recommendation made in the report "to replace natural gas with hydrogen combustion for conventional boilers…(d)ue to the high cost of replacing conventional gas-fired boilers with electric resistance boilers."[20] The report goes on to say that "(h)ydrogen combustion could also be a suitable decarbonization option for many process heating applications, but this was not examined in depth as part of this analysis." We urge that such analysis be rigorously performed in future studies undertaken by the state. We also encourage programs that support use of decarbonized hydrogen to replace fossil hydrogen feedstocks, which could be an early opportunity to expand the market for low and zero carbon hydrogen while significantly reducing greenhouse gases from ammonia production and refineries.

H. We strongly support the report's inclusion of hydrogen fuel cell electric technology as the solution for a large share heavy duty vehicles (HDVs), although the omission of hydrogen fuel cell technology for Medium Duty and Light Duty vehicles is premature in nascent market conditions and risks unfavorable impacts.

[20] Draft Report, p. 27

The Draft Report projects nearly half of HDV sales to be hydrogen fuel cell electric by 2035 in its Balanced scenario and half of HDVs to be hydrogen fuel cell electric by 2030 in its Zero Carbon scenario.[21] We agree with the Draft Report that it is premature at this early market stage to know precisely what share hydrogen fuel cell electric vehicles will have. That said, we think it is right to project that with the attributes of fast and flexible refueling and comparatively low weight, and with global analysts' projections for rapid cost-competitiveness,[22] hydrogen fuel cell electric HDVs will play a significant, if not dominant role in the HDV market.

The Draft Report also assumes that all Medium Duty vehicles (MDVs) and nearly all Light Duty vehicles (LDVs) will be battery electric in all three of its carbon neutral scenarios.[23] This differs from California's long-held technology neutral approach to ZEV policy, and risks sending a market signal that chills investment for hydrogen fuel cell technology development for these sectors.

Hydrogen fuel cell electric MDVs are being demonstrated on the roads in California,[24] Germany,[25] and beyond. That said, the zero emissions MDV market is nascent, and so the projection that 100% sales will be battery electric by 2030 or 2035 is at best premature. A comprehensive, third party reviewed, global industry analysis by McKinsey and the Hydrogen Council offers reason to think it could also be incorrect. They explain that the cost of MDVs is largely influenced by fuel cost. With the rapidly declining cost of hydrogen, they project that MDVs could become cost competitive with battery electric options as soon as 2025, particularly for vehicles in this class that require longer ranges, lighter payloads, and/or quick refueling.[26]

The LDV ZEV market is farther along, but still at a very early stage. Only about one twentieth - roughly 723,000[27] out of 15 million- passenger cars in California, which is home to about half of national plug-in

[21] ibid, p. 40
[22] See: https://hydrogencouncil.com/wp-content/uploads/2020/01/Path-to-Hydrogen-Competitiveness_Full-Study-1.pdf, starting at p. 37; https://www.ballard.com/about-ballard/newsroom/news-releases/2020/01/08/deloitte-ballard-joint-white-paper-assesses-hydrogen-fuel-cell-solutions-for-transportation
[23] Draft Report, p. 40
[24] https://www.hydrogen.energy.gov/pdfs/review19/ta016_hanlin_2019_o.pdf
[25] https://www.forbes.com/sites/alanohnsman/2019/05/29/hauling-with-hydrogen-dhl-adding-fuel-cell-vans-to-its-delivery-fleet/#463a485f79d8
[26] *Path to Hydrogen Competitiveness – A Cost Perspective,* Hydrogen Council with analytical support from McKinsey; January 2020, see p. 38
[27] https://www.veloz.org/sales-dashboard/;

vehicle sales are battery electric. [28] While this currently outpaces fuel cell electric LDV adoption to date significantly, these are still very early days to be picking a winner. Doing so not only sends investment signals that are misaligned with state policy to support both types of ZEV technology, but also risks placing bets on the option that is not necessarily more affordable. The Hydrogen Council and McKinsey project that fuel cell electric cars will be cost-competitive compared to battery electric options within only approximately 5 years under optimal policy and resource conditions and in about 7 years under average conditions.[29] They find it is especially likely for heavier models like SUVs, which is particularly significant, given that this type of vehicle dominates consumer preference, according to presenters at a recent IEPR workshop on LDV market trends.[30]

