DOCKETED	
Docket Number:	19-SB-100
Project Title:	SB 100 Joint Agency Report: Charting a path to a 100% Clean Energy Future
TN #:	232426
Document Title:	Janice Lin Comments - GHC comments in SB 100 Modeling and Assumptions
Description:	N/A
Filer:	System
Organization:	Janice Lin
Submitter Role:	Intervenor
Submission Date:	3/15/2020 5:12:52 PM
Docketed Date:	3/16/2020

Comment Received From: Janice Lin
Submitted On: 3/15/2020
Docket Number: 19-SB-100

GHC comments in SB 100 Modeling and Assumptions

Re sending GHC comments in searchable MS word format. Thank you for confirming receipt

Additional submitted attachment is included below.

March 9, 2020

Email to: docket@energy.ca.gov
Docket Number: 19-SB-100
Subject: GHC's SB 100 Inputs and Assumptions Workshop Comments

Re: Comments of the Green Hydrogen Coalition (GHC) following the February 24, 2020 Senate Bill 100 Inputs and Assumptions Workshop

---

The Green Hydrogen Coalition (GHC) appreciates the opportunity to provide feedback on the Inputs and Assumptions Workshop, conducted with the scope of the Senate Bill (SB) 100 Joint Agency Report. GHC seeks to offer insights on the benefits and opportunities green hydrogen represents for California's state-wide decarbonization efforts.

GHC is a California non-profit that is a fiscally sponsored project of Community Initiatives, a 501(c)(3) tax exempt educational non-profit. GHC seeks to facilitate policies and practices to advance the production and use of green hydrogen in all sectors to accelerate a carbon free energy future. GHC defines green hydrogen as hydrogen made from eligible renewables and/or carbon free energy sources, such as large hydro or curtailed renewables. GHC believes that the prioritization of green hydrogen project deployment at scale is fundamental in order to reduce cost; which, in turn, will enable green hydrogen to accelerate decarbonization beyond the power sector. Large scale green hydrogen production and use opportunities exist today … for example, in the use of renewable electricity to make hydrogen via electrolysis and then to use the resulting hydrogen in an existing thermal electricity generation plant to produce dispatchable, carbon free reliable power.

In these comments, GHC urges the Joint Agencies to acknowledge the transformative capacity of green hydrogen for the achievement of SB 100 goals. GHC considers that the Joint Agencies ought to think expansively regarding the role green hydrogen could play in the State's power, transportation, agricultural and industrial sectors. As the subsequent sections describe in further detail, GHC recommends the Joint Agencies consider the following recommendations:

- The Joint Agencies should establish a Green Hydrogen Taskforce within the scope of the SB 100 Joint Agency Report in order to develop a statewide plan to evaluate and accelerate a roadmap for achieving the multi-sectoral economic and emissions benefits of deploying green hydrogen solutions at scale.

- The Joint Agencies and Energy + Environmental Economics (E3) should modify RESOLVE to consider all green hydrogen production methods and their potential applications within the electric sector. The Joint Agencies, via a Green Hydrogen Task Force, should also identify and consider other analytical tools capable of modeling the multi sectoral benefits of deploying green hydrogen at scale for California.

- The Joint Agencies must consider green hydrogen production and utilization as a no-regrets investment that is commercially proven and able to provide flexibility and reliability in a cost-effective fashion … because it can be used decarbonize, repurpose and re-use existing infrastructure and human assets.

Despite its cross-sectoral benefits, California is behind on green hydrogen planning

With SB 100, California faces the colossal challenge of supplying all kilowatt-hours (kWh) sold at retail using zero-carbon resources by December 31st, 2045. Such an ambitious goal, however, presents a series of opportunities for the State to leverage existing supply chains and deepen the decarbonization of other sectors tangential to the electric grid.

Globally, hydrogen is a widely used commodity with over 100M metric tons sold per year for various applications including oil refining, manufacturing ammonia and other industrial processes. Over 99% of the hydrogen produced and used in the world today is produced using from fossil fuels, such as coal, oil and natural gas.[1] Meanwhile, California's decarbonization targets have resulted in an unprecedented levels of very low-cost renewable electricity availability and curtailment. Given the current and future abundance of solar PV and wind generation, the production of hydrogen via electrolysis is on track to be more cost-effective than hydrogen production using fossil fuels and carbon capture and sequestration (CCS), and in some markets, even lower cost than hydrogen produced by natural gas.[2] Green hydrogen is identical to hydrogen produced by fossil fuels. The decarbonization of hydrogen as a globally traded commodity is advantageous not only for the power sector, but also for the transportation, industrial, chemical, and agricultural sectors. Processes such as refining, steel manufacturing, production of fertilizer and even heavy freight could be decarbonized with the widespread availability of green hydrogen. Thus, GHC encourages the Joint Agencies to view the SB 100 process as an opportunity to craft a statewide action plan that recognizes the unique value of this resource and evaluates proper pathways for its deployment and utilization.

