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Comments of GHC on June 30th Long Duration Storage Scenarios Selection Workshop

Additional submitted attachment is included below.

GREEN
HYDROGEN
COALITION

July 14, 2021

Email to: docket@energy.ca.gov
Docket Number: 20-MISC-01
Subject: GHC's Long Duration Energy Storage Scenarios Workshop Comments

Re: Comments of the Green Hydrogen Coalition (GHC) following the June 30, 2021 Long Duration Storage Data & Scenario Selection Workshop

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Overview

The Green Hydrogen Coalition ("GHC")[1] appreciates the opportunity to provide comments on the *CEC EPC-19-056 Assessing the Value of Long Duration Storage Date & Scenario Selection Public Workshop*. GHC seeks to offer constructive feedback to inform the modeling scenarios and inputs.

GHC is a California educational non-profit organization founded in 2019 to facilitate policies and practices to advance the production and use of green hydrogen at scale in all sectors to accelerate a carbon-free energy future. GHC defines green hydrogen as hydrogen that is not produced from fossil fuel feedstocks. Such pathways can include but are not limited to electrolysis of water, steam methane reforming, autothermal reforming of methane pyrolysis of renewable gas, and thermochemical conversion of biomass. GHC believes that the prioritization of green hydrogen project deployment at scale is fundamental to reduce cost and to meet California's climate and carbon goals.

We commend the EPC-19-056 project team for considering green hydrogen as a form of long-duration storage and potentially as a drop-in fuel replacement. The inclusion of green hydrogen in this analysis is a critical first step to incorporating green hydrogen into California's energy resource planning and procurement toolkit and, ultimately, to enable at-scale production, transport, and storage of green hydrogen necessary to benefit the power sector and accelerate decarbonization in multiple hard-to-abate sectors such as transportation, heavy industry, shipping, and aviation.

Accelerated deployment of green hydrogen to achieve carbon goals can be realized through an initial focus on the power sector. Given the size of this sector and the abundance of intermittent renewable power in California, the power sector offers a significant opportunity to quickly scale green hydrogen. Large-scale green hydrogen

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[1] https://www.ghcoalition.org/

production and use opportunities in the power sector today include using curtailed and purpose-built renewable electricity to make hydrogen through electrolysis; as well as using the resulting hydrogen in existing thermal electricity generation plant to produce dispatchable, carbon-free reliable power. In sum, green hydrogen gives Californians a way to 'bottle' zero-carbon resources like sunshine and wind on a multi-day and even seasonal basis; effectively taking abundant renewable power and making it dispatchable across long periods of time.

Recommendations

1. The GHC strongly supports the finding that hydrogen has a Technology Readiness Level ("TRL") of *at least* 9, and recommends this be reflected appropriately in the technology screening approach.

GHC supports the use of International Energy Agency's ("IEA") clean energy technology guide and believes the finding that hydrogen has a TRL of 9 is a good starting point to reflect current market conditions.[2] Hydrogen is a mainstream commodity – with an annual global demand of approximately 70 million metric tons – that is widely used today for many industrial processes. However, more than 99% of the hydrogen used today is produced from fossil fuels, releasing over 830 million tons of greenhouse gas emissions ("GHGs") per year. [3] Green hydrogen has the potential to displace these GHG emissions and also presents an opportunity to decarbonize sectors where hydrogen is not widely used today, including in the power sector.

Green hydrogen relies on commercially available production pathways including via renewable electricity by electrolysis, from biogas by steam reforming, and from biomass through thermal conversion. The technologies used to produce green hydrogen are commercially available and in use, with over 199 projects being tracked around the world.[4] In California, fuel cell electric vehicles ("FCEVs") can refuel at any of 47 open retail hydrogen fueling stations, each of which must supply at least 33% renewable hydrogen, with some stations achieving 100%.[5] With this in mind, GHC posits green hydrogen likely has a TRL of greater than 9. Notably, E3's *Draft Emerging Technology Review: Proposed Technology Screening Approach* lists H_2 as an example of an emerging

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[2] *CEC EPC-19-056 Assessing the Value of Long Duration Storage: Data & Scenario Selection Public Workshop*. E3, June 30, 2021 (hereinafter "Workshop presentation"). Slide 11.

[3] *Green Hydrogen Guidebook.* Green Hydrogen Coalition, https://www.ghcoalition.org/guidebook. Page 7.