Furthermore, and perhaps even more importantly, if 100% of LDV sales are battery electric as the Draft Report surmises, half of Californians, including lower income residents, risks not being able to easily drive a zero emissions car because of difficulties charging. More than 80% of battery electric car drivers charge their cars at home.[31] This convenience is a major selling point of this type of vehicle. But nearly half of Californians live in homes without easy access to plugging in.[32] This includes nearly all multi-unit dwellings. Lower income Californians are not only more likely to live in apartments in much of the state, but also least likely to be able to afford the cost of installing charging in their home parking spot, if they even have a parking spot and are instead parking on the street. While California has created policies and programs to support electric charging in multi-unit dwellings, the feasibility and affordability of scaling that up to give everyone who wants a car access to chargers at home is highly uncertain if not impractical. Furthermore, it is inconvenient for commuters to wait for their car to charge at a public charging station, and charging at work is also impossible for many types of wage earners. Hydrogen fuel cell electric vehicles are a more elegant and convenient option in these cases with fast centralized refueling, while still having zero emissions.

Battery mineral mining also presents challenges. Most of the cobalt used in lithium-ion batteries comes from the Democratic Republic of Congo, where practices reportedly have a track record of being unsafe,

[28] https://www.statista.com/statistics/196010/total-number-of-registered-automobiles-in-the-us-by-state/
[29] *Path to Hydrogen Competitiveness – A Cost Perspective,* Hydrogen Council with analytical support from McKinsey; January 2020, see p. 10
[30] https://www.energy.ca.gov/event/workshop/2020-06/session-1-light-duty-zev-update-and-trends-larger-vehicles-iepr-commissioner
[31] https://www.energy.gov/eere/electricvehicles/charging-home
[32] 2019 Final Integrated Energy Policy Report – Clean Version, CEC, p. 99

unjust, and environmentally unsound.[33] Lithium mining is similarly problematic.[34] Fuel cells are less energy intensive to produce, use and easier to recycle at the end of life.[35]

The CHBC favors a diversified approach that supports both battery electric and fuel cell electric vehicle adoption in the MDV and LDV classes. We believe enabling both sets of technologies to rapidly scale and provide consumer choice is the wisest approach to address our collective climate and air quality protection needs.

I. Limiting building decarbonization strategies to 100% directly electrified end uses for all buildings is suboptimal, and we urge the state to take a more diversified approach.

The Draft Report assumes in each of its three scenarios that all building appliance sales will be electric by 2030-2045, depending on the scenario, and that building energy will be all or nearly all electric by 2045. The report acknowledges that "eliminating fossil fuel combustion in buildings by 2045 would be particularly challenging as it would require early and rapid deployment of electric end uses in buildings, as well as a plan for how to safely reduce, and eventually eliminate, gas throughput across the substantial retail gas infrastructure in the State."[36] The report does not, however, inquire into how the gas system might be optimized to help decarbonize buildings by deploying zero carbon gas, such as hydrogen. We urge CARB and other state agencies to undertake this effort.

A one-size fits all approach will not be best in every circumstance, leaves the state's building decarbonization strategy vulnerable to seen (e.g., a less reliable grid facing public safety power shutoffs) or unforeseen (e.g. shut downs due to natural disasters or equipment failure) circumstances, and ignores additional opportunities to decarbonize buildings that may become favorable. It is not technically possible at this time to predict that all direct electric end uses will be the optimal pathway for all buildings to decarbonize, and this direction creates risks for negative reliability, public health, safety, and potentially negative cost impacts.