Due to its cross-sectoral benefits, many jurisdictions around the world have developed their own green hydrogen roadmaps. For example, the European Union (EU), aware of its climate commitments and its substantial winter-peaking needs, has created Hydrogen

[1] See International Energy Agency (IEA), *The Future of Hydrogen: Seizing Today's Opportunities*.
[2] See International Renewable Energy Agency (IRENA), *Hydrogen: A Renewable Energy Perspective*, 2019.

Roadmap Europe; an effort that seeks to harness the benefits of green hydrogen in the transportation, heating, industrial, and power sectors.[3] Across the world, Australia, cognizant of their solar irradiance abundance, has also developed a National Hydrogen Roadmap; which notes that the technologies associated with green hydrogen production have reached maturity thus making green hydrogen an excellent economic development opportunity as a national export product.[4]

California, on the other hand, despite its globally recognized leadership in environmental matters, has yet to come up with a cohesive strategy that would allow her to leverage green hydrogen in an effective manner. Thus, GHC urges the Joint Agencies to harness this opportunity and establish a Green Hydrogen Taskforce within the scope of the SB 100 Joint Agency Report in order to elaborate a statewide plan to effectively accelerate the deployment of these mature technologies. GHC, in line with IRENA and CSIRO, considers that market activation is fundamental to ensure a responsible and affordable transition to the use of green hydrogen in a number of sectors, including electricity. Thus, GHC is willing to provide its services as a facilitator of the proposed Taskforce, in order to ensure the State has a cohesive, expansive plan to utilize this resource for the benefit of all Californians.

The creation of a Green Hydrogen Taskforce could also bring regional benefits via properly planned investments such as the Intermountain Power Project (IPP), an ongoing effort to convert a coal plant in Delta Utah to a combined cycle gas turbine ultimately capable of combusting 100% green hydrogen. The green hydrogen would be stored underground in a nearby, purpose-built salt cavern, similar to the salt caverns used to store compressed hydrogen in Texas today. The salt cavern near IPP is the largest salt dome formation in the Western United States and has the potential to serve as the world's first large-scale regional renewable reliability reserve, similar to how the United States has historically kept barrels of oil for strategic energy resiliency reasons. The conversion of IPP is a globally significant project that is currently being carried out by the Los Angeles Department of Water and Power (LADWP) and Utah's Intermountain Power Agency (IPA). Learning from such experiences and planning ahead with the cooperation of other Western regional stakeholders could accelerate decarbonization at far larger scale, and lower marginal cost to each participant, an outcome completely in line with SB 100.

RESOLVE must be able to consider all green hydrogen production methods, as well as their potential applications for the electric sector

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,

[3] See Fuel Cells and Hydrogen Joint Undertaking (FCH JU), *Hydrogen Roadmap Europe*, 2019, available at https://www.fch.europa.eu/news/hydrogen-roadmap-europe-sustainable-pathway-european-energy-transition

[4] See Commonwealth Scientific and Industrial Research Organisation (CSIRO), *National Hydrogen Roadmap*, 2018, available at https://www.csiro.au/en/Do-business/Futures/Reports/Hydrogen-Roadmap

an essential technology to capture the suite of benefits associated with increased green hydrogen production in the State, particularly for distributed electricity generation applications such as carbon free resilient microgrids. Similarly, GHC supports the suggestion shared during the workshop regarding the modeling of hydrogen as a drop-in fuel. 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 this could be done by including the improvement costs for existing gas generators, and modeling expected hydrogen costs as a function of both electrolyzer costs and expected energy prices. As a stored fuel, green hydrogen would not only provide greater energy resilience by diversifying our fuel supply with domestically produced zero carbon fuels, but it would also serve as an effective multi day and seasonal zero carbon bulk energy storage solution. Various means and costs for storing hydrogen and green hydrogen are well known – the lowest cost per unit is via underground salt cavern.

