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Additional submitted attachment is included below.

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CHBC Comments on the June 29, 2017 IEPR Joint Agency Workshop on Application of Distributed Energy Resources on the California Grid

July 21, 2017

The California Hydrogen Business Council (CHBC) appreciates the opportunity to provide comments on the June 29 workshop and would like to thank the agencies and their staff for all of their efforts in the IEPR proceedings and encouraging comments and presentations. We also appreciate the Commissioners' interest in hydrogen and power-to-gas (P2G) technology as displayed in the June 29 workshop.

With today's comments, the CHBC continues to highlight the need to recognize hydrogen and fuel cell technologies as a key distributed energy resources in the IEPR. Hydrogen can play a critical role in supporting grid reliability and the integration of increasing levels of renewables onto the regional electric grid. In that context, the CHBC would like to make the following key points:

- (Renewable) hydrogen increases grid reliability and the integration of increasing levels of renewables onto the regional electric grid.
- Hydrogen and P2G is the only technology capable of providing storage at terawatt-hour scale without location limitations.
- Hydrogen also has the advantage of providing a climate protective pathway for energy uses that are difficult to decarbonize with electrification only.
- P2G is more cost-effective and geographically efficient than Li-ion batteries at high capacity and more geographically flexible than pumped hydro and compressed air.
- Renewable hydrogen is bankable today, although it needs multiple revenue opportunities to ensure economic viability.

In summary, renewable hydrogen produced from excess renewable electricity via electrolysis can be used as a distributed energy resource and an energy storage medium. Electrolysis is a mature technology that converts electricity into hydrogen (and oxygen) by splitting water.[1] Beyond the storage function of converting electricity to gaseous fuel for later use, these systems can cycle up and down rapidly providing multiple services including voltage and frequency regulation, rapid demand response and spinning reserves across multiple grid domains. With fast response times, electrolyzers provide operational flexibility and can modulate hydrogen output to participate in energy management[2] and ancillary services markets on a utility scale and at end user facilities, all while producing hydrogen.[3]

[1] White Paper: "Power-to-Gas: The Case for Hydrogen", CHBC, 2015, https://californiahydrogen.org/sites/default/files/CHBC%20Hydrogen%20Energy%20Storage%20White%20Paper%20FINAL.pdf

[2] Electrolyzers provide operational flexibility to participate in multiple energy markets including Regulation, Load Following or Fast Energy Markets, Spinning Reserves, Non-Spinning Reserves and Replacement/Supplemental Reserves.

[3] Novel Electrolyzer Applications: Providing More Than Just Hydrogen, NREL, 2014, www.nrel.gov/docs/fy14osti/61758.pdf

Power-to-Gas (P2G) is a technology that can be similar in scale to pumped hydro and compressed air, but is much more modular and flexible in siting and size (kilowatt to multi-megawatt scale and gigawatt-hours of storage capacity). Unusual about hydrogen is that it is a technology that:

- may store electrical energy and may return (use) the energy in a form other than electric energy,
- may store energy from the grid at one location and may return it to the grid or otherwise use the energy at another location,
- can store energy for long durations (e.g., seasonally, or annually), and
- can transport and distribute renewable energy throughout society at lower cost than electric transmission and distribution, and with inherent storage capacity.

Like customer-side solutions that may never return stored energy to the grid, all storage solutions that provide energy services and benefits to the grid should be properly accommodated in the state's regulatory and market frameworks.

The opportunity of hydrogen and power-to-gas cannot be understated. In Europe, P2G is expected to reach gigawatt levels in the next few years and is in the early commercialization phase in North America, where policy and regulatory support are key to achieving a fully mature market.

