BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to Develop an Electricity Integrated Resource Planning Framework and to Coordinate and Refine Long-Term Procurement Planning Requirements.	Rulemaking 16-02-007 (Filed February 21, 2016)

COMMENTS OF CALIFORNIA HYDROGEN BUSINESS COUNCIL ON ASSIGNED COMMISSIONER'S RULING ON INPUTS AND ASSUMPTIONS FOR DEVELOPMENT OF THE 2019-2020 REFERENCE SYSTEM PLAN

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Pursuant to the Assigned Commissioner's Ruling dated Nov. 29, 2018, California Hydrogen Business Council (CHBC) respectfully submits its Comments on the proposed ruling.

I. INTRODUCTION

The CHBC[1] appreciates the opportunity to provide comments on the Assigned Commissioner's Ruling on Inputs and Assumptions for Development of the 2019-202 Reference System Plan.

[1] The California Hydrogen Business Council (CHBC) is a California industry trade association, comprised of over 100 companies and agencies involved in the business of hydrogen, with a mission to advance the commercialization of hydrogen in the energy sector, including transportation, goods movement, and stationary power systems to reduce emissions and dependence on oil. The views expressed in these comments are those of the CHBC, and do not necessarily reflect the views of all of the individual CHBC member companies. Members of the CHBC include Air Liquide; Advanced Technologies U.S..; Alameda-Contra Costa Transit District (AC Transit); American Honda Motor Company; Anaerobe Systems; Arriba Energy; Ballard Power Systems, Inc.; Bay Area Air Quality Management District (BAAQMD); Beijing SinoHytec; Black & Veatch; BMW of North America; California Air Resources Board (CARB); California Fuel Cell Partnership (CaFCP); CALSTART; Cambridge LCF Group; Center for Transportation and the Environment (CTE); Chiyoda Corporation; Coalition for Clean Air; Community Environmental Services; CP Industries; DasH2energy; Eco Energy International; EcoNavitas; ElDorado National – California; Energy Independence Now (EIN); EPC - Engineering, Procurement & Construction; Ergostech Renewal Energy Solution; EWII Fuel Cells LLC; FIBA Technologies; First Element Fuel; FuelCell Energy; GenCell; General Motors; Infrastructure Planning; Geoffrey Budd G&SB Consulting; Giner ELX; Gladstein, Neandross & Associates; Greenlight Innovation; GTA; GTM Technologies; H2B2 USA; H2Safe; H2SG Energy Pte; Hexagon Lincoln; Hitachi Zosen Inova ETOGAS; HODPros; Hydrogen Law; Hydrogenics; Hydrogenious Technologies; HydrogenXT; HyET - Hydrogen Efficiency Technologies; Hyundai Motor Company; ITM Power; Ivys; Johnson Matthey Fuel Cells; KORE Infrastructure; Kraft Powercon; Life Cycle Associates; Linde North America; Longitude 122 West; Loop Energy; Millennium Reign Energy; Mitsubishi Hitachi Power Systems Americas; Montreux Energy; Motive Energy; Natural Gas Fueling Solutions (NGFS); Natural Hydrogen Energy; Nel Hydrogen; Neo-H2; Neuman & Esser USA; New Flyer of America; Next Hydrogen; Noyes Law Corporation; Nuvera Fuel Cells; Pacific Gas and Electric Company (PG&E); Pacific Northwest National Laboratory (PNNL);

We strongly believes that hydrogen energy and storage technologies will be essential to ensuring a reliable grid in California and successful integration of renewable and zero carbon electricity, as mandated by SB 100, and will also be critical to meeting the state's ambitious aim to achieve deep greenhouse gas emission reduction and carbon neutrality within the next couple decades. Electrolytic hydrogen solutions are the only flexible, zero carbon pathways to achieve long duration, seasonal storage at mass scale, as well as to addressing other difficult applications such as heavy duty, long haul trucks, shipping, aviation, and decarbonized residential cooking.

