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HYDROGEN WORKSHOP 28 July , 2021

If you have difficulty viewing the pdf, I am happy to send a .docx.

Additional submitted attachment is included below.

HYDROGEN
JULY 28, 2021 CEC WORKSHOPS 1 & 2

Comments by David Bezanson, Ph.D., CA voter

Thank you for presenting the workshops and inviting industry representatives who are enthusiastically driving innovation in H2 generation and storage.

DEFINITIONS

When the term green hydrogen was used during the workshops it was usually not defined. When it was, each presenter used a unique definition. This was confusing and made it challenging to evaluate the potential of H2 for energy generation and storage.

Existing

Universal Citation: CA Pub Util Code § 400.2 (2018)

400.2.

For the purposes of this article, “green electrolytic hydrogen” means hydrogen gas produced through electrolysis and does not include hydrogen gas manufactured using steam reforming or any other conversion technology that produces hydrogen from a fossil fuel feedstock.

Proposed

The above definition is inadequate and creates ambiguity. It is recommended that it be replaced by the following two definitions of kinds of H2 production. These should be used in 400.2 or other sections of CPUC. This is important for use in new legislation, agency Scoping Plans, agency rulemaking, Executive Orders, science, and communications from industry (e.g., bids and RFPs). (NG has been called clean and green for decades, but that has been disproven. The lifecycle GHG emissions of NG are about the same as the emissions of coal.)

Green hydrogen - H2 produced without use of fossil fuels, biomass, biofuels, biogas, CCS, and does not emit GHGs or toxins. Examples are photocatalytic water splitting (which has been demonstrated in laboratories, but is not commercially available) and electrolysis of carbon-free electrolytes (e.g., H2O with or without minerals). CCS is excluded because it only removes 11% - 30% of CO2 and none of the airborne toxic pollutants from combustion. To improve public health, curtail the climate crisis, and decarbonize our economy, it is much more cost effective to use feedstocks and energy sources that are carbon-free rather than combust carbon-rich feedstocks and install CCS (1).

Renewable green hydrogen (RGH) - Green hydrogen that is produced exclusively with renewable electricity - per the definition of Renewable Portfolio Standard used in SB 100 and excludes use of biomass.

One feedstock for generation of electricity that is regarded by many as renewable is biomass. Because a) combustion of biomass to generate electricity emits substantial CO_2, CH_4, and toxic emissions, b) the quantity of GHGs from biomass combustion can be as much as 50% more per kW than GHGs from coal combustion (2, 3, 4, 5); it is recommended that biomass be disqualified as a source of renewable electricity for purposes of an RGH definition as well as the Renewable Portfolio Standard. This is justified because a) climate change and drought have intensified since 2018 when SB 100 was chaptered, b) the most recent GHG inventory on the CARB website indicates that our CO_2e emissions are less than 1% below the all-time high, and c) our carbon stocks in natural and working lands are dwindling and projected to decrease for a least several decades.
To qualify as a renewable in the RPS, any energy source should have lifecycle GHG emissions equal to or lower than geothermal, PV solar, and wind.

The term clean hydrogen should not be used because it is ambiguous. There is no H_2 production technology that has zero carbon emissions over its lifecycle. The terms emissions-free, carbon-free, CO_2-free, and zero carbon should not be used to refer to H_2 production or storage.

HYDROGEN

Exclude public funding for use of H_2 turbines, powered by non-renewables, from the Scoping Plan because they emit toxics, e.g., NOx, and, at least indirectly, GHGs.

95% of world production of H_2 is from fossil fuel feedstocks. The second most prevalent feedstock is biomass. Emissions of GHGs from the latter may be up to 50% higher than emissions from coal and may emit more toxics than coal combustion. A tiny percentage of H_2, less than 1%, is from electrolysis of water. The HyBlend research project is being conducted by Dept. of Energy to assess the feasibility of blending H_2 and CH_4 in the same pipelines. Like other H_2/NG blend technologies in USA and Europe, the maximum safe percentage of H_2 Is 5% - 15%. The remainder of the mix is NG. Pipeline embrittlement increases as the percent of H_2 increases. At percentages above 15%, HVAC systems and NG appliances need modifications to accept and combust the blends. This inefficiency is costly financially and is unethical because it accelerates climate change. Because H_2 molecules are much smaller than CH_4 (methane), fugitive emissions of H_2 from existing NG pipelines exceed fugitive emissions of CH_4. Consequently, at the point of consumption (e.g., a cement factory), the ratio of H_2: CH_4 is less than the ratio at the point of origin (the beginning of the pipeline where the blend is loaded).

