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Hydrogen Role in Microgrids

Additional submitted attachment is included below.

CALIFORNIA HYDROGEN BUSINESS COUNCIL

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Comments of California Hydrogen Business Council to the California Microgrid Roadmap Scoping Workshop (16-EPIC-01)

California Hydrogen Business Council (CHBC) respectfully submits these comments to the Joint Agency workshop held on July 26th, 2017 focusing on the development of a Roadmap for Commercializing Microgrids in California.

The California Hydrogen Business Council (CHBC) is comprised of over 100 companies, agencies and individuals involved in the business of hydrogen. The organization's 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 vision of the CHBC is to reinforce California's position as the most advanced clean energy state in the nation, expanding the sustainable use of its precious natural and renewable resources and providing clean air to its citizens, by adopting hydrogen and fuel cell technologies in transportation, power and goods movement markets.1

CHBC is pleased to see the important cross-agency effort between CEC, CAISO and CPUC to develop a roadmap for commercialization of microgrids in California through the EPIC funding program, which is pivotal to the safety, reliability and resiliency of microgrids.

The CHBC believes that hydrogen can play important energy storage, delivery, and conversion roles in microgrid applications, supporting critical loads within a community that includes grid resiliency, redundancy and security services that are provided to the electrical distribution system.

Hydrogen solutions such as Power-to-Gas (P2G) can be deployed to support continued operations of critical loads across multiple microgrid market segments including universities and

[1] The views expressed in these comments are those of the CHBC, and do not necessarily reflect the views of all the individual CHBC member companies. A complete list of members can be found at https://www.californiahydrogen.org/

other institutions, commercial and industrial entities, local communities, military installations, and off-grid or remote island locations.

Renewable hydrogen produced from excess renewable electricity via electrolysis can be used as a dispatchable load-balancing resource (complementing the renewable intermittency) and as an energy storage medium in microgrids with high levels of renewable power generation. Hydrogen can be dynamically produced during peak renewable electricity production times and can be converted back into electricity through a fuel cell when solar or wind energy is not available. In this way, hydrogen supports increased deployment of intermittent, renewable power production assets into microgrids and the utility grid network as a whole. Hydrogen is an especially attractive energy storage solution that is cheaper than battery energy storage when massive amounts of energy storage or long durations of energy storage are required (for example as required for seasonal shifting of renewable energy).

Electrolysis is a mature technology that converts electricity into hydrogen (and oxygen) by splitting water. Beyond the storage function of converting electricity into gaseous fuel for later use, these systems can cycle up and down rapidly providing multiple services including voltage and frequency regulation, spinning reserves, ramping services, and capacity across multiple grid domains. Electrolyzers are connected to the grid via inverters (in the same manner as batteries) which have very fast response times, allowing them to provide operational flexibility and they can modulate hydrogen output to provide energy management and ancillary services to the microgrid system and as well as participation in energy markets on the utility grid at network scale, all while producing hydrogen.

Universities and other institutions across the US are taking steps to develop microgrids, for knowledge-building, industry and technology collaboration, and improving energy resiliency. At the University of California, San Diego (UCSD), the campus microgrid supplies electricity, heating and cooling for the 450-hectare campus supported by several key resources including solar photovoltaic systems, a cogeneration plant, and fuel cells using biogas feedstock and technology that is capable of generating hydrogen, electricity and heat through the process[2].

The University of California, Irvine (UCI) campus microgrid is comprised of over 4.0 MW of solar photovoltaics (PV), a 4.5-million-gallon thermal energy storage (TES) system with district heating and cooling, a 19 MW natural gas combined cycle (NGCC) cogenerating plant,

[2] UC San Diego: https://sustainability.ucsd.edu/highlights/microgrids.html

and a 2 MW/0.5 MWh lithium ion battery energy storage system serving a community of more than 30,000 people and encompassing a wide array of building types, and transportation options[3].

The newest addition to the UCI campus microgrid is a 60-kW power-to-gas (P2G) system that uses a polymer electrolyte membrane (PEM)[4] electrolyzer to convert excess renewable power into hydrogen gas. The hydrogen gas is injected onto the campus pipeline system where it is blended with natural gas. The hydrogen/natural gas blend is then used to power the onsite NGCC system.

The UCI system demonstrates several of the value propositions (e.g., dispatchable load, capturing otherwise curtailed intermittent renewable power, using the natural gas system for storage) that P2G technology can provide for microgrids. A simulation of the UCI microgrid conducted by researchers at the Advanced Power and Energy Program (APEP) showed that a hypothetical 27 MW P2G system could allow UCI to deploy significantly more solar PV capacity and increase the renewable energy consumed on campus from 3.5% of total consumption to 35% of total consumption, an increase of 10 times.