The CHBC would specifically like to reference examples from Germany, which has proceeded to build dozens of Power-to-Gas facilities in the last years. Germany is focused on regional grid cooperation as a top priority for the near term, and similar to the CAISO, German TSOs believe this is likely the most cost-effective solution for integrating renewable electricity generation up to 60-70% penetration into the power grid.[4] In addition, Germany continues to focus significantly on P2G development. As stated by the German Federal Economic Development Agency, "Hydrogen and power-to-gas technologies occupy a prominent place in the long-term energy storage plans and future mobility and fuel strategy of the German government."[5]

This is echoed in policy positions throughout the national government, such as the German Energy Agency's Power-to-Gas Roadmap and Strategy Platform that targets 2020-2025 for one GW installed and full commercialization of P2G[6] and the German Federal Environment Agency's approach to achieving near carbon neutrality. This was summed up by the former agency leader (now State Secretary at the Ministry for Energy and Economics), Jochen Flasbarth, as follows:

"The essential component in the transition to a society that is almost completely greenhouse gas-neutral is to convert the power which will be produced entirely from renewables into hydrogen, methane and long-chain hydrocarbons."[7]

[4] Source: Presentations by 50Hertz CEO Boris Schucht and TenneT COO Ben Voorhorst at 2015 Stakeholder CAISO
[5] 2017/2018 Fact Sheet on The Energy Storage Market in Germany, GTAI
https://www.gtai.de/GTAI/Content/EN/Invest/_SharedDocs/Downloads/GTAI/Fact-sheets/Energy-environmental/fact- sheet-energy-storage-market-germany-en.pdf?v=9
[6] See: http://www.powertogas.info/english/roadmap-power-to-gas/
[7] https://www.umweltbundesamt.de/en/press/pressinformation/a-greenhouse-gas-neutral-germany-is-almost-possible

In keeping with this view, last year Rainer Baake, State Secretary at the Federal Ministry for Economic Affairs and Energy called for P2G as necessary for decarbonizing existing and potentially a limited number of additional gas power plants to achieve 2050 greenhouse gas targets.[8]

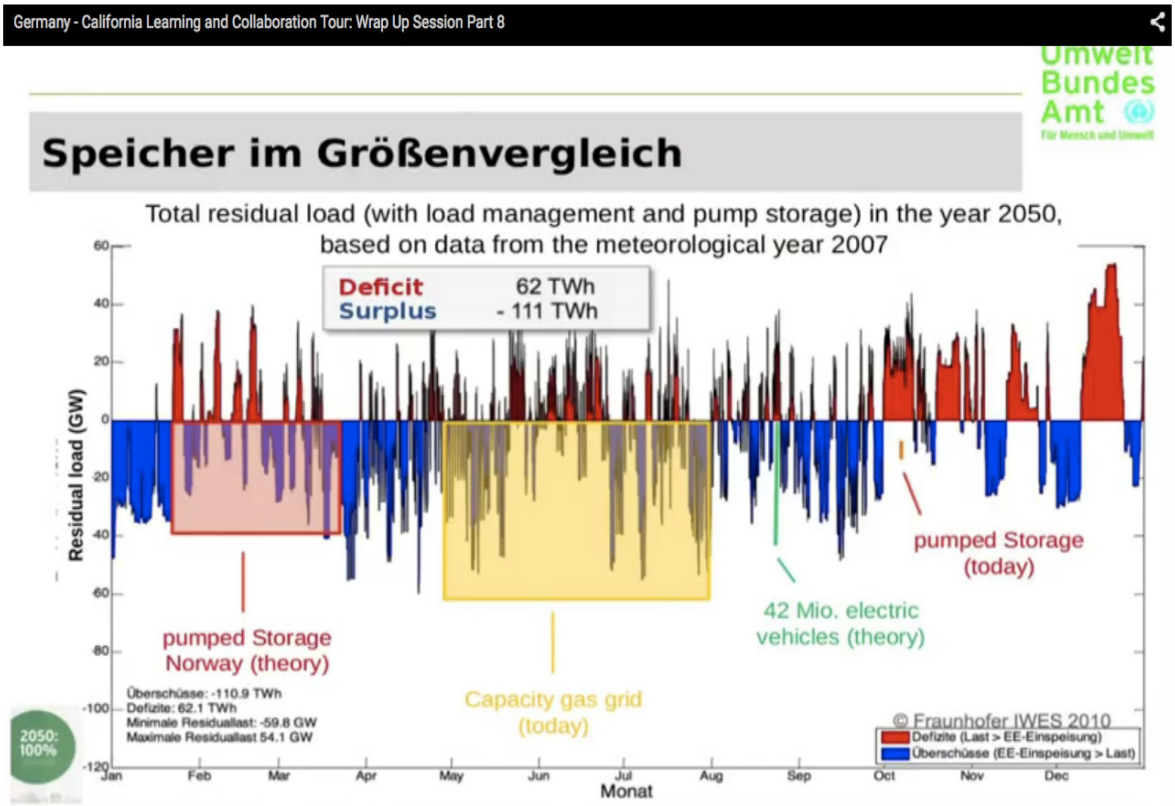
In reflection of federal policy, Germany has become home to several dozen P2G projects, and its energy and environment agencies continue to focus on research and development, as well as policy implementation of power-to-gas and power-to-liquid, e.g. renewable hydrogen produced by electrolysis used to make gas (hydrogen or synthetic methane) and synthetic liquid fuel. In the last year, the German Federal Environment Agency issued two in-depth analytical position papers on these topics.[9]

