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California Hydrogen Business Council Comments on CARB Workshop on Fuels and Infrastructure for a Carbon Neutral Economy

August 5, 2020

I. Introduction

The California Hydrogen Business Council (CHBC)[1] welcomes the opportunity to comment on the July 15, 2020 California Air Resources Board (CARB) workshop on Fuels and Infrastructure for a Carbon Neutral Economy. We applaud CARB for hosting this important discussion, which sheds light on two major areas that require a focused effort to decarbonize fuels and realize a carbon neutral economy. The first is policies to support market development of zero carbon gaseous fuels. The second is infrastructure that includes repurposing the incumbent gas system to transition to decarbonized gaseous fuels and avoid stranding existing assets, building out mass-scale renewable power, and encouraging investment in new infrastructure as needed to support the transition to decarbonized gaseous fuels.

Below is a summary of our main comments to the workshop, which are elaborated on in the section that follows:

A. As several panelists pointed out, hydrogen holds promise to help decarbonize a diverse range of applications, unlocking California's ability to achieve carbon neutrality across sectors and economy wide.

B. As the lead agency implementing climate and clean air policies in California, CARB is uniquely positioned to oversee establishing and implementing targets

[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 are listed here: www.californiahydrogen.org/aboutus/chbc-members/

to decarbonize use of gaseous fuels across sectors.

C. **Overseeing California's effort to transition to carbon neutral fuels is the next step to build upon CARB's pioneering programs to advance low carbon transportation fuels and zero emissions transportation and take them to the next level.**

D. **The CHBC wishes to clarify for the record that the Resolve model presented by the CPUC does not pick hydrogen as a least cost option because hydrogen is not included in the model, but recent analysis by UC Irvine using the Resolve model shows green electrolytic hydrogen will likely be cost competitive for electricity generation in California within the next decade.**

E. **Global analysts project that hydrogen made with decarbonized feedstock will likely be cost competitive in numerous applications in addition to electricity generation within the next decade, if not sooner.**

F. **Advancing green hydrogen to achieve a carbon neutral economy in California is a massive opportunity to retain and create jobs and should be a pillar of the state's green economic recovery plan, as is the case in the European Union.**

G. **To realize hydrogen's potential to decarbonize the economy, CARB should build on state policies to support market development of zero carbon hydrogen production and utilization across sectors.**

H. **Ensuring hydrogen advances the green economy will also require a focus on infrastructure that includes 1) repair, upgrades, research, and development to repurpose existing gas infrastructure and avoid stranding assets, 2) mass-scale build out of renewable power to support full decarbonization of the fuels**

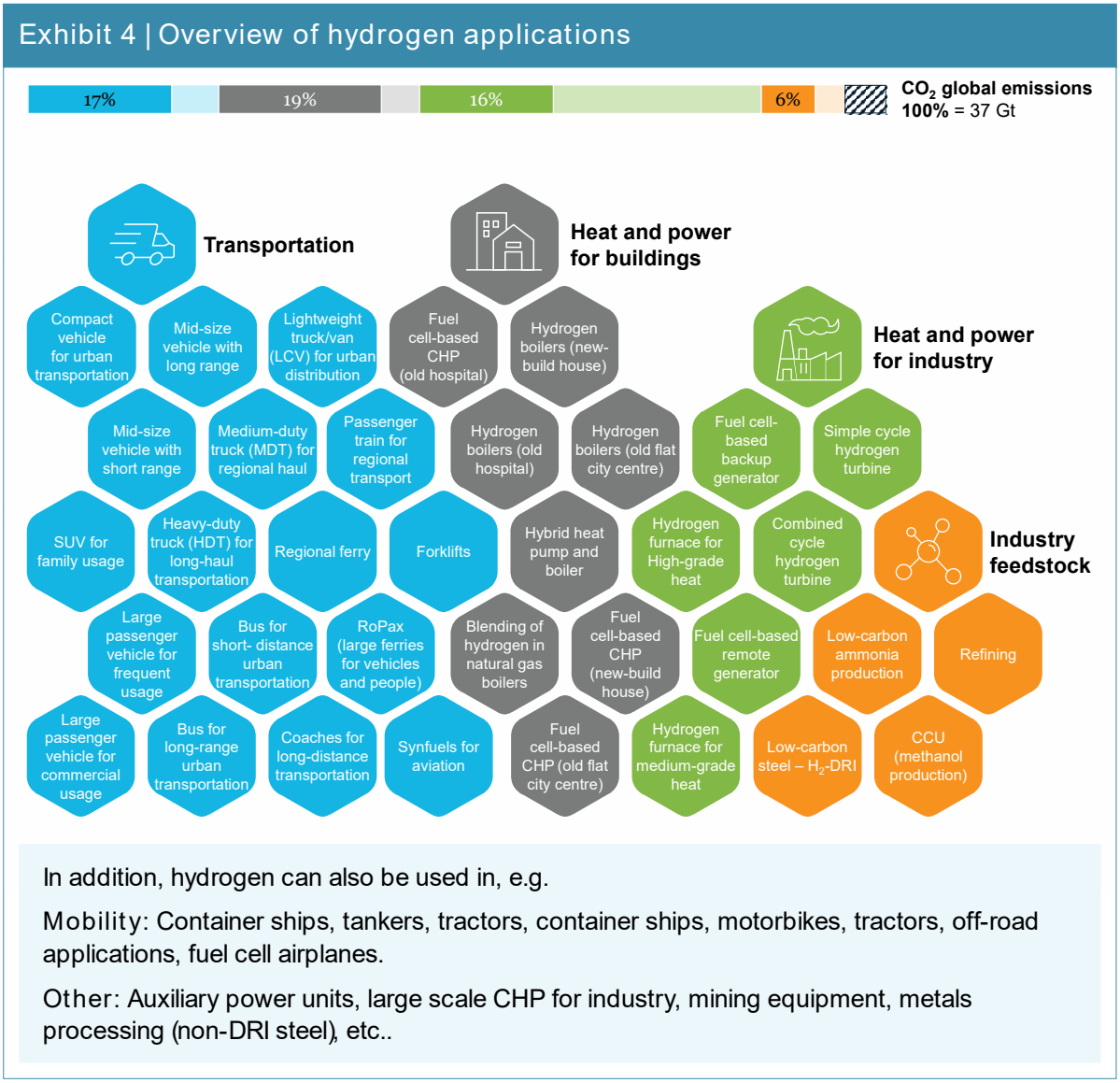
supply, and 3) building out hydrogen fueling infrastructure for transportation.

