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Additional submitted attachment is included below.

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California Hydrogen Business Council Workshop Comments on SB 100 Joint Agency Report February 24, 2020 Modeling Inputs and Assumptions Workshop

March 9, 2020

I. Introduction

The California Hydrogen Business Council (CHBC)[1] appreciates the opportunity to submit these comments on the SB 100 Modeling Inputs and Assumptions Workshop held at the Energy Commission on February 24, 2020 in preparation for the Joint Report on SB 100. We were encouraged by and agree with the direction of commenters thus far to ensure implementation of SB 100 is not prescriptive, maximizes optionality, and is technology inclusive.[2] We focus our comments on including hydrogen technologies as eligible supply-side and storage candidate resources for achieving SB 100 targets. We agree presenters and commenters at the workshop, including Balancing Authority of Northern California and others, who emphasized that hydrogen is one of the areas of innovation that will be needed over the next 25 years for successful implementation of SB 100's goals.[3] **Specifically, we urge that hydrogen made from renewable and zero carbon sources (renewable and zero carbon electricity or biowaste feedstocks) be eligible in SB 100 implementation as a drop-in fuel in gas thermal generation plants, in fuel cells as proposed in E3's presentation,[4] and as long duration and seasonal storage.**

II. Comments

A. We agree with E3 that gaseous fuels will be needed to successfully reach SB 100 goals, and highly encourage California, as it seeks to maintain power supply reliability, to transition from fossil

[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/

[2] Slide 14, *SB 100 Joint-agency report overview and analytical approach - Staff presentation*

[3] Page 7, Balancing Authority of Northern California Comments - BANC Presentation

[4] See Slide 28, *Introduction to PATHWAYS and RESOLVE - E3 Presentation;* E3 February 25, 2020

natural gas generation to renewable and zero carbon gas generation, including power generated using renewable and zero carbon hydrogen and synthetic methane derived from such hydrogen.

Using electrolytic hydrogen and methanated electrolytic hydrogen to store and generate electricity would enable expansion of renewables needed to reach SB 100's targets by absorbing excess generation that otherwise would be curtailed and wasted and storing it for useful purposes when needed in designated storage facilities, caverns, or in the gas system. It would also enable achieving the state goal of economy wide carbon neutrality by replacing fossil natural gas and buffer against the economic volatility and other constraints of continued dependence on finite fossil gas resources.

At the workshop, E3's presentation included as supply-side candidate resources: natural gas (CCGT, CT), renewables (solar PV, wind, offshore wind, geothermal, biomass), utility-scale battery storage: (Li-ion, flow), pumped storage, carbon capture and sequestration (CCS), and hydrogen fuel cells.[5] We strongly agree with the inclusion of hydrogen fuel cells, which we believe have essential roles to play as flexible, dispatchable distributed energy resources that emit zero criteria air pollutants and zero greenhouse gas. We are also encouraged that the workshop discussion indicated that adding hydrogen as a fuel in thermal gas generation and long duration and seasonal storage resource are also being considered by the agencies, and we urge you to formalize this as a recommendation in the Joint Agency report.

Hydrogen gas, which is unusual among gaseous fuels in that it is completely free of greenhouse gas and if produced renewably emits zero greenhouse gases over its lifecycle, can be used to displace fossil natural gas in thermal generation, which will be required to ensure reliable power in a mostly or all renewable and zero carbon electricity future. Hydrogen can be blended in limited quantities with natural gas to reduce greenhouse gas emissions in thermal gas plant generation, be synthesized into renewable methane to eliminate carbon emissions without power plant equipment upgrades, or be used in large quantities – within the next few years up to 100% - in existing gas plants retrofitted with

[5] Ibid.

hydrogen turbines to reduce or eliminate greenhouse gases altogether. 100% low NOx hydrogen generation is already being demonstrated in a small gas unit in Japan,[6] while a utility power plant in the Netherlands is planning to convert a 440 MW gas turbine to 100% hydrogen by 2023.[7] Los Angeles Department of Water and Power (LADWP), as presented in the workshop, is also seeking to convert their Intermountain Power Project from fossil fuels to 100% renewable hydrogen by 2045. Meanwhile another 1 GW storage project using the same salt caverns in Utah is also aiming to deploy hydrogen storage and electricity generation among its suite of solutions.[8]

B. Hydrogen and methanated hydrogen produced with electricity can be stored for long periods in vast quantities, especially if the gas system is used as a storage medium, making it a particularly flexible and scalable resource for seasonal needs.