With regard to battery storage development in Germany, large-scale installations are modest compared to California – 200 MW of large scale battery storage is expected by the end of 2017 – with more activity in the small-scale residential sector.[10] Government support has been limited, and there are currently no plans for that to significantly change. The Federal Ministry of Energy and the Economy gives this restrained view on its website: "*Currently available electrochemical storage facilities do not deliver the necessary technological and commercial conditions for both uses (transportation and storage).*"[11]

Germany's energy system is also interconnected with ten countries with a total transfer capacity of more than 20 GW of hydropower. *Despite this,* the German government is still intent on supporting additional P2G development because, as the figure below illustrates, modeling has shown that the capacity of P2G for integrating high penetrations of renewable power up to 100% in Germany exceeds that of "out of country" (namely Norway) hydropower, thereby providing an even larger storage resource.

[8] https://www.cleanenergywire.org/news/phasing-out-conventional-cars-close-call-rwe
[9] https://www.umweltbundesamt.de/publikationen/integration-of-power-to-gas-power-to-liquids-into; http://www.lbst.de/ressources/docs2016/161005_uba_hintergrund_ptl_barrierrefrei.pdf
[10] https://www.gtai.de/GTAI/Content/EN/Invest/_SharedDocs/Downloads/GTAI/Fact-sheets/Energy-environmental/fact-sheet-energy-storage-market-germany-en.pdf?v=9
[11] http://www.bmwi.de/Redaktion/EN/Artikel/Energy/research-priorities-energy-storage.html

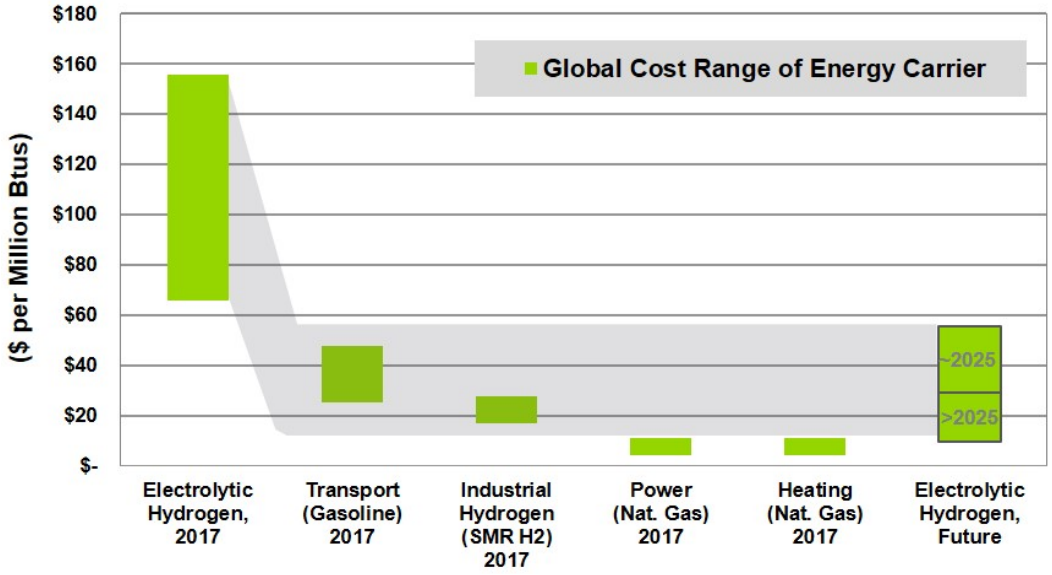
Storage Size Comparison for Germany



Moreover, a study conducted by McKinsey & Company found that converting renewable power into hydrogen by P2G followed by salt cavern hydrogen storage and use of combined cycle power plant conversion back to electricity (called Power-to-Power, P2P) was cheaper than pumped hydro storage. The findings showed that P2P with a round trip efficiency of 40% and capital costs of $1,000/kW has a lower levelized cost of electricity than pumped hydro storage, the current lowest cost energy storage solution.[12]