I. In response to a question raised during the workshop regarding the total cost of investment required to make green hydrogen cost competitive, we refer you to estimates from global analysts and European governments.

II. COMMENTS

A. As several panelists pointed out, hydrogen holds promise to help decarbonize a diverse range of applications, unlocking California's ability to achieve carbon neutrality across sectors and economy wide.

Speakers from UC Irvine, Energy Futures Initiative (EFI), Institute for Sustainable Development and International Relations (IDDRI), and the Green Hydrogen Coalition emphasized hydrogen's flexibility as a resource that is capable of helping lower and ultimately eliminate greenhouse gas emissions in numerous applications, including all classes of transportation, buildings, electricity generation, energy storage, industrial heat and processes, and goods movement. They explained how when hydrogen is made using low and zero carbon pathways like renewable electricity or biogas made from organic waste, it is greenhouse gas neutral over its lifecycle. Green hydrogen holds a particularly important key to enabling California to achieve carbon neutrality in hard to abate applications, like industry, heavy duty trucks, shipping, aviation, passenger vehicles for those who cannot easily plug in at home or who need bigger cars like SUVs or longer ranges, long duration and seasonal energy storage, firm power, legacy buildings, and new construction in regions like wildfire zones where the electricity grid is particularly vulnerable. The chart on the following page from the Hydrogen Council's report *Path to*



Hydrogen Competitiveness shows the many ways hydrogen can decarbonize the economy.[2]

B. As the lead agency implementing climate and clean air policies in California, CARB is uniquely positioned to oversee establishing and implementing targets to decarbonize use of gaseous fuels across sectors.

CARB has a long history of overseeing California's efforts to reduce greenhouse gas emissions, from the Scoping Plan, Cap-and-Trade, Low Carbon Fuel Standard, and other vital climate

[2] *Path to Hydrogen Competitiveness, A Cost Perspective,* p. 8, Hydrogen Council; 2020 https://hydrogencouncil.com/en/path-to-hydrogen-competitiveness-a-cost-perspective/

programs. The agency also oversees criteria air pollution standards and reduction in the state. These efforts require a holistic, cross-sectoral approach, which will also be critical to decarbonizing the gas system because programs will need to be designed and implemented that utilize both the electricity system and the gas system in new ways and that cross multiple sectors, including heavy industry, transportation, electricity generation, energy storage, equipment, and buildings. We therefore recommend that CARB, which already oversees the majority of gas users in the state, due to its jurisdiction over non-core customers, lead on designing and implementing the state's gaseous fuels carbon neutrality program, in consultation with the CPUC, which retains jurisdiction over gas delivery to core customers. We think, as recommended by the California Council on Science and Technology (CCST), this should include an integrated analysis of capacity and reliability that includes seasonal and all other time scales for core and non-core gas customers and for multiple fuel end uses – electricity, heat, transportation, industry, etc.[3]

C. Overseeing California's effort to transition to carbon neutral fuels is the next step to build upon CARB's pioneering programs to advance low carbon transportation fuels and zero emissions transportation and take them to the next level.