Fugitive emissions from NG pipelines are a daily occurrence in CA. There are 650,000 miles of pipelines and over 1800 leaks are reported daily in CA. Seismic activity of a magnitude <3 on the Richter Scale is thought to present low risk of leaks. However, further study of the issue is called for, especially for more severe seismic tremors. Like NG, H_2 transported via pipelines is at risk for explosion and fire. This is the case for blends as well as separate pipeline infrastructures designed just for H_2. When H_2 is burning there are no visible flames. Further repurposing of NG pipelines for blend pipelines should be discontinued for the above reasons and because they extend the scale and lifespan of fossil fuel combustion. Blend pipelines carry a mix of NG and H_2 that is at least 80% NG. Methane comprises 70 - 90% of NG. Methane has a GWP that is 85 times higher than CO_2 during its initial 20 years in the atmosphere. It naturally degrades into H_2O and CO_2. The latter lingers in the atmosphere for centuries. Most energy research indicates that we have sufficient renewable energy potential to meet our electricity demands 50 - 100 times over. There are many other storage options. The lifecycle GHG emissions of renewables are tiny compared to emissions of NG.

A moral hazard is that use of carbon-intensive H_2 production technologies (biomass, biofuels, biogas, and fossil fuels powered primarily by fossil electricity in Scope 2) will extend the lifespan and emissions of the fossil fuel industry. This would magnify the destruction from climate change for current and future generations of all species. Air pollution from the fossil fuel industry killed 8.7 million people in 2018 (6).

The only H_2 production technology that avoids this hazard is electrolysis of water using 100% renewable electricity and is distributed via portable tanks or separate pipelines used exclusively for H_2. A corollary hazard is failure to scale up renewable generation and storage rapidly enough to displace fossil fuel energy and prevent emissions of GHGs and toxic co-pollutants.

There is considerable agreement about the sectors that are most suitable for H_2 use. The building sector is not one of them. This sector already has the electrical infrastructure to serve all of its energy demands. And the forms of energy with the lowest cost/kW can be delivered and managed safely with the current transmission, smart grid, metering, and control systems. H_2 costs at least twice as much per kW as renewable electricity. Construction of thousands of miles of H_2 pipelines in CA would be costly and prevent H_2 from being cost-competitive for many years.

Continued reliance on distributed renewable electricity is prudent until H_2 technologies are in widespread use for difficult to decarbonize sectors, e.g., heavy industry, ammonia (refrigerant), marine cargo and cruise ships, and large trucks. At that point, the role of H_2 in buildings may be reevaluated (7).

Cost: benefit studies of carbon-intensive H_2 should contrast it with established renewable energy technologies (geothermal, wind, solar) and with RGH. Costs to factor in include $/kW, efficiency, emissions regulation, transmission infrastructure maintenance (electric power v pipelines), Social Cost of Carbon, and Environmental Injustice. Fossil fuel and biomass infrastructure, operations, and toxic emissions create proximal sacrifice zones with high rates of mortality and morbidity. Using blend pipelines would perpetuate sacrifice zones. The most comprehensive, real-life model to use is lifecycle analysis, which includes Scope 1, Scope 2, and Scope 3. This provides a more accurate picture of the total environmental impact of each energy option than studies limited to the operating phase (8). NEL Hydrogen projected the cost/kg. of renewable H2 to be less than the cost of fossil fuel H2 by 2050.

Until comparative research discovers an H2 production technology that has lower toxic and GHG emissions than RGH, public funds should be used only for RGH (8).

STORAGE

Geologic storage requires regulation and monitoring. Using the honor system, i.e., accepting claims from industry about fugitive emissions, is very risky. CARB should monitor fugitive emissions at injection portals as well as on the ground above storage caverns or depleted fossil fuel wells. H2 companies should pay for all costs of initial and annual permitting, monitoring, and regulation conducted by CARB. Storage sites need protection from fire hazards, e.g. wildfires and flaring from fracking wells. Risks of seismic activity should be assessed prior to issuing permits.

Endnotes

1. https://web.stanford.edu/group/efmh/jacobson/Articles/Others/19-CCS-DAC.pdf

2. www.pfpi.net

3. Smith, P. et. al. (2014) Agriculture, forestry and other land use. In *Climate Change 2014* NY: Cambridge University Press.

4.https://www.researchgate.net/publication/228090129_Hydrogen_production_via_biomass_gasification-A_life_cycle_assessment_approach

5. https://web.stanford.edu/group/efmh/jacobson/Articles/I/NonEnergySolutions.pdf

6.Deaths from fossil fuel emissions higher than previously thought (harvard.edu)

7. Net-zero emissions energy systems | Science (sciencemag.org)

8.https://escholarship.org/content/qt3pn8s961/qt3pn8s961_noSplash_b1d302a49f54828e57a5e496836ad255.pdf?t=qep7n5