Navigant Research just published an article with current and future cost data for hydrogen from electrolysis. In the analysis, the authors state "a*s seen in in the following chart, electrolysis remains expensive today. This is because electrolyzer capital costs have not fallen much below $1,000/kW. Renewable electricity costs, while falling dramatically, remain relatively high compared to a very high penetration future. But as those two costs fall, as is projected through 2025 and beyond, the cost of clean hydrogen falls substantially."*

[12] McKinsey & Company, "Commercialisation of Energy Storage in Europe," Fuel Cell and Hydrogen Joint Undertaking, European Commission, March, 2015.



HYDROGEN COST COMPARISON WITH OTHER ENERGY CARRIERS, WORLD MARKETS: 2017, 2025, AND BEYOND[13]

The CHBC submitted a document titled "Economic of Power-to-Gas (P2G)" to the Renewable Gas docket on June 26, 2017. Also submitted to that docket is the recently released European Commission supported "Study on Early Business Cases for H2 in Energy Storage and More Broadly Power to H2 Applications" by the Fuel Cells and Hydrogen Joint Undertaking[14]. The June 2017 Report for the Fuel Cells and Hydrogen 2 Joint Undertaking, states that "*within the portfolio of storage technologies, hydrogen is widely recognized as a promising option for storing large quantities of renewable electricity over longer periods.*"[15] One conclusion of the comprehensive report is that power-to-hydrogen is bankable already today, but needs to be allowed to stack up several revenue streams from a variety of market applications. With that, revenues from providing frequency services to the power system (frequency containment and/or restoration reserves) will significantly improve bankability and cut payback times.

The CHBC believes governmental agencies ought to focus on the following five actions:

1. It is essential that state agencies ensure that hydrogen-based products remains part of the implementation of SB 1383, in which the legislature explicitly directed the Energy Commission to look at "renewable gas" - that both houses of the legislature and the Governor's office understood at the time of the bill's passage to include agency consideration of electrolyzer-produced renewable hydrogen.
2. The CPUC ought to ensure that P2G facilities are eligible for appropriate (wholesale or at least more aggressive retail rate structures) electricity rates, as well as low T&D rates for fuel production and industrial process applications.

[13] https://www.navigantresearch.com/blog/a-roadmap-to-the-coming-hydrogen-economy-in-one-chart
[14] http://www.fch.europa.eu/sites/default/files/P2H_Full_Study_FCHJU.pdf
[15] http://www.fch.europa.eu/sites/default/files/P2H_Full_Study_FCHJU.pdf

3. Gas utilities should be allowed to purchase renewable gas, including hydrogen, along with associated renewable attributes, and work with stakeholders to develop in-state markets of hydrogen and other renewable gases through procurement policies.
4. The CAISO ought to examine the ancillary services market for opportunities for P2G.
5. The state ought to adopt a method for testing compliance of power-to-gas with advancing state energy and climate goals. An appropriate test would be along the lines of that which is applied to energy storage in AB 2514: *An "energy storage system" shall be cost effective and either reduce emissions of greenhouse gases, reduce demand for peak electrical generation, defer or substitute for an investment in generation, transmission, or distribution assets, or improve the reliable operation of the electrical transmission or distribution grid.*[16] When an electrolyzer serves a power to gas function, it would not only be cost effective and reduce greenhouse gas emissions, it would also serve as a grid asset.

Thank you for your consideration.

Sincerely,

Emanuel Wagner
Assistant Director
California Hydrogen Business Council

[16] SEC. 2, Ch. 7.7, Sec. 2835 a)(3) See: http://www.leginfo.ca.gov/pub/09-10/bill/asm/ab_2501-2550/ab_2514_bill_20100929_chaptered.pdf