CARB has long been a global leader on clean transportation through its groundbreaking policy programs, such as the Low Carbon Fuel Standard and mobile source emissions standards. The recent passage of the Advanced Clean Truck Rule, the first of its kind in the world to mandate that diesel trucks and vans transition to zero emissions starting in 2024, is another example of the agency's capacity for bold vision and enactment of revolutionary programs that can galvanize the transformation of the fuels sector away from traditional polluting sources. Because of California's economic power and track record of global innovation, such actions have impacts far beyond state borders. By taking the lead now to put California on course to fully decarbonize fuels for not only the transportation sector, but economy wide, CARB will take

[3] CCST Presentation, CPUC 7/21/20 R.20-01-007 Track 1B: Market Structure and Reliability Workshop: 2:15:25 on this link (password: Gasplanning123)
https://cpuc.webex.com/recordingservice/sites/cpuc/recording/play/8f41736f0ab34b13aeb0a16dd3bb2329

the next critical step in propelling California and the world into a climate neutral, post-fossil fuel future.

D. The CHBC wishes to clarify for the record that the Resolve model presented by the CPUC does not pick hydrogen as a least cost option because hydrogen is not included in the model, but recent analysis by UC Irvine using the Resolve model shows green electrolytic hydrogen will likely be cost competitive for electricity generation in California within the next decade.

The CPUC presentation included a slide showing how the Resolve model selects the least-cost electricity resource portfolio options for three scenarios to achieve SB 100 electricity targets by 2045: a High Electrification Scenario, a High Biofuels Scenario, and a High Hydrogen Scenario.[4] The presenter explained that the model is picking solar and batteries to meet these goals and that the model also shows that nearly all the current fossil natural gas capacity will need to be retained to meet demand peaks and to cover the winter drop in solar generation.

The model does not show hydrogen as an option because hydrogen is not included in the Resolve model. However, recent preliminary analysis by UC Irvine shows that if hydrogen and methane derived from it are inserted into the model (using biomethane as a proxy resource for injected hydrogen and synthetic methane), at a cost electrolytic hydrogen is widely forecasted (e.g. by UC Irvine,[5] Bloomberg,[6] Hydrogen Council[7]) to likely reach by 2030 ($2/kg or $16/MMBTU) , the model does in fact select hydrogen – and does all the more so when optimistic pricing for electrolytic hydrogen is inserted into the model. This selection of

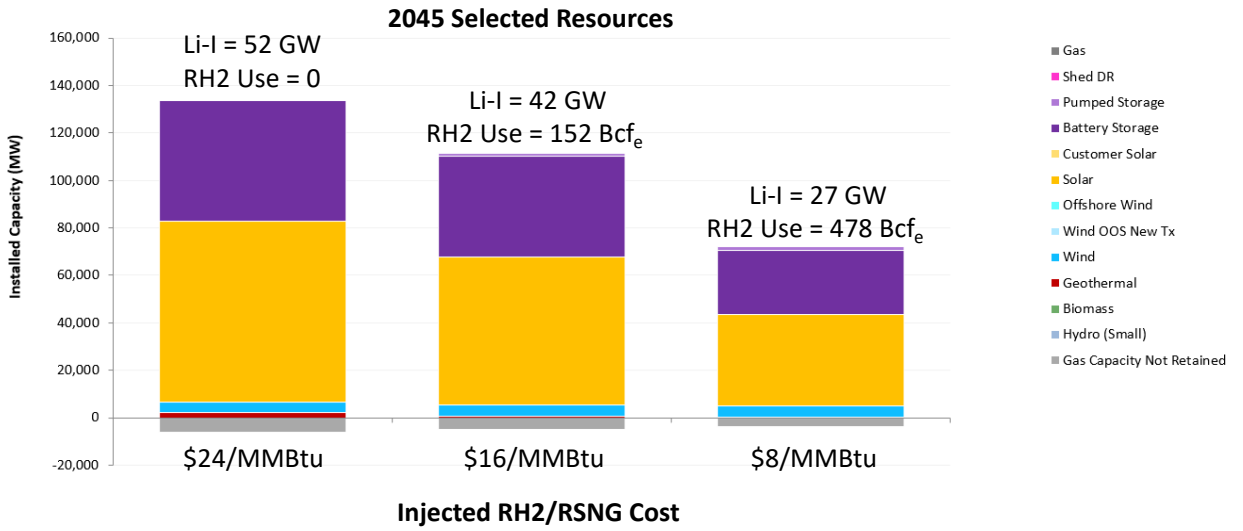
[4] Slide 10, CPUC Presentation *Getting to the Future: Infrastructure and the Energy Transition* https://ww2.arb.ca.gov/sites/default/files/2020-07/cpuc_cn_fuels_infra_july2020_0.pdf
[5] http://www.apep.uci.edu/Press_Release_APEP_Releases_California_Renewable_Hydrogen_Production_Roadmap.html
[6] Bloomberg New Energy Finance, *Hydrogen Economy Outlook, Key Messages*, p.4; March 2020 https://data.bloomberglp.com/professional/sites/24/BNEF-Hydrogen-Economy-Outlook-Key-Messages-30-Mar-2020.pdf
[7] Using analysis by McKinsey, the Hydrogen Council's *Path to Hydrogen Competitiveness – A Cost Perspective,* on p. 15, concludes: "Within five to ten years – driven by strong reductions in electrolyser capex of about 70 to 80 per cent and falling renewables' levelised costs of energy (LCOE) – renewable hydrogen costs could drop to about USD 1 to 1.50 per kg in optimal locations, and roughly USD 2 to 3 per kg under average conditions."

