CALIFORNIA HYDROGEN BUSINESS COUNCIL

Hydrogen Means Business in California!

Electrolytic Hydrogen: Enabling Deep Decarbonization by Harnessing and Storing Renewable and Zero-Carbon Power

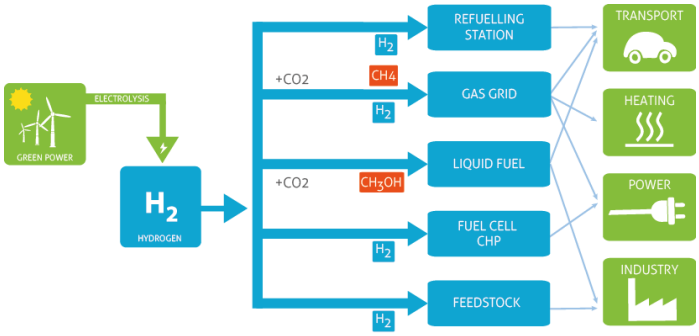
Hydrogen offers unique features that can address specific challenges that California is facing, but a number of political and regulatory barriers are impeding the deployment of this technology.

California is facing an increasing need to deploy utility-scale energy storage and flexible-load solutions to support the integration of intermittent renewable power generation resources (solar and wind). With the passage of SB 100[1], setting the goal of 100% carbon-free electricity by 2045, and the signing of Executive Order B-55-18[2] to achieve carbon neutrality by 2045, a major focus for policymakers to achieve these goals will be the deployment of grid-scale energy storage.

In 2018, the California Independent System Operator (CAISO) reported that approximately 461 GWh of solar and wind energy was curtailed that year[3]. If that energy had instead been channeled to electrolyzers, it could have produced 9 million kg of hydrogen, enough to fuel 40,000 fuel cell electric vehicles for an entire year.[4] This hydrogen can also be used in other sectors beyond transportation, including heating, power, and industrial processes (steelmaking, fertilizer, oil refining, chemical production).

The 2019 CAISO data show a significant increase of over 700 GWh of curtailed solar and wind power as of July 2019, and up to as much as 12,000 GWh are expected to be curtailed by 2030. As renewable generation continues to grow, stored energy will need to meet the energy demand when solar and wind generation are not available to meet demand.

Power-to-X (P2X) Introduction



Without grid-scale storage of electrical energy and greater deployment of large, flexible loads, power grids cannot accommodate high levels of intermittent renewable resources, as supply and demand mismatches can result in periods of significant excess generation creating the need for bulk storage. One promising approach is to use electrolyzers to produce hydrogen thus storing the input electrical energy as hydrogen fuel. The produced hydrogen can be used for transportation, power generation, heating, and industry. This is referred to as Power-to-X (P2X).[5] When the electrolytic hydrogen is used for power generation, the function is identical to a battery but with the potential for storage of massive amounts of energy for any duration of time from hours to seasons. In non-power applications, electrolyzers can serve as a flexible load having similar benefits to traditional storage resources.