Renewable hydrogen used for heating would have zero risk of emitting greenhouse gases over its entire lifecycle, unlike the technologies proposed in the Draft report – namely heat pumps, which are highly

[33] https://www.cbsnews.com/news/cobalt-children-mining-democratic-republic-congo-cbs-news-investigation/
[34] https://goodelectronics.org/lithium-mining-encroches-on-the-rights-of-indigenous-peoples/
[35] https://tech.hyundaimotorgroup.com/article/the-future-lies-in-ev-or-fcev/
[36] ibid, p. 5

efficient but also contain HFCs, and fossil natural gas, which is a source of methane that risks being exposed to the atmosphere during production and transport and emits carbon dioxide when combusted.

Deploying hydrogen as a building decarbonization strategy can also lessen the costs required for new electricity infrastructure and the risk of building energy being interrupted by problems with the vulnerable overhead power grid.

While the state considers electrification as one path forward, we encourage that it additionally enable the decarbonized gas market, including low and zero carbon hydrogen, along with looking into converting distribution and end use equipment to be compatible with hydrogen, so that the state may boost energy system reliability and allow multiple strategies to compete to find optimal, low cost solutions providing maximum emissions reductions.

J. We generally agree with the further areas of study and next steps proposed in the Draft Report, with specific policy recommendations.

The Draft Report identifies a few areas where "further investigation is needed…pertaining to the risk and feasibility" of the proposed carbon neutral scenarios. We think this is a good start and have the following specific recommendations related to three of them.

1. *Maximizing co-benefits for heavily burdened communities with respect to environmental justice issues and equity ought to include prioritizing*
    - Ensuring equitable access to all to zero emissions vehicles by accelerating hydrogen refueling infrastructure, hydrogen production, and economies of scale in fuel cell electric passenger vehicles.
    - ZEV HDV, MDV, and equipment deployment and infrastructure expansion, including fuel cell electric vehicle and equipment options and hydrogen refueling, in order to help eliminate diesel emissions that are causing about 70% of California's estimated known cancer risk attributable to toxic air contaminants[37] and are most concentrated in lower income communities that live nearest to ports and freight corridors.

[37] https://ww2.arb.ca.gov/resources/summary-diesel-particulate-matter-health-impacts

- Workforce training and educational support that prepares workers to build, operate and maintain the infrastructure that will be needed along the decarbonized hydrogen supply chain.

2. *To enable better understanding of the adoption challenges that vehicle and building electrification strategies might face as well as the practical infrastructure rollout needed, e.g. distribution and transmission upgrades to match growth in electric loads:*
    - We urge that there be rigorous, peer-reviewed scientific analysis of the of the reliability, cost, environmental and broader economic impacts of these strategies and that this effort include comparison with various diversified approaches that combine electrification with decarbonized gas – including decarbonized hydrogen and synthetic methane strategies – and that also consider diversified regional approaches that take into account resources and needs in different areas of the state. For example, an all or predominantly battery electric car strategy stands to have very different ramifications for neighborhoods that are all single family home with plug-in capability than a neighborhood dominated by low-income, multi-unit dwellings. Similarly building electrification will differently impact new construction in an urban, temperate neighborhood than old existing homes and rural, fire-prone neighborhoods.

3. *Among the strategies to incentivize the development of advanced mitigation strategies, in particular low carbon fuel production, and to bring down their costs, we recommend, as shared in our comments for the previous carbon neutrality workshop, that California*
    - **Establish a Program that Encourages Carbon Neutral Gas Procurement,** overseen by CARB and implemented in consultation with the CPUC, that requires each gas corporation in California to procure gas from a broad range of decarbonized sources, including bio-based and green electrolytic hydrogen, with stepped up targets and that also sets a long term target for 100% carbon neutrality of the gas sector by 2045 to enable the state to achieve its 2045 carbon neutrality goal. The program should include long-term contracts to attract stable investment.

    - **Adopt a Strategic Plan for accelerating the production and use of decarbonized hydrogen** in California, that includes among other elements a strategy for advancing hydrogen

produced via electrolysis, biogas reforming and other low or zero carbon pathways as fuel for a variety of end uses including firm renewable power generation, fuel cells, transportation, industry and buildings.