hydrogen, in turn, reduces the need for battery storage, thermal capacity retirement, and curtailment.[8]

2045 Resource Mix vs. RH2 Cost

Preliminary Results

- **Biomethane resource in RESOLVE used as a proxy for injected hydrogen and synthetic methane**
- **Making low-cost hydrogen available for use in thermal resources reduces the need for storage and reduces the amount of thermal capacity that is retired**
- **Curtailment is also reduced substantially**



Page 3

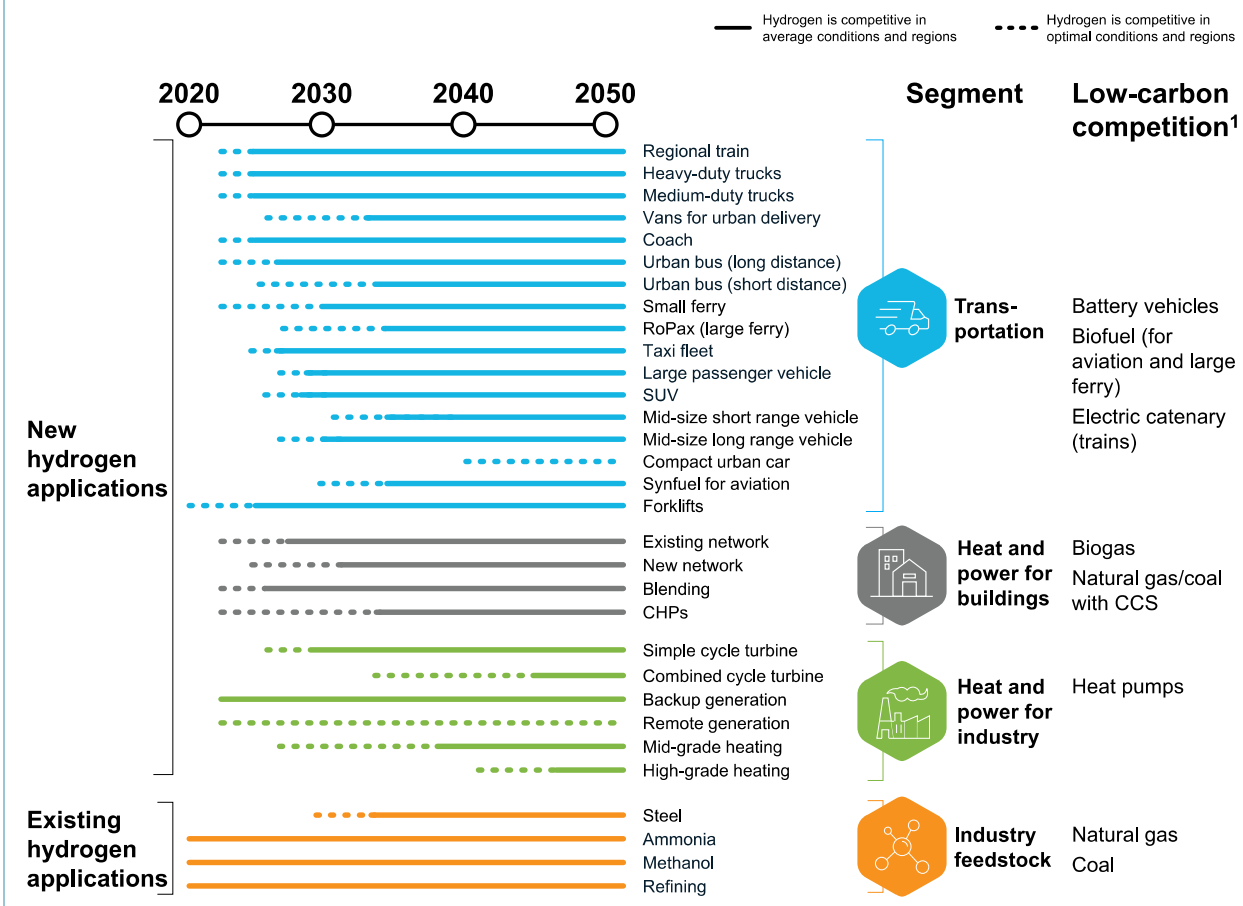
This indicates that electrolytic hydrogen is a promising cost-effective means of achieving carbon neutrality in electricity generation. Therefore, the CHBC urges that this ought to be integrated into state planning and programs starting now.