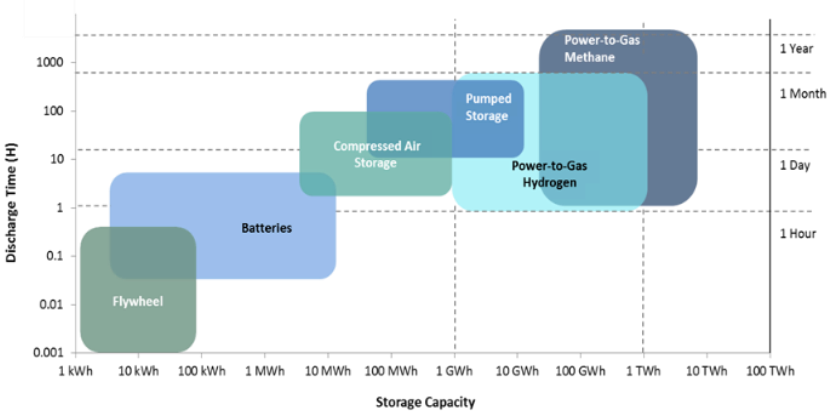
P2X uses electrolysis to split water into hydrogen and oxygen. Through this process, electrical energy is converted to chemical energy in the form of hydrogen. The hydrogen can then be stored, transported and used in a variety of ways. One of the least expensive and most accessible means of transport could be through the natural gas grid via direct injection (blending) or prior conversion to methane. Hydrogen can also be transported by other means, such as trucks and ships, or used directly at the point of production. The stored chemical energy can be used to generate electricity via a fuel cell or a turbine, as a transportation fuel, or for any other purpose for which hydrogen or methane is used.[6] An important distinction between P2X and other forms of energy storage is that P2X allows conversion of energy amongst a variety of sectors and end-uses (e.g., electric grid, gas grid, transportation fuel) and can take advantage of the natural gas grid as an existing, ubiquitous and inexpensive storage and transport resource to augment, and in some instances replace, dedicated hydrogen

[1] https://www.cbsnews.com/news/california-aims-to-go-100-percent-carbon-neutral/
[2] https://www.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf
[3] http://www.caiso.com/informed/Pages/ManagingOversupply.aspx
[4] Susan M.Schoenung, Jay O.Keller: "Commercial potential for renewable hydrogen in California" - https://doi.org/10.1016/j.ijhydene.2017.01.005
[5] https://new.siemens.com/global/en/products/energy/topics/power-to-x.html
[6] Figure: Storage Technologies and Power / Energy Characteristics (After Fraunhofer ISE, 2015)

storage infrastructure. P2X has the potential to store energy at a greater capacity (e.g., > 1 GWh) compared to battery and other energy storage systems that typically have smaller capacities.

In addition to using intermittent renewable power, electrolyzers can be integrated with existing zero carbon power sources, like large hydro and nuclear, to produce hydrogen and make these resources more dynamic and dispatchable so that they better complement solar and wind power.

Power-to-X Around the Globe



Power-to-X projects are being developed around the world, including in Canada, Denmark, France, Germany, Netherlands and the United Kingdom[7]. These P2X projects are primarily utilizing excess wind power generation to inject hydrogen into existing natural gas infrastructure. As development continues, limits on the natural gas pipeline injection levels will become more established. For example, E.ON has announced that it will raise the hydrogen admixture-rate for its natural gas pipeline grid to as much as 20%, a first in German gas distribution[8].

Enabling Power-to-X in California by Overcoming Regulatory Barriers

To enable the development of power-to-X systems in California, state agencies should adjust current policies.

In 2018, the state passed SB 1369 (Skinner), which requires state agencies to consider green electrolytic hydrogen an eligible energy storage technology for procurement purposes and directs the agencies to consider hydrogen in all related proceedings.[9] To implement this direction, the California Public Utilities Commission must establish appropriate blending limits for hydrogen as a blend-stock with natural gas. Blend limits as high as 12% by volume exist in Europe and, in the U.S., the Hawaiian natural gas system already contains approximately 10% hydrogen by volume.

In addition to establishing blending limits, the state must establish direct access tariffs to facilitate the important role that electrolytic hydrogen can play in enabling integration of intermittent renewables by providing flexible load during periods of high renewable electricity production. With proper electric rate design, green electrolytic hydrogen see a cost-effective solution for transportation, renewables integration and a wide range of other applications.

Finally, other regulatory and policy support needed to launch and scale up use of the renewable hydrogen sector in California include state funding for pilot projects and RD&D, and continued state support for carbon credit markets that fully value the carbon reduction that results from use of renewable hydrogen.

[7] https://www.sciencedirect.com/science/article/pii/S1876610218309883
[8] 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
[9] https://sd09.senate.ca.gov/news/20180831-california-legislature-passes-skinner%E2%80%99s-sb-1369-laying-groundwork-green-hydrogen