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CEC Staff Workshop on Strategies to Model LDS

Additional submitted attachment is included below.

December 7, 2021

Email to: docket@energy.ca.gov
Docket Number: 20-MISC-01
Subject: Staff Workshop on Strategies to Model Long Duration Storage

Re: Comments of the Green Hydrogen Coalition (GHC) following the November 17, 2021, CEC Staff Workshop on Strategies to Model Long Duration Storage

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OVERVIEW

GHC[1] is a California educational 501(c)(3) non-profit organization. GHC was formed in 2019 to recognize the game-changing potential of "green hydrogen" to accelerate multi-sector decarbonization and combat climate change. GHC's mission is to facilitate policies and practices that advance green hydrogen production and use in all sectors of the economy to accelerate a carbon-free energy future. Our sponsors include renewable energy users and developers, utilities, and other supporters of a reliable, affordable green hydrogen fuel economy for all.

GHC defines green hydrogen as hydrogen produced from non-fossil fuel resources and has climate integrity – emits zero or de minimis[2] greenhouse gases on a lifecycle basis. Green hydrogen can be used as a fuel for electricity production and a means for long-duration storage (LDS) for multi-day and seasonal needs. In addition, once scaled, green hydrogen can help California move away from fossil fuel use in other applications such as transportation, industrial, maritime, and aviation. Considering that hydrogen is a mainstream commodity that can be utilized in many applications across many sectors of the economy, the production and use of green hydrogen will be essential to decarbonize sectors beyond electricity, further enabling the attainment of our climate goals.

GHC applauds the California Energy Commission (CEC) and the Regents of the University of California, Merced (UC Merced) efforts including hydrogen as an LDS option in its study. This effort will help enable the at-scale production, transport, and storage of green hydrogen to benefit California's power sector and accelerate decarbonization in multiple hard-to-abate

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

[2] "De minimis" means an insignificant amount of non-renewable energy resources (does not exceed 10 percent of the total energy inputs) allowed to be counted as RPS-eligible. See Green, Lynette, Christina Crume. 2017. Renewables Portfolio Standard Eligibility Guidebook, Ninth Edition. California Energy Commission, Publication Number: CEC-300-2016-006-ED9-CMFREV.

sectors. In these comments, GHC provides feedback on the hydrogen portion of UC Merced's draft *Storage Technologies Summary Report*.

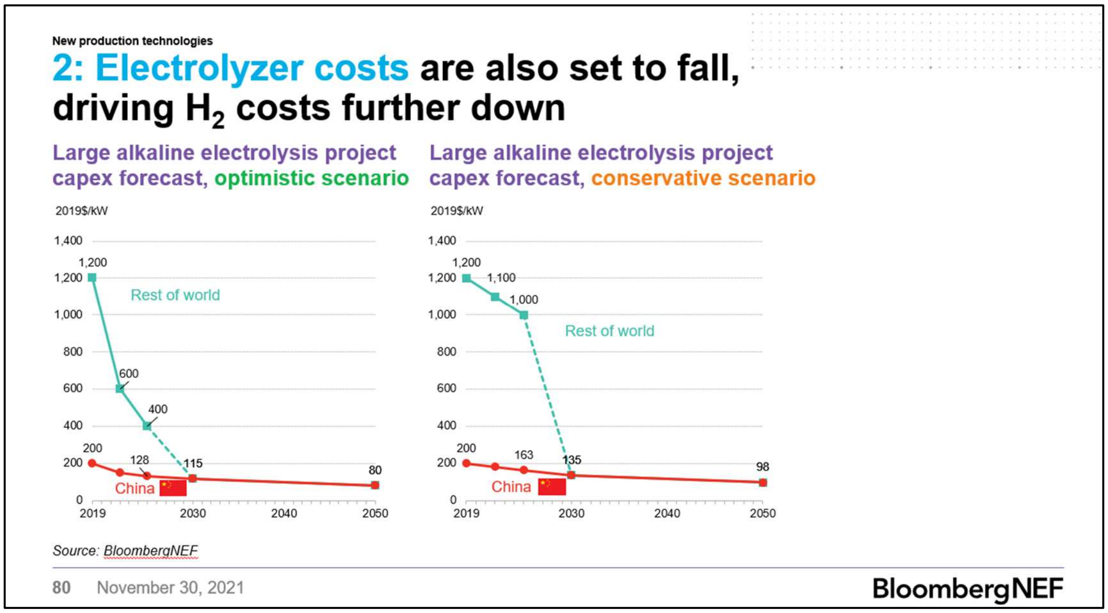
COMMENTS

RESOLVE electrolyzer CapEx costs are too high and should be revised.