E. Global analysts project that hydrogen made with decarbonized feedstock will likely be cost competitive in numerous applications in addition to electricity generation within the next decade, if not sooner.

[8] For a further explanation of this graphic and concept, please see the presentation on behalf of CHBC by Dr. Jeffrey Reed, Chief Scientist – Renewable Fuels and Energy Storage, Advanced Power and Energy Program, UC Irvine, given on July 21 at the CPUC Track 1B Workshop on Gas System Reliability. Approx. 2:22 https://cpuc.webex.com/recordingservice/sites/cpuc/recording/play/8f41736f0ab34b13aeb0a16dd3bb2329 Password: Gasplanning123

A growing number of analysts are projecting that the falling cost of renewable electricity generation and electrolyzer technology, along with policies such as carbon neutrality targets, cap-and-trade, and those outlined at the end of this document, promise to put green hydrogen on a pathway to scale and cost competitiveness. This chart from the Hydrogen Council, which

Exhibit 6 | Cost competitiveness trajectories of hydrogen applications



reflects 25,000 data points from over 30 global companies that were rigorously and independently reviewed,[9] projects decarbonized hydrogen will be cost competitive with other low carbon options in nearly every application, in many cases within the next five years.[10]

[9] *Path to Hydrogen Competitiveness, A Cost Perspective,* p. 4, Hydrogen Council; 2020 https://hydrogencouncil.com/en/path-to-hydrogen-competitiveness-a-cost-perspective/

[10] Id p. 10

Furthermore, Lawrence Livermore National Laboratory (LLNL) has concluded that hydrogen produced via gasification of biomass is the least cost option for achieving carbon neutrality in California.[11]

F. Advancing green hydrogen to achieve a carbon neutral economy in California is a massive opportunity to retain and create jobs and should be a pillar of the state's green economic recovery plan, as is the case in the European Union.

With COVID-19 devastating our economy and leading to historic unemployment, California policymakers must create programs that help build up business in the state and put Californians back to work. Notably clean hydrogen is a centerpiece of the European Union's recently announced 750 billion euro green stimulus package.[12] We strongly encourage California to undertake a parallel effort.

The gas system, like the electricity distribution and transmission grids, spans both the state and across regions, and decarbonizing the gas that runs through the system presents a clear opportunity to spawn a vast number of good construction, engineering and other blue and white collar jobs, similar to what we have seen in the electricity system with the increase in renewable power. Unleashing decarbonized hydrogen market development in California would greatly support job retention in the gas sector, as the gas system's massive workforce repurposes their skills to transition the pipeline network from a climate challenge into a climate solution. This would also encourage creation of new jobs along the renewable gas production supply chain - for example, numerous people will need to go to work to build electrolytic hydrogen production facilities and the renewable electricity sources, such as solar and wind, to power them.

[11] *Getting to Neutral,* p. 5, 7, LLNL; January 2020, Link to Download: https://www.climateworks.org/programs/carbon-dioxide-removal/getting-to-neutral/

[12] https://www.fch.europa.eu/news/clean-hydrogen-next-generation-eu

G. To realize hydrogen's potential to decarbonize the economy, CARB should build on state policies to support market development of zero carbon hydrogen production and utilization across sectors.