GHC believes the modeling of these alternatives is valuable; nevertheless, we are still concerned with the focused approach of the Joint Agencies and E3. GHC urges the Joint Agencies to consider other methods of hydrogen creation, such as from biomass and biogas. This method of producing green hydrogen also serves the public by re-using waste. Encouraging diversity and competition across all pathways to produce green hydrogen at scale would encourage innovation and accelerate cost reduction which in turn would result in faster decarbonization of multiple sectors – including those that are less likely to benefit from electrification; such as manufacturing processes, aviation, fertilizer and long-haul freight. Thus, RESOLVE, PATHWAYS, and any other analytical tool used for SB 100 purposes should be able to consider all hydrogen production methods, and their potential applications. GHC is aware RESOLVE is not set up to capture GHG constraints in sectors other than the power sector; thus, GHC encourages the Joint Agencies, through their Green Hydrogen Taskforce, to qualitatively evaluate the benefits of cross sectoral decarbonization via green hydrogen in a dedicated chapter within the Joint Agency Report and to evaluate alternative tools that would enable modeling of cross sector GHG and cost/benefits impacts.

Finally, GHC would like to urge the Joint Agencies and E3 to reconsider the impacts of the modeling limitations inherent to RESOLVE's design when it comes to its perceived need for long-duration storage resources. It is GHC's understanding that RESOLVE's optimization process represents each year using a set of 37 non-consecutive representative days. Given the expected reliance on variable energy resources such as solar PV generation,[5] GHC considers the modification of the optimization horizon to be urgent; since the current method completely overlooks grid needs related to consecutive periods of low solar irradiance, and the expected seasonal abundance or shortage of renewable energy depending on the time of year.

[5] The most recent IRP Proposed Decision notes the selection of over 11 GW of solar PV capacity by 2030.

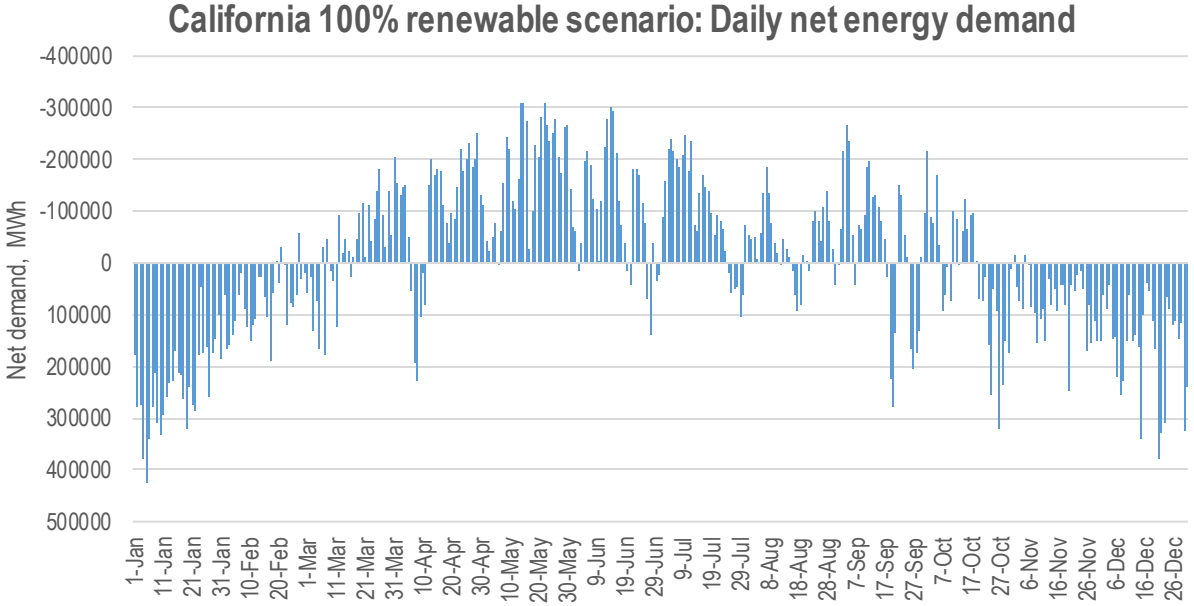
Green hydrogen is a commercially viable, low-risk investment that can ensure affordability, flexibility, and reliability