During the fall 2019 Near Zero Energy Electricity workshop at the Energy Commission, E3[9] and the Energy Futures Initiative agreed that solar, wind, hydropower, demand response and batteries, while very important, will be insufficient to achieve zero carbon electricity, and Energy Futures Initiative made the case that to provide stable electricity through seasonal shifts in supply and demand, as California transitions to predominantly variable renewable power, hydrogen, particularly produced by renewable electricity, will be an important focus of innovation to ensure power supply remains stable, while also reducing greenhouse gas reductions in a predominantly renewable electricity future.[10]

Similarly, the Green Hydrogen Council/Strategen showed in a recent presentation at a SB 100 technical workshop that using CAISO data and a growth rate for solar and wind in proportion to the California Energy Commission projection for 2016-2027,[11] several instances of multi-day weather events would

[6] https://global.kawasaki.com/en/stories/articles/vol74/
[7] https://www.nsenergybusiness.com/projects/nuon-magnum-power-plant/
[8] https://amer.mhps.com/world%E2%80%99s-largest-renewable-energy-storage-project-announced-in-utah.html
[9] p. 10, *The Role of Electricity in Decarbonizing CA's Energy System*, E3, September 23, 2019 https://ww2.energy.ca.gov/2019_energypolicy/documents/2019-09-24_workshop/2019-09-24_presentations.php
[10] See 1:40-1:41; 2:06:35-2:09:35 https://ww2.energy.ca.gov/php/yt_player.php?vidNo=VZp3oSUSmfg&title=IEPR%20Commissioner%20Workshop%20on%20Near-Zero%20Carbon%20Electricity&desc=CEC%20and%20CARB%20provide%20an%20overview%20of%20CA%E2%80%99s%20climate%20and%20energy%20policies.%20Researche
[11] Source of data assumptions: Strategen

cause power generation deficits - and that these will require the long duration multi-day, up to seasonal storage, that electrolytic hydrogen is particularly well suited to supply.[12]

C. Experts are furthermore projecting renewable hydrogen to become increasingly economical.

There is tremendous potential to see cost reductions of electrolytic hydrogen over the next decade, due to the falling price of renewable electricity that can be used to power electrolysis that produces hydrogen. This has been recognized widely, for example, by both of former President Obama's Secretaries of Energy,[13] the current Department of Energy, and analysts like Bloomberg New Energy Finance.[14] But they all also agree to unleash this potential, policy implementation by leaders like the agencies present at the workshop will be necessary.

A recently released report by Lawrence Berkeley Livermore Laboratories also finds that renewable hydrogen, and in particular hydrogen produced from gasification of biomass, is the lowest cost pathway to realize carbon neurality in California and will be a key component of achieving negative carbon emissions.[15] We believe this is important to consider, and we urge inclusion of this as the Joint Report on SB 100 implementation is prepared.

D. Accelerating adoption of green electrolytic hydrogen as a storage and power generation resource is aligned with state legislative direction.

Underscoring the interest in California in hydrogen as an energy storage and power generation resource, SB 1369, signed into law in 2018, calls upon CARB, CEC, and CPUC to consider green electrolytic hydrogen, defined as hydrogen gas produced with electrolysis, as an energy storage

[12] See Slide 3, *Presentation - Achieving the goals of SB 100 with Green Hydrogen*, Presented by Janice Lin, November 18 SB 100 Technical Workshop; https://www.energy.ca.gov/event/workshop/2019-11/sb-100-technical-workshop

[13] https://www.forbes.com/sites/jeffmcmahon/2019/04/02/get-ready-for-1-5%C2%A2-renewable-electricity-steven-chu-says-which-could-unleash-hydrogen-economy/#1ddd4e081c01; and p. xi, *Optionality, Flexibility & Innovation - Pathways for Deep Decarbonization in California, Summary for Policymakers,* Energy Futures Initiative, April 2019 https://static1.squarespace.com/static/58ec123cb3db2bd94e057628/t/5d4c4c012023770001582b2f/1565281308104/EFI+CA+Decarbonization+SFPM

[14] https://www.bloomberg.com/news/articles/2019-08-21/cost-of-hydrogen-from-renewables-to-plummet-next-decade-bnef