The following are specific policy recommendations to help drive decarbonized hydrogen market development, which we strongly believe can play pivotal roles in California's ability to achieve carbon neutrality, while enabling California's ambitious other climate, air quality, clean energy, equity and resilience goals, as well as the state's economic recovery by expanding green jobs.

1. **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 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.

2. **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.

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

4. **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, ARB should be encouraged to direct cap-and-trade revenue to support and incentivize accelerated adoption of hydrogen made from low and zero carbon feedstocks. ARB might, as part of this program, 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.

5. **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.

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

7. **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.**

8. **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.

9. **Implement all recommendations related to hydrogen fuel cell transportation 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, a 10-year sales and use tax exemption on hydrogen fuel production and dispensing equipment, and a uniform exemption for the taxation of zero-emission vehicles fuels.**

10. **Support the CPUC implementing a protocol and standard for hydrogen injection into the existing gas pipeline,** as is currently underway in the CPUC Rulemaking R.13-02-008.

11. **Support additional hydrogen research and development** that includes, for example:
    - studying *the repurposing of California's depleted oil and gas fields for storage of decarbonized hydrogen*, as recommended by UC Irvine in the workshop presentation.[13]
    - establishing *industrial hydrogen hubs* that, for example, repurpose state ports as centers of hydrogen development, as suggested in the presentation by EFI.[14]
    - studying *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.[15]

H. Ensuring hydrogen advances the green economy will also require a focus on Infrastructure that includes 1) repair, upgrades, research, and development to repurpose existing gas infrastructure and avoid stranding assets, 2) mass-scale build out of renewable power to support full decarbonization of the fuels supply, and 3) building out hydrogen fueling infrastructure for transportation.

The Green Hydrogen Coalition presentation articulated, "Green Hydrogen (H2) can repurpose existing infrastructure, enabling an affordable and responsible transition" to carbon

[13] 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
[14] 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
[15] 100% Hydrogen Test Facility at Canberra https://www.evoenergy.com.au/emerging-technology/hydrogen-test-facility

neutrality.[16] The CHBC agrees with them and several other panelists who pointed out that California ought to prioritize repurposing the existing gas system to store and transport low and zero carbon hydrogen to avoid stranded assets, lower electricity infrastructure costs, increase resilience, and provide the infrastructure that will be needed to ensure hydrogen provides critical support to integrating high penetrations of renewable electricity and decarbonizing hard to abate applications.

The CPUC presentation cautioned that California faces a major challenge of aging gas distribution infrastructure and posed the important question of whether the state ought to invest in repairing old gas pipelines or instead retire them in favor of all electrification of buildings. The presentation touched upon many risks of retirement of these pipelines, including stranded assets, cost impacts to the customers who retain gas service, and lack of political will to all-electrify buildings in regions in need of gas infrastructure replacement. The following week on July 21, Jane Long of the CCST further warned at a CPUC workshop on long term gas reliability that retiring the gas system in favor of electrifying heat for California buildings is setting up a "perfect storm" because the state would be most relying on electricity for heat in the winter period when renewables are generating the least power.[17] An additional concern is the risk of relying only on power during planned and unplanned shutoffs of the electricity grid, which is particularly vulnerable to weather and disaster related disturbance.

In view of these serious obstacles and the importance of hydrogen to enabling so many of California's policy goals, California ought to use the challenge of aging gas infrastructure as an opportunity to upgrade and repurpose this infrastructure to carry decarbonized gas, particularly decarbonized hydrogen, which is the most scalable option. California should look to regions like Germany, where gas TSOs are already planning to repurpose hundreds of miles of

[16] Green Hydrogen Coalition Presentation, *Beyond Power: Opportunities and Challenges for Green Hydrogen,* Slide 9 https://ww2.arb.ca.gov/sites/default/files/2020-07/ghc_cn_fuels_infra_july2020.pdf

[17] CCST Presentation, CPUC 7/21/20 R.20-01-007 Track 1B: Market Structure and Reliability Workshop: ~ 2:13-2:14:46 on this link (password: Gasplanning123) https://cpuc.webex.com/recordingservice/sites/cpuc/recording/play/8f41736f0ab34b13aeb0a16dd3bb2329

existing gas pipeline to transport hydrogen by 2030 and envision expanding that to thousands of miles.[18]

The National Fuel Cell Research Center (NFCRC) explained at the July 15 workshop that hydrogen injection into the existing pipeline system and end use in applications like cook stoves present technical challenges that are fortunately surmountable.[19] The presenter added that this would likely present a more cost effective route that all electrification, which NFCRC estimates would require tripling existing electric infrastructure.[20] He also opined that this would be a more resilient option than relying solely on vulnerable overhead power lines.