We thank the Commission for requesting feedback on the RESOLVE model inputs and assumptions for the 2019-2020 Integrated Resource Plan (IRP) cycle. Our comments are focused on the importance of including hydrogen resources in this process.

II. BACKGROUND

A challenge accompanying the state's progress toward an all RPS eligible other zero carbon electricity mix is the risk of having to curtail renewable generation. Curtailment is already happening in larger volumes than anticipated, with CAISO's 2021 curtailment projections occurring as prematurely as last year. To address this growing challenge and ensure reliable, economical electricity services, California will need to aggressively adopt solutions to integrating the increasingly high amounts of renewable generation. Renewable hydrogen facilities provide a solution by using otherwise curtailed renewable generation to power electrolysis to produce hydrogen. The highest volume option is electrolysis, which uses electricity to power an electrolyzer, a mature technology that splits water into oxygen and hydrogen and has the unique capability of absorbing surplus generation continually and storing the energy at mass scale. Hydrogen can be stored in either designated tanks, caverns, designated pipelines, or in the natural gas system in limited quantities as pure hydrogen or in limitless quantities if the hydrogen is mixed with CO2 (e.g. from biodigesters or the atmosphere). The hydrogen can be used for a wide range of applications, including decarbonized electricity generation via zero emissions fuel cells or gas turbines – Mitsubishi has developed a turbine that can blend 33% hydrogen into natural gas

PDC Machines; Planet Hydrogen; Plug Power; Politecnico di Torino; Port of Long Beach; Powertech Labs; Primidea Building Solutions; Proton OnSite; RG Associates; Rio Hondo College; Rix Industries; Sacramento Municipal Utility District (SMUD); SAFCell; Schatz Energy Research Center (SERC); Sheldon Research and Consulting; Solar Wind Storage; South Coast Air Quality Management District; Southern California Gas Company; Strategic Analysis; Sumitomo Corporation of Americas; Sumitomo Electric; Sunline Transit Agency; T2M Global; Tatsuno North America Inc.; Terrella Energy Systems; The Leighty Foundation; TLM Petro Labor Force; Toyota Motor Sales; Trillium - A Love's Company; University of California, Irvine; US Hybrid; Valley Environmental Associates; Vaughan Pratt; Verde; Vinjamuri Innovations; Winkelmann Flowform Technology; WireTough Cylinders; Yanli Design; Zero Carbon Energy Solutions.

without increasing NOx and is working on a model that can take 100% hydrogen[2] – or transportation fuel, or storage, or decarbonized gas end uses.

California's support of renewable hydrogen market development is also an opportunity for the state to apply its commitment to environmental justice and become a role model for other regions on how to adopt a socio-economically inclusive approach. Hydrogen fuel cell technology, due to its relatively low weight, long range, and quick fueling, is the most promising zero emission solution to fully replace heavy duty diesel vehicles, including buses, trucks, rail and other transport equipment, without the need to change the behavior or impact operations. Heavy duty diesel engines are among the leading causes of pollution in areas that fail to attain air quality standards and where disadvantaged communities are especially vulnerable to negative health impacts.[3] Hydrogen fuel cell technology also allows for silent operation, thereby reducing noise pollution in heavy trafficked areas. Pure hydrogen fuel cell electric vehicles (FCEVs) and plug-in hydrogen FCEVs also enable zero emission vehicle (ZEV) access for inner cities, multifamily, low income dwellings where dedicated parking and charging, and therefore full reliance on battery plug-in technology, is not viable. Hydrogen and fuel cell technologies can additionally replace fossil fuels for local and backup generators, for example at cell towers, where it has been replacing diesel, thus eliminating harmful emissions. They can also replace fossil fuel for port and warehouses equipment, with performance superior to batteries and no emission related health impacts on workers. One example is fuel cell fork lifts, which are becoming the industry standard for warehouses, distribution centers and factories, with better functionality and lower overall costs than batteries.[4] Furthermore, renewable hydrogen is key to replacing fossil fueled electricity generation, which disproportionately impacts underserved communities, with renewables. All these applications have the potential to create many new green jobs in the state.