[4] https://www.thehydrogenmap.com/

[5] *2020 Annual Evaluation of Fuel Cell Electric Vehicle Deployment & Hydrogen Fuel Station Network Development.* California Air Resources Board, September 2020, https://ww2.arb.ca.gov/sites/default/files/2020-09/ab8_report_2020.pdf. *Appendix B: Station Status Summary*, page 71.

technology.[6] Given green hydrogen's high TRL and commercial deployment level, GHC recommends that green hydrogen be categorized as a "commercialized" technology, rather than "emerging."

2. E3 should recognize and model the immense potential flexibility of electrolysis load within the High Load Flexibility demand scenario.

The modeling results under the latest Integrated Resource Planning ("IRP") and the 2021 SB 100 Joint Agency Report showed that renewable curtailment can range from 2% (60% RPS scenario) to 11% (high-load scenario). These results imply approximately 55 TWh of unused electricity.[7] GHC believes that producing green hydrogen via electrolysis is a no-regrets solution to capture this tremendous projected oversupply of renewables. Electrolyzers are inverter-based loads that operate on a fast response time,[8] and the resulting green hydrogen can be stored across days, months, seasons, or years. In contrast to other flexible loads (e.g., electric vehicles), electrolyzers are relatively less time constrained. In addition to using this load flexibility to reduce peak system demand and manage oversupply, it can also be leveraged in strategic locations to reduce congestion on nodes where renewables supply is particularly high.

GHC appreciates that the latest modeling efforts (i.e., IRP and SB 100) did incorporate hydrogen end-uses. While these efforts assumed hydrogen production via electrolysis, the hydrogen was only assumed to be produced off-grid. As such, electrolysis load was not meaningfully incorporated into the model formulation of RESOLVE. Furthermore, the non-combustion scenario resulted around 23 GW of fuel cells being selected, which would require an immense amount of hydrogen.[9] GHC believes that overlooking electrolysis load in the model does not accurately represent the benefits of green hydrogen can bring to the grid, especially in light of the overall renewable energy capacity selected by 2045 in these same analyses.

GHC notes that some modeling tools[10] currently consider the production of hydrogen inside of the model construct and calculates the amount of electricity required per unit of

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[6] Workshop presentation at slide 46.

[7] Assuming that the modeled annual generation for 2045 is about 500 TWh for the core scenarios of the SB100

[8] The National Renewable Energy Laboratory (NREL) has shown that both PEM and alkaline electrolysis systems can ramp power up and down very quickly to accommodate the needs of grids with high penetration of renewable electricity installed. In addition, their ability to ramp quickly enables these electrolysis systems to participate in grid ancillary services aimed at assuring a safe and reliability electrical grid. See also the HyStock Netherlands demonstration (pg 5): https://irena.org/-/media/Files/IRENA/Agency/Topics/Innovation-and-Technology/IRENA_Landscape_Solution_11.pdf?la=en&hash=2BE79AC597ED18A96E5415942E0B93232F82FD85.

[9] This capacity was select mostly for reserve purposes, but could change if inclusion of circular hydrogen economy.

[10] *WIS:dom®-P. Weather-Informed energy Systems: for design, operations and markets*. 2020. [Online]. Available at https://tinyurl.com/5wa7m24n

fuel while keeping track of fuel flows between regions. This approach can be utilized and adopted as a first approximation to more accurately model hydrogen production. This should be incorporated into E3's modeling effort as a sensitivity study that models the demand of electrolysis and its ability to absorb oversupply. In addition, this study should create a candidate resource that could utilize the hydrogen being produced. The inclusion of this scenario will not only support the electric resource modeling task at hand, but also (a) inform stakeholders in other sectors as to the locations for hydrogen production, storage, transport, and use, and (b) optimize hydrogen for local areas and transport between modeled zones.

Leveraging the load flexibility of electrolysis equipment will ensure that electrolytic hydrogen is sourced from renewables or SB 100 eligible resources, reduce system costs by managing oversupply, and achieve a lower delivered cost of green hydrogen by making use of low-cost electricity. GHC strongly recommends E3 clarify the treatment of electrolysis load under the various scenarios and consider electrolysis as a key source of load flexibility in the High Load flexibility scenario.

3. <u>The GHC strongly supports the development of modeling reduction experiments to achieve multi-year, hourly capacity expansion modeling.</u>

In the presentation materials for the June 30th Workshop, E3 included a series of capacity expansion model reduction experiments in which the project team would evaluate modifications to the model to increase its temporal representation. GHC strongly supports these experiments as they are essential for the model to be able to identify part of the value proposition of hydrogen storage.

