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CHBC Comments on June 20 IEPR Workshop

Please see the detailed comments of the CHBC to the June 20 IEPR workshop in the attachment.

Additional submitted attachment is included below.

CALIFORNIA HYDROGEN BUSINESS COUNCIL
Hydrogen Means Business in California!

CA Office: 18847 Via Sereno
Yorba Linda, CA 92886

DC Office: 1211 Connecticut Ave NW, Ste 650
Washington, DC 20036

Phone: (310) 455-6095 | Fax: (202) 223-5537
info@californiahydrogen.org | www.californiahydrogen.org

Comments by the California Hydrogen Business Council to June 20, 2018 IEPR Commissioner Workshop on Renewable Integration and Electric System Flexibility

Introduction

The following are comments by the California Hydrogen Business Council (CHBC)[i] submitted in response to the Energy Commission's June 20 *IEPR Commissioner Workshop on Renewable Integration and Electric System Flexibility*. The CHBC appreciates the opportunity to share our perspective and urges the Commission to consider the points below on the role hydrogen can play as an important flexible load by integrating high penetrations of variable renewable electricity and decarbonizing California's energy system.

A summary of five main points is:

1. Electrolysis to create hydrogen can address CAISO's urgent net load and ramping challenges. It can absorb excess renewable power to make useful hydrogen during peak renewable generation, thus helping to flatten "the belly of the duck," and provide rapid downward load capability that eases the ramping requirement.
2. Power-to-gas technology is ready today – demonstrating its capability around the world as an important flexible resource that can be used to enable renewable integration and grid reliability.
3. Power-to-gas is a long duration energy storage solution and the only technology capable of storage at a terawatt hour scale, giving it unique seasonal storage capabilities.
4. At 50% capacity, power-to-gas technology is cost-competitive with batteries.
5. Like any technology, further innovation can and will happen with volume installation of power-to-gas technology. Just as California developed supportive policies for solar or batteries prior to these technologies being perfected, including the creation of strong incentives for rapid adoption and emissions reduction and job creation, so should the state do for power-to-gas.

Note that hydrogen can be produced via several pathways, many using renewable feedstocks that emit no greenhouse gas, such as from biogas, syngas made from bio-waste, solar water splitting, or electrolysis using renewable electricity. For the purposes of these comments, we will focus on electrolytic hydrogen (also known as "power-to-gas" [P2G] or "power-to-X"),[ii] since it has the greatest potential to support renewable power integration and grid stability and flexibility.

We particularly call attention to two presentations given at the workshop: *Renewable Integration Update* by the CAISO, and *Deep Decarbonization In a High Renewables Future* by E3.

I. Electrolytic hydrogen as a solution for CAISO's urgent challenges

The CAISO presentation showed that high mid-day net load with a 3-hour, approximately 13,000 MW ramp requirement in the early evening is already happening about four years before originally anticipated, which is resulting in an urgent need for flexible loads to maintain grid stability. Electrolysis can help meet this need by absorbing the excess renewable power to make useful hydrogen during peak renewable generation, thus helping to flatten "the belly of the duck," and by providing rapid downward load capability that can ease the ramping requirement.

II. Electrolytic hydrogen as a flexible resource that is ready today

The E3 presentation states that hydrogen produced with renewable electricity could "potentially" be a flexible load that, along with other resources, acts as a renewable diversification and integration solution to reduce overgeneration of renewables and lower electric system costs. CHBC by and large agrees with this conclusion, except that we think the technology does not only have potential, but actually is ready today and demonstrating its capability around the world as an important flexible resource that can be used for renewable integration and grid reliability. For this reason, it has become a key component of clean energy and climate policy strategies in front runner regions across the globe.

Here in North America, for example:

- Ontario, Canada's independent system operator IESO is contracted with a 5 MW power-to-gas facility for energy storage and to provide regulation services,[iii] and recently released a request for information with the aim of expanding power to gas projects.
- A 2.5 MW electrolysis facility powered by 100% wind electricity to create hydrogen for transportation fuel is scheduled to soon be operational in Palm Springs.[iv]
- A pilot project at UC Irvine is using excess solar generation on campus to produce hydrogen and to help decarbonize the university's co-generation plant. Research at the university has shown that their electrolytic hydrogen production could increase the amount of solar energy used by the campus microgrid tenfold from 3.5% to 35%.[v]
- NREL additionally has a power-to-gas project on its campus in Colorado that is using excess renewables to make hydrogen, along with a bioreactor to convert the hydrogen into pipeline quality methane.
- Legislation is being considered in California to expand green electrolytic hydrogen projects in the state for energy storage and renewable integration, in order to increase the state's ability to reach its greenhouse gas and criteria pollution reduction goals, advance electrification, displace natural gas, and avoid incurring new infrastructure costs and stranded assets.[vi]