Notably, hydrogen is already integral to California's clean energy, climate, and pollution reduction policies, both explicitly and implicitly. For example:

- *SB 1369* – Requires the California Public Utility Commission (CPUC), State Air Resources Board (ARB), and the California Energy Commission (CEC) to consider zero carbon hydrogen

[2] https://www.mhps.com/special/hydrogen/article_1/index.html

[3] See diesel to FC truck comparison: https://www.youtube.com/watch?v=Od81_2mglRE

[4] See, e.g. https://www.bloomberg.com/news/articles/2017-07-31/amazon-and-wal-mart-finally-give-hydrogen-power-a-reason-to-be

produced from electrolysis as an eligible form of energy storage and to consider other potential uses for it. Note that zero emissions hydrogen energy solutions come in multiple energy forms (electrical, chemical, thermal) and applications (power, transportation fuel, heat) will play a critical role in California's energy storage roadmap development, energy policy and regulatory frameworks, and should be part of the Integrated Resource Planning modeling development framework.

- *SB 1383* - Requires the Public Utilities Commission, along with other state agencies, "to consider and, as appropriate, adopt policies and incentives to significantly increase the sustainable production and use of renewable gas." The CHBC worked closely with the author of SB 1383 to ensure that the law explicitly does not limit the scope of the agencies' consideration to biomethane and biogas when deciding upon solutions to mitigating short lived climate pollutants, but instead to broaden it to "renewable gas," so that renewable hydrogen is included in all relevant deliberations. The CEC's 2017 IEPR reinforces this broad definition in its interpretation of SB 1383.[5]
- *Executive Order B-48-18* – Calls for 5 million ZEVS, including FCEVs, to be on the state's roads, along with 200 H2 fueling stations by 2030.
- *AB 8* – Called for funding alternative transportation fuels in California, which has lead to investment in hydrogen development and helped make the state the national leader on hydrogen transportation.
- *SB 1505* – Calls for a third of hydrogen used in transportation in California to be derived from renewable resources. Notably, the industry has surpassed this requirement and increasingly is in support of transitioning to 100% renewable hydrogen for transportation.
- *SB 350 and Executive Order B-55-18* - Calls for deep greenhouse gas reductions in California, which will almost surely only be possible with inclusion of renewable hydrogen in the state's energy portfolio. Renewable hydrogen, for one, will be necessary to decarbonize transportation applications that batteries cannot address at scale, such as heavy duty trucks, which are responsible for about 20% of on-road vehicle greenhouse gas emissions.

The hydrogen economy is being developed around the world as a strategy for transitioning from conventional fuels and lowering emissions. In California, thousands of FCEVs are on the road today

[5] See, e.g. pp. 245, 246, 268, 280. Download the 2017 IEPR here: https://www.energy.ca.gov/2017_energypolicy/

and the University of California, Irvine (UCI) campus hosts a demonstration/pilot microgrid using an electrolyzer system[6] to capture otherwise-curtailed solar power and store as hydrogen[7] for future use as part of its microgrid, as a flexible, dispatchable load when needed.

Renewable hydrogen is also a cornerstone of greenhouse gas reduction, renewable electricity integration, and pollution reduction policy elsewhere in the US and around the world. NREL, for example, is engaged on a pilot project to convert renewable electricity into hydrogen and then to convert that into renewable methane.[8] In Canada, the Enbridge 2MW electrolytic hydrogen project acts as a showcase for Enbridge's initiative to integrate grid renewables and to show how the natural gas pipeline system can support the storage of hydrogen produced from excess renewable electricity.[9] In Europe, over 30 power-to-gas (hydrogen or methane) projects that operational or in development.[10] In Australia, is making plans for Australia's first electrolytic hydrogen production facility utilizing excess electricity as the feedstock[11] to be built in Adelaide, South Australia. The hydrogen produced will be injected into the local gas distribution network to provide low-carbon gas to homes and businesses.[12] In Dubai, the Dubai Electricity and Water Authority (DEWA) and Siemens AG signed a memorandum of understanding in 2018 to kick off the region's first electrolytic hydrogen facility. The proposed project is aimed to be at "MW-Scale" and is part of DEWA's plan to convert photovoltaic (PV) electricity into hydrogen as part of a strategy to accelerate renewables integration and deployment in the region.[13]