Researchers at APEP also connected a PEM electrolyzer directly to a roof mounted PV array and showed that the electrolyzer could easily conform to the dynamics of PV power production even on cloudy days with highly intermittent solar production (Figure 1). These tests demonstrate that the rapid response characteristics of electrolyzers can assist in providing many ancillary services, including rapid ramping, frequency and voltage regulation to support microgrid power quality and resiliency.

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[3] Additional Information on the UCI Microgrid is available at: http://www.energy.ca.gov/research/notices/2015-09-30_workshop/presentations/03_UC_Irvine_Deployment_and_Integration_of_Renewables_at_UCI_9-30-15_Lynwood.pdf

[4] PEM electrolysis is a hydrogen-production technology that can enable a zero-carbon footprint when used with renewable resources. More information :https://energy.gov/eere/fuelcells/downloads/hydrogen-production-polymer-electrolyte-membrane-pem-electrolysis-spotlight

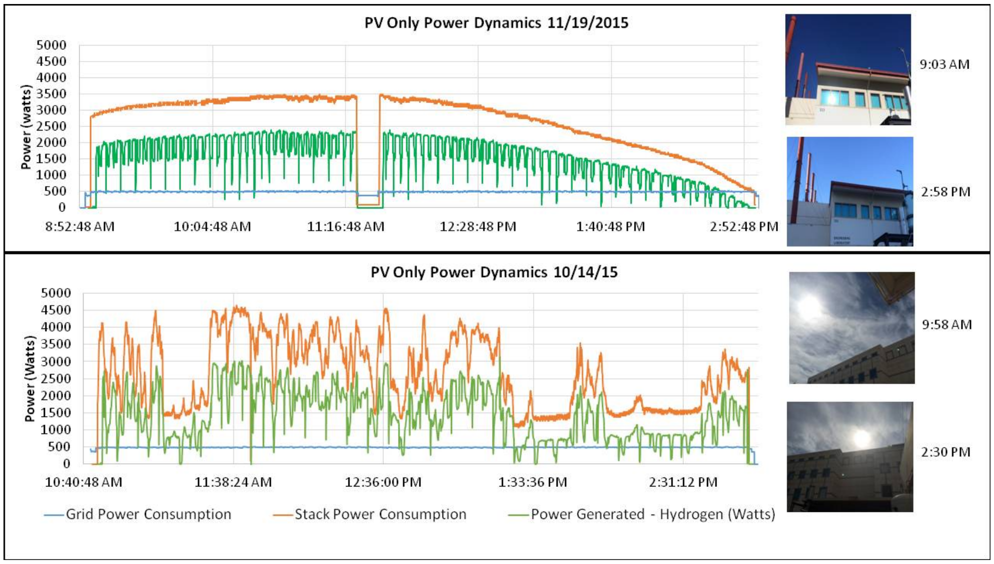

FIGURE 1 - POWER CONSUMPTION OF THE ELECTROLYZER WITH RESULTANT HYDROGEN PRODUCTION FOR TWO DIRECT DC-CONNECTED 'PV ONLY' TESTS CARRIED OUT IN THE FALL SEASON.

P2G can help microgrid operators like UCI reduce their carbon footprint by using the stored excess renewable energy and thereby reducing the amount of traditional power that must be generated on the microgrid, or imported from the grid at large. P2G can also help reduce the carbon intensity of transportation systems supported by the microgrid. Renewable hydrogen produced during peak renewable power production periods can also be used to power fuel cell electric vehicles (FCEVs) like the fuel cell electric bus being tested and demonstrated on the UCI campus as part of the "Anteater Express" shuttle service. The "multiple use application" aspects of P2G provide greater flexibility to integrate renewables beyond power applications into transportation.

CHBC agrees with the CEC that it is important to address diversity in microgrid technologies that can support local communities with multiple benefits beyond just electricity, and to target projects that could not move forward without government support. CHBC recommends that the California Energy Commission should not limit future funding for microgrids to just solar and battery energy storage technologies. Rather, funding and policy support should be technology neutral and should consider all types of emerging technologies that support microgrid renewable energy, including renewable hydrogen production and P2G. These hydrogen technologies can offer modular and flexible siting and sizing, massive and seasonal energy storage, and transportation integration that can pave the way for a more resilient, more energy efficient, more renewable and sustainable communities in California.