GHC urges the Joint Agencies to recognize the unique value proposition of green hydrogen to meet the States flexibility and reliability needs in a cost-effective fashion. Today, there are no other commercially available solutions for multi day and seasonal renewable energy storage. During the latter part of the Workshop, the California Independent System Operator (CAISO) pointed out that by 2030 its footprint could require up to 25 GW of flexible capacity to meet the daily evening ramp.[6] CASIO noted that battery storage systems are well positioned to meet this need; however, they expressed concern regarding their ability to maintain charge over long periods of low energy availability (i.e. low solar irradiance over a multi-day period). GHC is sympathetic to this concern. As the figure below shows, it is highly likely that a system fully operated with 100% renewable energy will suffer from many multi day and seasonal periods of supply-demand mismatch; that is, lapses when the available energy is different from the load[7]. GHC notes that, while available storage technologies will be able to cover several grid needs, few are able to perform bulk arbitrage of electricity for weeks or even months at a time. In this sense, green hydrogen is a commercially available long-hold, energy storage technology that can complement the others. Green hydrogen can be used to both store energy for a long period of time and then be later utilized, in a fuel cell or via combustion in a preexisting thermal plant, to generate zero-carbon electricity. GHC would like to note that most combustion turbines in operation today can combust a blend of natural gas and hydrogen. At least one manufacturer, Mitsubishi Hitachi Power Systems, has announced that it is converting a 440MW natural-gas-fired gas turbine in the Netherlands to combust 100% hydrogen by 2025.[8]

[6] CAISO presentation, at 5.

[7] Source: CAISO OASIS data, Strategen Analysis (2016 CAISO OASIS data modified to show net daily load such that 100% load is supplied by 100% renewable energy)

[8] https://www.mhps.com/special/hydrogen/article_2/index.html



In their presentation, the Balancing Authority of Northern California (BANC) noted that the deployment of bulk storage technologies, while necessary, may require a colossal research and development (R&D) effort. [9] GHC disagrees with this argument since most of the technologies associated with the production and utilization of green hydrogen are mature, commercially available, and proven in markets such as Australia, Denmark, Germany, Canada, Japan, South Korea and, the Western United States. Hence, GHC encourages the Joint Agencies to disregard BANCs comment and instead consider the many announced large-scale green hydrogen projects that are already being built around the world today.

Finally, GHC would like to remind the Joint Agencies of the economic case for green hydrogen. Green hydrogen within the power sector represents an opportunity to leverage existing infrastructure in creative and profound ways. For example, green hydrogen will enable renewable energy that would otherwise be curtailed to find other uses that could decarbonize many other sectors beyond the power sector, such as the industrial and transportation sectors. In short, green hydrogen represents a pathway forward allowing low cost wind and solar to electrify and decarbonize even more energy uses beyond the power sector, including very hard to abate sectors such as heavy-duty transport, shipping and even aviation. Green hydrogen can also help leverage existing thermal generation infrastructure, and even ultimately help to decarbonize the existing gas pipeline, either through direct injection or via methanation of green hydrogen into a synthetic carbon neutral natural gas. Green hydrogen is so flexible, it has been called a 'vector resource' that can leverage not only power sector infrastructure, but also natural gas sector and transportation fuels sector

[9] BANC presentation at 7.

infrastructure. With green hydrogen, the State can now contemplate investment tradeoffs across sectors to optimize benefits for consumers at lowest total cost.

Transitioning to a green hydrogen-fueled future will enable the State to comply with its renewable and carbon reduction targets and maintain reliability, even across seasons. Most importantly, because of its ability to repurpose existing infrastructure, green hydrogen will enable a pathway forward to also transition the existing workforce, another very key California asset. By leveraging energy that would otherwise be curtailed, infrastructure that would otherwise be abandoned, and expertise that would otherwise be wasted, green hydrogen provides a framework for maximum resource utilization. Investing in this resource and its future is a no-regrets decision; it is a commitment to maintain a reliable, clean, and affordable system for all Californians.

Conclusion

In conclusion, GHC is supportive of the Joint Agencies and their work in the Joint Agency Report. GHC believes that further consideration of the cross-sectoral benefits of green hydrogen is warranted, as it could help regulators identify innovative paths that could lead to deeper and faster decarbonization in California and the rest of the Western grid. GHC encourages the CEC, CPUC, and CARB to recognize that green hydrogen is not an emerging technology but a mature solution that can enable the decarbonization of numerous sectors and processes…at scale. GHC urges the Joint Agencies to note that any selection of an optimal plan must take into account the benefits just as much as the costs; thus, GHC offers its expertise and vision to ensure the State can take the most advantage of this historic opportunity.

GHC appreciates the opportunity to provide these comments and feedback, and looks forward to collaborating with the CEC, CPUC, CARB, and other stakeholders in this proceeding.

Sincerely,

Janice Lin
Founder and President
GREEN HYDROGEN COALITION
jlin@ghcoalition.org
415-595-8301