As California transitions towards SB 100's goal covering 100% of electricity demand with RPS eligible and other zero carbon generation, a balanced energy portfolio of resources, technologies and pathways that provide energy security, services and benefits to the grid should be properly accommodated in the state's regulatory and market frameworks as part of the Integrated Resource Planning Process.

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[6] SoCalGas has provided funding to the UCI electrolytic hydrogen project, in partnership with Proton Onsite and Empowered Energy

[7] Power-to-Gas: Dynamic Operation of Electrolyzer Systems and Integration with Central Plan, National Fuel Cell Research Center, UCI (September 2017)

[8] https://www.nrel.gov/esif/partnerships-southern-california-gas.html

[9] http://www.energymag.ca/markets/power-to-gas-rethinking-energy-storage-options/

[10] http://europeanpowertogas.com/projects-in-europe/

[11] Electrolytic hydrogen technology has the potential to provide a large-scale, cost-effective solution for storing excess energy produced from renewable sources.

[12] https://www.greentechmedia.com/articles/read/australia-looks-to-hydrogen-to-soak-up-excess-renewable-energy-production#gs.sb4MM1M

[13] https://www.businesswire.com/news/home/20180212006494/en/DEWA-Signs-MoU-Expo- 2020-Dubai-Siemens

III. COMMENTS TO QUESTIONS ON ATTACHMENT A

1. **Base case selection.** Please comment on the recommended base case assumptions outlined in Section 1 above. What assumptions would you modify and why?

   No comments on this question at this time.

2. **Baseline resources.** What changes would you make to the assumptions in Section 3 of Attachment A with respect to baseline resources? Explain.

   No comments on this question at this time.

3. For planned resources with Commission- or CCA-board- approved contracts, for which the Commission may need to seek additional information as described in Section 3 of Attachment A, in the base case:
   a) Is the existence of an approved contract a reasonable determinant for inclusion in the baseline? Why or why not?

      No comments on this question at this time.

   b) Is it reasonable to assume a 15 percent failure rate for these approved contracts? If not, what are the sources of uncertainty for these types of resources and how should the Commission plan and account for that uncertainty?

      No comments on this question at this time.

   c) Provide data sources that speak to contract success rates

      No comments on this question at this time.

4. For planned resources without approved contracts in the base case:
   a) What criteria should the Commission use to evaluate whether it is reasonable to assume that a planned resource will be completed?

No comments on this question at this time.

b) Is it reasonable to assume a 50 percent failure rate for these types of resources? If not, what are the sources of uncertainty for these types of resources and how should the Commission plan and account for that uncertainty?

No comments on this question at this time.

c) Provide data sources that speak to contract or project success rates.

5. As described in Section 3.1 of Attachment A, the 2019-2020 IRP version of RESOLVE will be capable of retiring baseline thermal resources economically within the optimization process. Fixed operations and maintenance costs of baseline thermal resources will be added to RESOLVE's optimization logic, such that existing thermal generators may be retired by the model, subject to reliability constraints, if it is cost-effective to do so. Provide suggestions for data sources that could be used for the fixed operations and maintenance costs of baseline/existing thermal resources.

6. **Candidate resources.** Section 4 of Attachment A outlines the proposed candidate resources from which the model can choose for the development of new resources beyond the baseline.
    a) General: Comment on the appropriateness of all of the resource types proposed to be modeled.