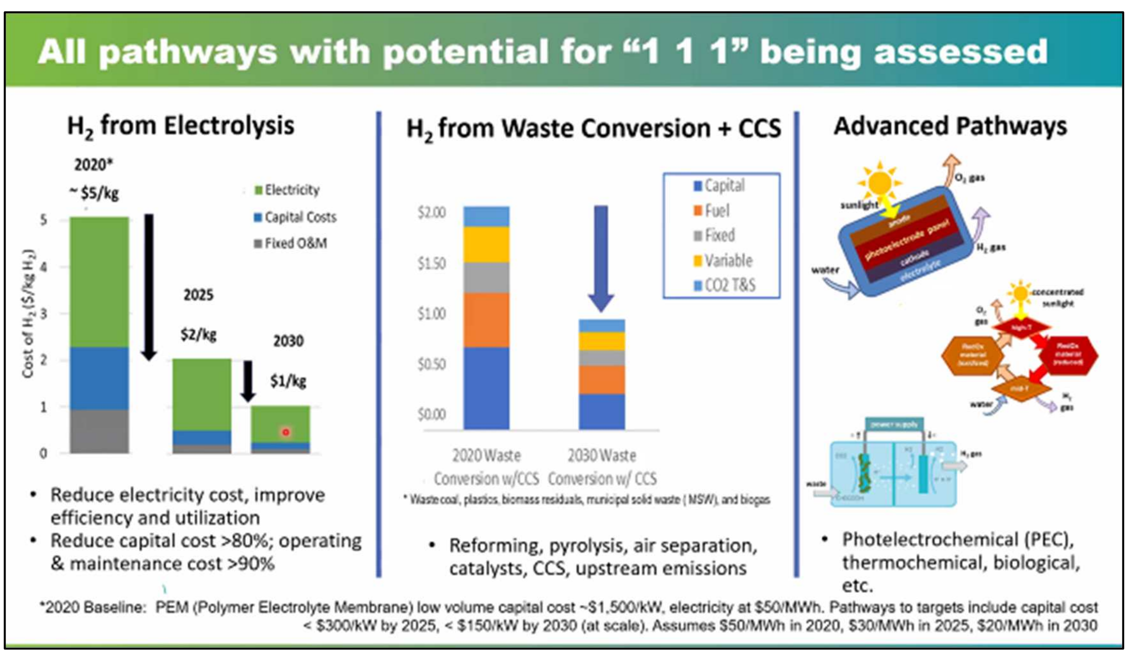
GHC submits that RESOLVE electrolyzer CapEx costs of 900 Euro/kW by 2025 to 430 Euros/kW by 2045 are too high and should be revised. GHC recently analyzed electrolyzer CapEx costs through its HyDeal Los Angeles (HyDeal LA) Phase 1 Initiative.[3] Findings from this analysis showed that electrolyzer CapEx costs are forecasted to be $500/kW by 2025 and $400/kW by 2030. These CapEx cost forecasts were derived from findings from HyDeal Ambition[4] and interviews with HyDeal LA participants who are currently developing electrolyzer projects. Further, these CapEx cost estimates align with recent research from BloombergNEF and the US Department of Energy's (DOE) Hydrogen & Fuel Cell Technologies Office.

During our GHC Fall Event, on November 30, 2021, BloombergNEF presented electrolyzer CapEx forecasts from their recent report titled, *New Energy Outlook 2021*.[5] Their research found that Alkaline electrolyzers are following a similar trajectory to solar and wind power - for every doubling in their cumulative installed capacity, costs have fallen by 18 ± 6%. Further (see below), BloombergNEF presented two scenarios for electrolyzer CapEx forecasts – optimistic and conservative. Under an optimistic scenario, they found that CapEx costs are forecasted to be $400/kW by 2025 and $115/kW by 2030, and under a conservative scenario, they found CapEx costs are forecasted to be $1000/kW by 2025 and $135/kW by 2030.[6]

[3] https://www.ghcoalition.org/hydeal-la
[4] https://www.dh2energy.com/project-hydeal
[5] https://about.bnef.com/new-energy-outlook/
[6] Bravante, Mathew. BloombergNEF Presentation Titled, *Global Hydrogen Update*. November 30, 2021.



Additionally, during the GHC Fall event, Sunita Satyapal, Director of the Hydrogen & Fuel Cell Technologies Office at the DOE, presented a slide (see below) that showed that the DOE is targeting to get PEM electrolyzer CapEx costs to <$300/kW by 2025 and <$150/kW by 2030.[7]



[7] Satyapal, Sunita. DOE Hydrogen & Fuel Cell Technologies Office presentation at the GHC Fall Event. December 1, 2021.