The NFCRC, along with EFI's presentation, additionally emphasized that California's depleted oil and gas fields could potentially be a massive hydrogen storage opportunity, and that this ought to be a priority for research.[21] EFI's presentation similarly called out California's abundant potential storage resources.[22]

The Los Angeles Department of Water and Power (LADWP) made evident the growing readiness to invest in hydrogen as a way to repurpose existing infrastructure for decarbonization in their presentation about their plans to convert the IPP coal power plant to 100% green hydrogen by 2045. The utility is part of a growing global movement toward expanded investment in green hydrogen for a broad range of benefits. NextEra just announced it would be investing $65 million to develop a 20 MW solar powered electrolyzer through its utility Florida Power and Light to help decarbonize gas generation. Elsewhere in the world, some examples of expanding investment in green hydrogen include the following:

[18] https://www.rechargenews.com/transition/german-pipeline-operators-present-plan-for-world-s-largest-hydrogen-grid/2-1-810731

[19] Slide 19, UC Irvine Presentation, *Do We Really Need Hydrogen Infrastructure?*; Dr. Brouwer also explained in Q and A that retrofitting cook stoves for hydrogen is not complex and akin to retrofitting a barbecue to use propane by adjusting the size of the gas hole.

[20] Id Slide 13 https://ww2.arb.ca.gov/sites/default/files/2020-07/nfcrc_cn_fuels_infra_july2020.pdf

[21] Id Slide 20; Slide 4, EFI *Presentation Re-purposing Fossil Fuel Infrastructure and Expertise for Low-carbon Energy Systems*, https://ww2.arb.ca.gov/sites/default/files/2020-07/efi_cn_fuels_infra_july2020.pdf;

[22] Id. Slide 10

- Recently **Germany** announced its National Hydrogen Strategy that commits 9 billion euros to developing green hydrogen in addition to about 2.5 billion euros committed previously through other programs.[23] In addition to the aforementioned plans by gas TSOs to invest in repurposing the gas network to transport hydrogen, German utility E.ON is going to be blending gas to 400 homes with 20% hydrogen to test the impacts on end uses.[24]
- The **European Union** recently announced that clean hydrogen would be a pillar of its 750 billion euro green economic recovery program. [25, 26]
- In **France,** 3.5 billion euros are being invested in the H2V Product, which aims to produce 200,000 tons of certified renewable hydrogen using existing natural gas transport infrastructure, which is projected to create 12,000 jobs.[27]
- In **Australia,** the ARENA program[28] has made uptake of renewable hydrogen one of its top investment priorities,[29] with $44 million in research and development funding already granted .[30] The H2-Hub[31] in Gladstone, Queensland is a multi-billion dollar project on a 171-hectare industrial site near existing energy export infrastructure being developed by The Hydrogen Utility, which aims to include electrolyzer capacity of up to 3,000MW for production of renewable hydrogen and 5,000 tonnes of daily production of green ammonia. This is coupled with a AUD 4.2 million hydrogen injection facility that will blend hydrogen with natural gas in the pipeline and ultimately convert the pipeline to 100% hydrogen.

[23] German Federal Government, June 2020. *The National Hydrogen Strategy, p. 3* *https://www.bmbf.de/files/bmwi_Nationale%20Wasserstoffstrategie_Eng_s01.pdf*
[24] https://www.eon.com/en/about-us/media/press-release/2019/hydrogen-levels-in-german-gas-distribution-system-to-be-raised-to-20-percent-for-the-first-time.html
[25] https://www.reuters.com/article/us-eu-energy-hydrogen/six-eu-countries-lead-push-for-clean-hydrogen-support-idUSKBN23M18G
[26] https://ec.europa.eu/commission/presscorner/detail/en/qanda_20_1257
[27] https://hydrogeneurope.eu/member/h2v-product; http://h2vproduct.net/en/h2v-industry-home/
[28] Webinar presentation, Slide 22
[29] https://arena.gov.au/blog/renewable-hydrogen-projects-receive-new-funding/
[30] https://arena.gov.au/news/arena-gets-cracking-on-commercial-scale-hydrogen/
[31] http://statements.qld.gov.au/Statement/2020/2/27/eye-on-gladstone-for-proposed-gigawattscale-green-hydrogen-and-ammonia-development