    Hydrogen energy storage should be included as a new candidate resource in the future IRP cycles as California's energy sector is already transitioning to a deep decarbonization phase by 2045 with 100% RPS requirements. Comments to question 6b below provide additional details on the type of research entities, topics, and available data inputs and assumptions on hydrogen energy storage.

b) <u>Storage:</u> Does the proposed approach for modeling energy storage in RESOLVE adequately reflect the latest available storage technologies? What energy storage technology types would require significantly different input values? Explain in detail how the inputs would vary.

As CAISO has pointed out with its famous Duck Curve, high variable renewable capacity in California risks over-generation, ramping challenges, curtailment, and slowing achievement of the state RPS. CAISO has stated that 350 out of 365 days of 2016 experienced some level of curtailment in the State. This was overall a tiny fraction of generation, but as California progresses from nearly 30% renewable electricity generation today to 100% renewable and zero carbon generation, there will be far greater risks of curtailment, balancing issues and negative pricing on renewable power, which must be addressed.

Surplus renewable electricity can lead to low and negative pricing, which present a potential opportunity to produce low cost renewable hydrogen that could be used or stored for later use. In other words, electrolytic hydrogen has the potential to turn the problem of over-generation of renewables into opportunities because low cost hydrogen production that allows more renewable electricity to be integrated economically into the grid and creates fuel for zero emissions vehicles and other industry products, as well as jobs and increased economic growth associated with electrolytic hydrogen.

Electrolytic hydrogen is more cost-effective and geographically efficient than Li-ion batteries at high capacity. Electrolyzers have continuous capacity in less space than Li-ion batteries. This is particularly important when there is a need to absorb continuous power generation or to provide time shifting of load over long periods. For example, a 1.2 MW Li-ion battery installation in Quebec uses a 53 ft. container and has a storage limit of only 1.2 MWh at a time. By comparison, a 1.5 MW capacity electrolyzer project in Hamburg uses a 40 ft. container and can store up to 36 MWh /day, as long as it is connected to the gas grid, and electricity generation to power the electrolyzer is continuous. At discharge durations of more than five hours, if hydrogen can be stored in the gas system, electrolyzers are also more economical than batteries.

Compared to pumped hydro and compressed air, electrolytic hydrogen carries the benefit of being more geographically flexible and therefore more scalable.

Numerous research experts point to the importance of hydrogen as a storage and renewable integration pathway:

- E3 in its presentation *Deep Decarbonization in a High Renewables Future - Implications for Renewable Integration and Electric System Flexibility* acknowledged that hydrogen production is among the key flexible load resources that can "absorb surplus renewable generation, and avoid costly need for additional storage and renewable overbuild."[14]
- NREL states: "Initial cost analysis indicates that hydrogen systems could be competitive with battery systems for energy storage and could be a viable alternative to pumped storage hydro and CAES at locations where these latter two technologies are not favorable." http://www.nrel.gov/docs/fy16osti/64764.pdf
- According to a recent report from the European Association for Energy Storage, P2G "is the only energy storage option available to store large amounts of energy seasonally and provide it on-demand to different sectors and applications."[15]
- According to the German Federal Environment Agency, electrolytic hydrogen and its derivatives are "needed to ensure a completely renewable energy supply for transport. In particular, (electrolytic hydrogen pathways to creating liquid fuel) can provide the liquid renewable fuels needed in aviation. (They) can also provide a renewable, GHG-neutral energy supply for shipping and long-distance road freight transport."[16]

CHBC requests that the Commission engage the RESOLVE model developer (E3)[17] to collaborate with independent research entities and review existing studies (listed below) to develop suitable input assumptions, costs and performance metrics of hydrogen production and storage for the next phase of the IRP cycle. The most notable research entities to address data inputs and assumptions for hydrogen include:

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[14] https://www.energy.ca.gov/2018_energypolicy/documents/2018-06-20_workshop/2018-06-20_presentations.php

[15] http://ease-storage.eu/wp-content/uploads/2017/05/2017.05.15_EASE-Recommendations-PtG-PtL_final.pdf