Overall, GHC contends that aligning electrolyzer CapEx costs with recent forecasts will improve the cost-competitiveness of green hydrogen and increase its attractiveness when compared to other storage technologies. For this reason, GHC asks that this study revise its CapEx cost forecasts and consider the most recent forecasts from HyDeal LA, BloombergNEF, and DOE's Hydrogen & Fuel Cell Technologies Office.

RESOLVE should include hydrogen combustion turbines as a candidate resource.

GHC supports some of the modifications E3 has done to the RESOLVE model. GHC is pleased to see E3 has expanded the pool of candidate resources to include hydrogen fuel cells, an essential technology to capture the suite of benefits associated with increased green hydrogen production in California. However, GHC urges E3 to include hydrogen combustion turbines as a candidate resource. GHC notes that this inclusion is fundamental, as it would capture the value of maintaining natural gas infrastructure and some thermal generation assets and repurposing them to use green hydrogen instead.

GHC believes hydrogen combustion turbines at thermal power plants will be essential to provide reliability, resiliency, and resource adequacy in a future decarbonized California to support weather-dependent intermittent renewable resources and fluctuations in demand. Ultimately, the critical value of hydrogen combustion turbines at thermal power plants will be to deliver the capacity backup needed to help ensure reliability during multi-day periods where renewable production is significantly lower than demand. Green hydrogen can serve as LDS and fuel for combustion turbines at thermal power plants to produce local dispatchable, resilient clean electricity. It can also address the opportunity to repurpose existing gas infrastructure while maintaining reliability.

For these reasons, GHC believes E3 should include a hydrogen combustion turbine option in the RESOLVE model. The E3 team could value hydrogen combustion turbines by including the improvement costs needed for existing gas generators and modeling expected hydrogen costs as a function of the revised electrolyzer CapEx costs and expected $/kg price, as proposed in the study.[8]

This study should include an analysis of green hydrogen LDS for power sector applications.

Hydrogen is a flexible energy carrier that can be produced from various types of energy sources and offers many opportunities for long-term energy storage. Hydrogen can be compressed, liquefied, or stored in a solid or liquid form for use in fuel cells or combustion turbines. However, these storage options depend on the demands of their target sector.

[8] UC Merced's draft *Storage Technologies Summary Report* proposes that the hydrogen price is adjusted to meet the U.S. Department of Energy's goal to reduce to $1/kg.

Understanding and analyzing each sector's hydrogen storage needs will be vital in enabling technology to advance hydrogen.

One critical analysis this study should prioritize is hydrogen LDS in power sector applications. Specifically, this study should take a deep dive into green hydrogen for LDS and as a fuel for combustion turbines at thermal powerplants using container storage in gaseous form, as this will be the most common hydrogen storage application in the absence of pipeline infrastructure. This study should examine the cost and efficiency of container storage in gaseous form, how much hydrogen storage is needed for the desired discharge duration (e.g., hourly, daily, weekly, monthly), and how repurposing existing combustion turbines at thermal powerplants can support long-duration energy needs. This modeling approach should reference the *Los Angeles 100% Renewable Energy Study* by LADWP and NREL ("LA100"), where they examine repurposing existing power plants with green hydrogen for critical backup to maintain reliability in the power sector.[9] By conducting such an analysis, this study could provide a basis for adequately assessing hydrogen LDS power sector opportunities and a solution to reduce natural gas use by repurposing existing infrastructure with green hydrogen to serve as critical backup power.

Overall, GHC believes green hydrogen LDS for power sector applications will be essential for firm dispatchable generation to ensure the grid can ride through periods of low renewable generation, contingencies, and outlier load conditions. Understanding and adequately modeling this application is critical to ensure this opportunity is not overlooked. For this reason, GHC encourages the CEC and UC Merced to include this analysis in their study.

<u>This study lacks detail regarding its approach for modeling cross-sector hydrogen storage.</u>

GHC commends the CEC and UC Merced for modeling hydrogen as a cross-sector resource. This approach will show how green hydrogen can be used as a firm, clean resource for the power sector and how it can help California move away from fossil fuel use in other transportation, industrial, maritime, and aviation applications. While GHC supports this approach, the specifics in the draft study are not detailed enough to provide feedback or recommendations. GHC would like to understand how this approach will be modeled. For this reason, GHC asks that the CEC and UC Merced hold another workshop or provide additional details outlining the specific approach for modeling cross-sector hydrogen.

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[9] Cochran et al., "LA100: The Los Angeles 100% Renewable Energy Study," National Renewable Energy Laboratory, NREL/TP-6A20-79444, Executive Summary, p. 14, available at: https://maps.nrel.gov/la100/report.

CONCLUSION

GHC appreciates the opportunity to provide these comments and looks forward to collaborating with the CEC and UC Merced, and other stakeholders on this study.

Sincerely,

Nicholas Connell
Policy Director

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