- The **UK** is investing $116 million[32] to deploy hydrogen to decarbonize energy for industry and homes, as part of the nation's carbon neutrality effort. That includes support for large scale green hydrogen projects like the Gigastack project, which is developing a 100 MW electrolyzer powered by wind to decarbonize a refinery.[33] Meanwhile, large businesses recently announced they are investing nearly $2 billion (1.5 billion British pounds) in hydrogen projects in the UK.[34]
- In **China**, a $199 million electrolyzer facility powered by 200 MW of solar is under construction and scheduled to produce green hydrogen for fuel cell vehicles sometime this year.[35] Additionally, state-owned utility Beijing Jingneng is planning to spend $3 billion on a 5 GW hybrid solar, wind, hydrogen and storage facility in northern China.[36]

NFCRC and others emphasized that another focal point of infrastructure development to realize full decarbonization of California's gaseous fuels will be a massive build out of renewable electricity generation to power electrolysis. Using the UC Irvine modeling described in Comment B above, decarbonizing electricity generation alone with a portfolio that uses green electrolytic hydrogen will require a build out of roughly 50-70 GW of renewable generation by 2045, depending on whether electrolytic hydrogen reaches likely or optimistic pricing by then. Notably, however, this is still significantly less renewable build out than is projected to be needed if hydrogen is not deployed for electricity generation and storage. Approximately 125 GW of new solar are projected to be needed for electricity by 2045 in the current Resolve model, which does not consider hydrogen as a potential generation or storage resource, and only considers it as a transportation fuel in its High Hydrogen scenario.[37]

[32] https://www.forbes.com/sites/davidrvetter/2020/02/21/elementary-uks-36-million-bet-on-hydrogen-explained/#50abf39f3491
[33] https://www.greencarcongress.com/2020/02/20200219-gigastack.html
[34] https://fuelcellsworks.com/news/businesses-call-on-chancellor-to-commit-to-uk-wide-hydrogen-strategy/
[35] https://ieefa.org/chinese-coal-company-planning-worlds-largest-solar-powered-hydrogen-plant/
[36] https://www.pv-tech.org/news/beijing-jingneng-plans-5gw-solar-wind-hydrogen-storage-complex-in-inner-mon
[37] See Slide 10, CPUC Presentation *Getting to the Future: Infrastructure and the Energy Transition* https://ww2.arb.ca.gov/sites/default/files/2020-07/cpuc_cn_fuels_infra_july2020_0.pdf

Lastly, California will need to build on its pioneering effort to build out hydrogen refueling infrastructure, starting with reaching the ZEV Executive Order target of 200 hydrogen fueling stations by 2025, the California Fuel Cell Partnership 2030 target of 1000 stations to fuel 1 million FCEVs, and adding refueling for heavy duty vehicles.

I. **In response to a question raised in the workshop regarding the total cost of investment required to make green hydrogen cost competitive, we refer you to estimates from global analysts and European governments.**

The Hydrogen Council has forecasted that a global investment of $70 Billion will be needed to make low carbon hydrogen cost competitive by 2030.[38] Germany alone, as indicated above, has already committed to spending 11.5 billion euros (approximately $13.5 billion) - nearly 20% of this total amount. The CHBC urges California to join Germany as a global leader in this next transformative greening of the economy by committing to similarly meaningful levels of investment.

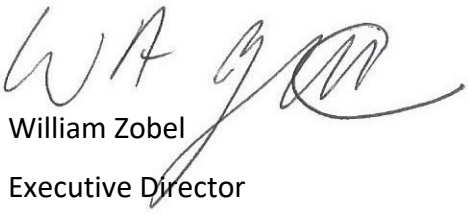
The EU Hydrogen investment agenda published in July 2020 by the European Commission projects that from now to 2030, investments in electrolyzers could range between 24 and 42 billion euros (about $28-50 billion), while 220-340 billion euros ($258-399 billion) would be required to scale up and directly connect 80-120 GW of solar and wind energy production to power the electrolyzers.[39] The agenda adds that 65 billion euros ($76 billion) must be invested to transport, distribute and store hydrogen, as well as to supply hydrogen for refueling stations. It also states that expanding small hydrogen fueling stations from 100 to 400 will cost up to another 1 billion euros($1.2 billion), while adapting end uses to accommodate hydrogen will further require additional investment.[40]

[38] *Path to Hydrogen Competitiveness, A Cost Perspective,* p. vi, Hydrogen Council; 2020 https://hydrogencouncil.com/en/path-to-hydrogen-competitiveness-a-cost-perspective/
[39] https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf, p. 7-8 – Cites *Hydrogen Roadmap Europe*, based on an ambitious scenario of 665 TWh by 2030 (FCH JU, 2019)
[40] Id. p 8

III. CONCLUSION

The CHBC appreciates your consideration of these comments and looks forward to working with you further to better understand how decarbonized hydrogen technologies can play vital roles in enabling California to reach its economy wide carbon neutrality goal.

Best regards,



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