[16] https://www.umweltbundesamt.de/sites/default/files/medien/377/publikationen/uba_position_powertoliquid_engl.pdf

[17] https://www.ethree.com/tools/

- Advanced Power and Energy Program (APEP) at University of California – Irvine focusing on the development and deployment of efficient, environmentally sensitive, sustainable power generation and energy conversion technologies including hydrogen and fuel cells.[18] APEP has been awarded a CEC grant "*to develop a deployment roadmap for renewable hydrogen production in California through 2050. The effort will initially focus on extracting insights from the first set of renewable hydrogen production facilities under development in California, and developing a roadmap for the build-out necessary to serve the growing demand for renewable hydrogen to serve transportation, power generation, and other applications. The roadmap will provide significant detail through 2025 and a higher-level outlook in five-year increments through 2050*".[19] The deployment roadmap is evaluating techno-economics for hydrogen production including cost reduction potentials over the 2050 planning horizon. The final report is expected in early-mid 2019.

  APEP is also developing a modeling tool, H2GRID, to analyze the impact and benefits of deploying electrolytic hydrogen across the CAISO grid. NREL and the Electric Power Research Institute (EPRI) are conducting a study titled "Valuation of Hydrogen the Electric Grid" under the Department of Energy's (DOE) H2@Scale program.

- H2@Scale (NREL) explores wide-scale hydrogen production and utilization at a wide scale in the United States to support resiliency of the power generation and transmission sectors [20]. The Hydrogen Analysis (H2A) production models developed "*provide transparent reporting of process design assumptions and a consistent cost analysis methodology for the production of hydrogen, at central and distributed facilities"*. The models include *"capital and operating costs for the hydrogen production process, fuel type and use, and financial parameters such as the type of financing, plant life, and desired internal rate of return"*[21]

[18] http://www.apep.uci.edu/

[19] http://www.apep.uci.edu/NewsAndEvents/APEP_Receives_CEC_Grant_For_California_Renewable_Hydrogen_Deployment_Roadmap_090518.aspx

[20] https://www.energy.gov/eere/fuelcells/h2-scale

[21] https://www.hydrogen.energy.gov/h2a_production.html

Notable studies providing cost and technical assessments for hydrogen production include:

- **National Hydrogen Roadmap: Pathways to an economically sustainable hydrogen industry in Australia, CSIRO, 2018.**
  https://www.csiro.au/en/Do-business/Futures/Reports/Hydrogen-Roadmap
  Description: The National Hydrogen Roadmap provides a blueprint for the development of a hydrogen industry in Australia. The report provides detailed cost-economics including levelized cost of hydrogen and cost reduction potentials for hydrogen production and storage.
- **World Energy Council – E Storage Report, 2016.**
  https://www.worldenergy.org/wp-content/uploads/2017/03/WEResources_E-storage_2016.pdf
  Description: A report from the World Energy Council evaluates the levelized cost of energy storage including power to hydrogen over the 2030 planning horizon with a comparative outlook across other storage resources.
- **Study on Early Business Cases for H2 in Energy Storage and More Broadly Power to H2 Applications, Fuel Cell and Hydrogen Joint Undertaking, June 2017.**
  http://www.fch.europa.eu/publications/study-early-business-cases-h2-energy-storage-and-more-broadly-power-h2-applications

  Description: Report identifies early business cases for hydrogen in energy storage and to assess their potential replicability within the EU until 2025. The report provides techno-economic and performance data of hydrogen energy storage technologies.
- **The Potential of Power-to-Gas, Enea Consulting, January 2016**
  http://www.enea-consulting.com/wp-content/uploads/2016/01/ENEA-Consulting-The-potential-of-power-to-gas.pdf

  Description: This study evaluates the economic potential of power-to-hydrogen and other power-to-X applications with a techno-economic modelling of six case studies targeting energy markets across multiple time horizons (2030 and 2050).

c) Offshore Wind: Public data about offshore wind cost and potential in California may be limited and/or outdated. Comment on what data is currently available regarding offshore wind development in California and its possible limitations. If you are aware of new data expected to become available in the next year or two, for example through the work of the California Intergovernmental Offshore Renewable Energy Task Force, provide specific reference to that information.