The global hydrogen market is notably gaining traction with significant investment potential for renewables integration. To illustrate:

- There are dozens of power-to-gas projects in operation in Europe, with many more in development.[vii]
- The European electricity industry, along with the German federal government[viii], has concluded that renewable hydrogen is integral to achieving deep decarbonization and electrification.[ix]
  France recently announced a "hydrogen strategy" to utilize hydrogen across all sectors with a 2023 goal of 10% hydrogen penetration and a 2028 goal of 20% to 40%. France has allocated 100 million Euro starting in 2019 as part of the hydrogen strategy.[x]
- Keele University (UK) has invested $9.5 million to explore hydrogen blending into its private gas network beginning 2019 to decarbonize their heating sector. The HyDeploy Project, is currently

performing gas safety checks in buildings within the trial area with up to 20% hydrogen blending content as part of decarbonization efforts.[xi]

- Australian Gas Infrastructure Group has announced plans to blend hydrogen into its natural gas supplies to take advantage of excess renewable generation. The utility announced plans for Australia's first P2G plant worth $8.9 million to be built in Adelaide, South Australia. The hydrogen produced will be injected into the local gas distribution network to provide low-carbon gas to homes and businesses.[xii]
- Dubai Electricity and Water Authority (DEWA) and Siemens signed an MOU in 2018 to kick off the region's first P2G electrolysis facility with more than $10 million. The proposed project is aimed to be at "MW-Scale" and is part of DEWA's broader plan to convert photovoltaic electricity generated at its Solar Park project into hydrogen to accelerate renewables integration and deployment in the region.[xiii]
- Hydrogen is central to Japan's electricity system plans as a means of managing high penetrations of fluctuating renewable generation and providing greater flexibility.[xiv]

III. Power-to-gas is a prime solution for long duration storage.

E3's presentation states: "Achieving absolute zero carbon electricity may not be necessary, and would require technology innovation, such as zero-carbon biofuels, power-to-gas, or multi-day/multi-week energy storage." It is misleading to distinguish power-to-gas from multi-day or multi-week energy storage, since power-to-gas *is* one of the most promising forms of multi-day or multi-week storage. In fact, it is the only technology capable of long duration energy storage at a terawatt hour scale.[xv]

As such, it offers a key solution for seasonal load shifting. For example, electrolyzers can absorb vast amounts of excess electricity in the high spring renewable generation months touched upon in the CAISO presentation. The electrolytic hydrogen can then be used either to fuel zero-carbon end uses like FCEVs, or it can be stored for return as a zero-carbon resource to the electricity grid via a fuel cell or gas power plant, when large amounts of power are needed during summer high demand.

Notably, power-to-gas is more geographically flexible than other long duration storage solutions like pumped hydro and compressed air, which are limited to restricted types of locations.

CHBC believes, that renewable gas, and particularly electrolytic hydrogen because of its high volume potential and multiple beneficial pathways to decarbonize the energy system, is capable of enabling the complete displacement of natural gas as an electricity system resource when combined with other zero carbon energy solutions like renewable power and batteries. This can not only benefit the climate, but also clean the air, especially in disadvantaged communities that are disproportionately impacted by natural gas electricity generation, and mitigate the negative effects of natural gas extraction on clean groundwater.

IV. Costs of Power-to-Gas

Regarding costs of power-to-gas, as mentioned in CHBC's document titled *The Economics of P2G* submitted in advance of the 2017 IEPR[xvi], at a capacity factor of 50% with 12 hours of usage per day, a power-to-gas facility is cost competitive with batteries. At a storage duration of 4 hours, P2G systems reach cost parity with a battery system.[xvii]

Notably, natural gas plant turbines can handle a gas mix with up to 20% hydrogen with no adverse impacts to the technology, while reducing NOx emissions of the plant. Gas turbine technology has been developed that is capable of seamlessly blending up to 30% hydrogen with no negative impacts, and gas turbines able to handle 100% hydrogen are expected to be available in the foreseeable future.[xviii]

V. Cost Reduction at Volume

Like any technology, further innovation can and will happen with installations at scale. California did not wait for solar or battery storage to be perfected before creating policies and incentives to support their rapid adoption and unleash their ability to reduce emissions and create jobs; neither should the state do so for electrolytic hydrogen.

Thank you for your attention and time, and we will gladly provide further information or brief staff more thoroughly if questions arise.