- **Establish near and long-term energy storage targets, including technologies that produce green electrolytic hydrogen** at the gigawatt scale to achieve cost competitiveness.

- **Direct cap and trade revenue to fund programs that incentivize bio-based and green electrolytic hydrogen market development through programs like grants or financing support, as have been employed in the dairy sector.** Specifically, CARB should be encouraged to direct cap-and-trade revenue to support and incentivize accelerated adoption of hydrogen made from low and zero carbon feedstocks. As part of this program, CARB might provide additional incentives to buy decarbonized hydrogen to large gas users who have been particularly hard hit by the COVID-19 economic downturn, to help ensure their economic recovery also protects the climate.

- **Call for bio-based and green electrolytic hydrogen to be considered zero carbon-emitting power generation resources and green electrolytic hydrogen to be considered a storage resource, for purposes of implementing SB 100 and the Executive Order on carbon neutrality,** in order to provide system reliability, enable higher levels of renewable power integration into the electricity grid, and ultimately advance toward carbon neutrality in the electricity sector.

- **Establish a critical consumption program that encourages green electrolytic hydrogen production to support grid reliability and integration of renewable generation.**

- **Call for electrical corporations to file a petition at the Federal Energy Regulatory Commission to file tariffs for the removal of the noncoincident peak demand charge.**

- **Encourage the Department of General Services to fuel switch from natural gas to low and zero carbon hydrogen, as part of their decarbonization strategy at existing buildings,** especially those that are high energy consumers and connected to natural gas infrastructure

(e.g. prisons). This could be implemented as a series of pilot projects that demonstrate large scale building decarbonization with hydrogen and other types of renewable gas.

- **Support additional hydrogen research and development** that includes establishing industrial hydrogen hubs that, for example, repurpose state ports as centers of hydrogen development, as suggested in the presentation by EFI.[38]

- **Support a 10-year sales and use tax exemption on hydrogen fuel production and dispensing equipment**.

4. *To better understand the infrastructure development needs to deploy a hydrogen and/or carbon dioxide transport and storage system in-state, and potentially out of state:*
    - **Support the CPUC implementing a protocol and standard for expanded limits for hydrogen injection into the existing gas pipeline and a renewable gas procurement program for utilities that includes hydrogen**, as is currently underway in the CPUC Rulemaking R.13-02-008.
    - **Study the repurposing of California's depleted oil and gas fields for storage of decarbonized hydrogen**, as recommended by UC Irvine in the workshop presentation in the July 15, 2020 carbon neutrality workshop.[39]
    - **Study impacts of up to 100% hydrogen on existing pipelines and end uses** in California, as is being done in places such as Europe and Australia.[40]
    - **Implement all recommendations related to hydrogen fuel cell transportation infrastructure** included in the *Draft Assessment of CARB's Zero Emissions Vehicle Programs Per Senate Bill 498*, in addition to establishing a state target of 1000 hydrogen fueling stations by 2030.

[38] Green Hydrogen Coalition Presentation, *Beyond Power: Opportunities and Challenges for Green Hydrogen,* Slide 3 https://ww2.arb.ca.gov/sites/default/files/2020-07/ghc_cn_fuels_infra_july2020.pdf
[39] Slide 20, UC Irvine Presentation, *Do We Really Need Hydrogen Infrastructure?* https://ww2.arb.ca.gov/sites/default/files/2020-07/nfcrc_cn_fuels_infra_july2020.pdf
[40] 100% Hydrogen Test Facility at Canberra https://www.evoenergy.com.au/emerging-technology/hydrogen-test-facility

III. CONCLUSION

The CHBC appreciates CARB's consideration of these comments and looks forward to working with the agency to develop understanding of how the state can most rapidly, cost-effectively, reliably, and equitably transition to carbon neutrality economy wide and the roles hydrogen-based solutions can play in enabling this.

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