[15] p. 5 and Chapter 4, Getting to Neutral, LLBL; January 2020 https://www-gs.llnl.gov/content/assets/docs/energy/Getting_to_Neutral.pdf

resource and for other uses.[16] The law's author Senator Nancy Skinner recently introduced SB 1122,[17] which would clarify that the agencies should consider green electrolytic hydrogen as a zero carbon-emitting supply-side resource in any plans developed to help California reach 100% zero-carbon electricity by 2045. We hope that the agencies will include green electrolytic hydrogen as an eligible storage and power generation resource in SB 100 implementation in alignment with these legislative actions.

E. Storage and generation projects are on the rise not only in the US, but also around the world, with many in operation or development on nearly every continent, in which the hydrogen is either returned to power, or used for other beneficial purposes such as industrial energy, building energy, or transportation.

Up until recently, electrolytic hydrogen storage projects were primarily small demonstrations of up to a couple megawatts, but recently, large scale projects are launching. A few examples of these are:

- **European Gas TSO's are planning to have up to 17 new industrial scale power-to-gas (electrolytic hydrogen and/or methanated electrolytic hydrogen) projects to be in operation by 2025 and another two by 2032**, in order to help manage the rising penetration of renewable electricity and take advantage of the plunging costs of renewable power.[18] According to the TSOs, Germany could have up to 7.5 GW of electrolytic hydrogen projects by 2030. One of the German projects, Element Eins, includes a 100 MW electrolytic hydrogen plant powered by wind that will at first blend renewable hydrogen into the gas grid to be used for gas end uses or extracted for transporation or heating, followed in a second phase by methanating the hydrogen, and in the final phase 100% hydrogen delivery for industrial customers.[19] Another example of the European TSO projects, expected to be online in 2023, is being developed by

[16] https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB1369
[17] http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200SB1122
[18] https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/111819-eu-gas-tsos-plan-17-power-to-gas-projects-by-2025-to-help-cut-co2; and https://www.entsog.eu/power-gas
[19] Ibid; and Element Eins project website: https://thyssengas.com/en/innovation/element-eins.html

Spanish TSO Enagas and includes a 10 MW solar powered electrolyzer plant that will produce green hydrogen for use by the transport sector and in the natural gas grid.

- **The Gigastack project being developed in the UK** will use offshore wind to power a 100MW electrolyzer system with a nominal capacity of 20MW and produce renewable hydrogen to decarbonize a local refinery.[20]
- **In Australia, several major projects are being developed**, including a 5 MW electrolyzer plant that will produce hydrogen from solar and wind, first for transportation, second to blend with natural gas in the local pipeline, and finally for export to Asian markets.[21] Other Australian projects include the Dyno Nobel facility in Moranbah, Queensland, which seeks to decarbonize the industrial facility that currently runs on natural gas to renewable hydrogen and consists of an approximately 210 megawatt solar farm coupled with a 160 megawatt electrolyzer that will produce renewable hydrogen and "green ammonia."[22] The Queensland Nitrates ammonia plant is another group of renewable hydrogen production and storage facilities to be built that use hydrogen produced with wind and solar power to supply a fifth of the ammonia production that currently is made using natural gas.[23] The H2-Hub[24], 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 that 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. The project 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, with a vision of ultimately converting to all hydrogen. Other projects are being developed in New Zealand and Asia.

[20] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/866377/Phase_1_-_ITM_-_Gigastack.pdf
[21] https://www.pv-magazine.com/2019/10/08/siemens-backs-5-gw-green-hydrogen-plan-for-australia/
[22] https://arena.gov.au/news/renewable-hydrogen-could-power-moranbah-ammonia-facility/
[23] https://arena.gov.au/news/queensland-green-ammonia-plant-could-use-renewable-hydrogen/
[24] http://statements.qld.gov.au/Statement/2020/2/27/eye-on-gladstone-for-proposed-gigawattscale-green-hydrogen-and-ammonia-development

III. Conclusion

In conclusion, we thank the agencies for the consideration of these comments and look forward to working with you to better understand and integrate hydrogen technology solutions to ensure that SB 100 implementation achieves the environmental protection, economic benefits, and safe and reliable electricity supply that California needs.

Regards,

Emanuel Wagner

Deputy Director

California Hydrogen Business Council