In the context of the energy sector, green hydrogen produced from excess renewable energy that would be otherwise curtailed can substantially contribute to the energy sufficiency of the state in periods of low renewable generation, such as extended periods of solar irradiation. Since it can be later utilized as a source of electricity via a fuel cell or in the form of drop-in fuel, the hydrogen molecule offers a means of chemical storage that could arbitrage renewable power for months, even years at a time. Nevertheless, the modeling toolkit currently utilized by regulators makes capacity expansion decisions based only on 37 non-consecutive days, eliminating the possibility of capturing the benefits of this form of arbitrage. Given the commercial readiness of green hydrogen production and current developments in large scale green hydrogen projects, GHC considers that it is urgent to reform these models in order to properly assess the transformative power of this technology.

Green electrolytic hydrogen, synthetic methane, and biomethane are gaining breakthroughs and cost reductions as "drop-in" or replacement fuels in natural gas-fired power plants and potential zero-carbon dispatchable generation resources. Today, these fuels can be blended with natural gas to reduce emissions in the near term, and industry aims to eventually use 100% green hydrogen in retrofitted gas plants. Hydrogen can also be synthesized into renewable methane as a drop-in fuel. The Los Angeles Department of Water & Power ("LADWP"), for example, is exploring the conversion of its Intermountain Power Plant in Utah to 30% hydrogen by 2025; and, eventually 100% hydrogen fuel. As stated in the comments above, green hydrogen is a commercially-available technology with a deeply transformative potential beyond the electric sector. As such, it is imperative that the planning tools are able to identify these benefits and consider them in capacity expansion decisions that ultimately drive procurement.

During the Workshop, E3 noted that the value stream experiments they have developed for a series of representative storage technologies demonstrate that longer-duration storage primarily responds to weekly and seasonal price signals. The use of green electrolytic hydrogen as a means of chemical storage could very well be represented by those resources in the 1,000-hour range; thus, consideration of value streams across days, and even years, is key to obtain capacity expansion results that fairly estimate the potential for green hydrogen. As a result, the GHC strongly supports the development of modeling reduction experiments to achieve multi-year, hourly capacity expansion modeling.

4. The GHC requests clarity on the representation of green hydrogen as a storage technology and as a drop-in fuel.

In the presentation materials from the June 30th Workshop, E3 explained the preliminary work on the "bulk" of scenarios to be considered for the project. As highlighted in the materials provided, the proposed scenarios will be consistent with economywide decarbonization pathways and aligned with scenarios from SB 100. However, from the presentation materials it is not clear how this new modeling toolkit will approach hydrogen economies to accelerate decarbonization.

Under the SB 100 scenarios, hydrogen was only considered as demand-side modifier and excluded potential technologies that could produce and use hydrogen. The reason provided was that drop-in renewable fuels are not yet commercially available in California or inadequate cost and supply data for modeling or both. This rationale is incorrect, as all gas turbines can already combust a blend of hydrogen, and some manufacturers, such as Mitsubishi, have committed to supplying gas turbines that can run on 100% hydrogen as early as 2025. Further, even without pipeline injection or 100% hydrogen pipelines, electrolytic hydrogen can be commercially produced & stored at or near gas turbines with off-the-shelf technologies to provide a blended 8+ hour supply of dispatchable green hydrogen storage for these turbines near-term. The GHC respectfully requests that E3 further explain how this project will consider hydrogen as a drop-in fuel replacement, particularly for the example provided

As mentioned above, hydrogen is a commodity that could impact drastically the results of the capacity expansion by considering green hydrogen as storage technology and as a drop-in fuel. With scale, the cost of green hydrogen is anticipated to reduce from $4-6/kg to $1-2/kg and could be modeled as a potential candidate technology by the timeframe considered under the IRP and SB 100.[11] Therefore, the GHC kindly request E3 to clarify the status and modeling assumptions (if new) that will be incorporated for this modeling effort.

Conclusion

In conclusion, GHC is supportive of the project team efforts in the scenario developments stage of EPC-19-056. GHC appreciates the opportunity to provide these comments and feedback and looks forward to collaborating with stakeholders on this initiative.

Sincerely,

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[11] See, for example, *Green Hydrogen Guidebook.* Green Hydrogen Coalition, https://www.ghcoalition.org/guidebook. Page 30.