Best,

Emanuel Wagner
Deputy Director
California Hydrogen Business Council
ewagner@californiahydrogen.org | 310-455-6095

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[i] The CHBC is a California industry trade association with a mission to advance the commercialization of hydrogen in transportation and stationary sources to reduce greenhouse gas, criteria pollutant emissions and dependence on oil. The CHBC is comprised of over 100 companies, agencies and individuals creating businesses for hydrogen-fueled zero emission energy and transportation markets in California. 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 include AC Transit, Air Liquide Advanced Technologies U.S. LLC., American Honda Motor Co., Inc., Ballard Power Systems, Bay Area Air Quality Management District, Beijing SinoHytec, BMW of North America LLC, California Air Resources Board, California Fuel Cell Partnership, California Performance Engineering Inc., CALSTART, Cambridge LCF Group, Center for Transportation and the Environment, China Hydrogen Fuel Cell Corporation, Coalition for Clean Air, Community Environmental Services, E4 Strategic Solutions, ElDorado National – California, Energy Independence Now, Engineering, Procurement and Construction, LLC, Ergostech Renewal Energy Solution, First Element Fuel Inc, FuelCell Energy, Inc., General Motors Corporation, Giner, Inc., Gladstein, Neandross & Associates, Greenlight Innovation, GTA, Inc., GTM Technologies Inc., H2B2, H2Safe, LLC, H2SG Energy Pte Ltd, H2Tech Systems, Horizon Fuel Cells Americas, Inc., Hydrogenics Corporation, Hydrogenious Technologies, HydrogenXT, Hyundai Motor Company & Kia Motors Corp, i-2-m, Idaho National Laboratory, Intelligent Energy, IRD Fuel Cells LLC, ITM Power Inc, Ivys Inc., Johnson Matthey Fuel Cells, Linde North America Inc, Loop Energy Inc, McPhy Energy, MPL Consulting, Inc., National Renewable Energy Laboratory, Nel Hydrogen, New Flyer of America Inc, Next Hydrogen Corporation, Noyes Law Corporation, Nuvera Fuel Cells LLC, Pacific Gas and Electric Company, Paramount Energy West LLC, PDC Machines, Inc., Plug Power, Inc., Port of Long Beach, PowerHouse Energy Americas, Powertech Labs, Inc., Proton OnSite, Ramco Consulting Company Inc, Rio Hondo College, RIX Industries, Sacramento Municipal Utility District, SAFCell Inc, Schatz Energy Research Center, Solar Hydrogen System, South Coast Air Quality Management District, Southern California Gas Company, Sumitomo Corporation of Americas, SunLine Transit Agency, Tatsuno North America Inc, Terrella Energy Systems Ltd, Toyota Motor North America Inc., Advanced

Power and Energy Program - UC Irvine, United Hydrogen Group Inc, US Hybrid Corporation, WireTough Cylinders, LLC, Zero Carbon Energy Solutions, Ztek Corporation

[ii] The term "power to gas" also can refer to synthetic methane made by mixing electrolytic hydrogen with carbon dioxide.

[iii] The original announcement was for 2 MW, but the facility in place is 5 MW. See: http://www.hydrogenics.com/2014/07/25/hydrogenics-selected-for-2-megawatt-energy-storage-facility-in-ontario/; https://www.h2fc-fair.com/hm17/images/forum/tf/2017-04-25-1020.pdf

[iv] https://www.prweb.com/releases/2016/10/prweb13807575.htm

[v] https://www.prnewswire.com/news-releases/socalgas-and-university-of-california-irvine-demonstrate-power-to-gas-technology-can-dramatically-increase-the-use-of-renewable-energy-300432101.html

[vi] SB 1369 (Skinner)

[vii] http://europeanpowertogas.com/projects-in-europe/

[viii] See: https://www.umweltbundesamt.de/en/press/pressinformation/a-greenhouse-gas-neutral-germany-is-almost-possible.

[ix] https://cdn.eurelectric.org/media/3172/decarbonisation-pathways-electrificatino-part-study-results-h-AD171CCC.pdf

[x] https://www.electrive.com/2018/06/04/france-to-utilise-hydrogen-across-all-sectors/

[xi] https://networks.online/gphsn/news/1000904/trial-explore-blending-hydrogen-gas-network

[xii] https://www.greentechmedia.com/articles/read/australia-looks-to-hydrogen-to-soak-up-excess-renewable-energy-production#gs.sb4MM1M

[xiii] https://www.businesswire.com/news/home/20180212006494/en/DEWA-Signs-MoU-Expo-2020-Dubai-Siemens

[xiv] https://asia.nikkei.com/Politics/Renewables-to-form-core-of-Japan-s-new-long-term-energy-strategy

[xv] Source: Fraunhofer Institute

[xvi] https://efiling.energy.ca.gov/GetDocument.aspx?tn=220310

[xvii] The case is for a power-to-gas-to-power system, in which power-to-gas systems return energy in the form of electricity generation via a power plant (either a fuel cell or a gas turbine).

[xviii] https://www.mhps.com/special/hydrogen/article_1/index.html