No comments on this question at this time.

7. Should large periodic maintenance costs to utility-scale generators be included in IRP modeling? If so, what data sources should be used to estimate these costs? Please refer to Section 3.1.1 of Attachment A for more discussion of this issue.

The Commission should not ignore substantial periodic maintenance costs to both utility-scale generators and energy storage resources, which can result from the fact that certain resources at grid scale have limited discharge cycles before capacity degradation lessens usable capacity over a short period. We therefore recommend as part of the IRP pro-forma evaluations that the CPUC include a large periodic maintenance stress test across all resources in the RESOLVE model and evaluation of potential life-cycle cost increases of the resources.

8. IRP modeling in 2017 optimized investment and system dispatch for four representative years: 2018, 2022, 2026, and 2030. The number of representative years represents a balance between precision and model runtime. In modeling for the 2019-20 IRP cycle RSP, Commission staff again proposes to limit the simulation to four years, replacing the 2018 Year with 2020, but continuing to include Years 2022, 2026, and 2030. Then, in the next IRP cycle, study years would become 2022, 2026, 2030, and 2034, with the subsequent cycle addressing Years 2024, 2026, 2030, and 2034 (and so on). This allows for continuity and comparison of assumptions and results across IRP cycles, while continuing to focus between 10 and 12 years in the future. Do you support this approach or recommend a different distribution of study years (i.e., updating the

study years with each IRP cycle)? Explain your answer.

No comments on this question at this time.

9. In order to analyze the Senate Bill (SB) 100 goal of 100 percent of retail electricity sales being supplied by zero-carbon resources by 2045, Commission staff are also considering using RESOLVE to run a limited number of scenarios on years beyond 2030. Considering the significant amount of modeling and run-time cost of each additional planning year, as well as potentially limited availability of data for years beyond 2030, what year(s) should be studied (e.g., 2035, 2040, 2045) and why?

We suggest the Commission extend the RESOLVE model to comply with SB 100 goals and timelines (i.e. 44% RPS by 2024, 52% RPS by 2027, 60% RPS by 2030 and 100% RPS/Zero Carbon by 2045)[22]. As renewable and other variable zero carbon generation reaches higher concentrations on the grid, better understanding of how to manage the constraints and opportunities is needed. This should be a coordinated, multi-agency effort to maximize efficient, well informed and effective planning. Voluntary procurement of in-front-of-the-meter renewables beyond statutorily-required levels could impact the development of new renewable energy facilities. For example, many LSEs have programs that allow customers to choose a higher portion of renewables in their electricity supply than required by the RPS, which could result in a need to build additional new renewable energy facilities. Should RESOLVE include projections of voluntary planned procurement (but not yet contracted) when developing future resource portfolios? If so, what are publicly available sources of information that could be used to forecast the volume of such procurement?

No comments on this question at this time.

10. How should the utilization of the LSEs' current and forecasted REC banks be represented in RESOLVE? Which of the modeling options described in Section 8.3.2 of Attachment A are most appropriate for the base case? What additional options should be considered?

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[22] https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB100

No comments on this question at this time.

11. Provide any additional comments on the appropriateness of the draft inputs and assumptions proposed for the 2019 RESOLVE model runs for IRP purposes. What changes would you make and why? Please include references to the appropriate section number of Attachment A.

    Section 3.4.1: Pumped Storage (Attachment A of the ruling) states that the "*capability to store energy beyond one day is not captured in the RESOLVE model*" due to RESOLVE's 24-hour dispatch window. We would like the Commission to encourage expanding the capability beyond one day to days and months, in view of the need for seasonal storage options in an increasingly and all renewable/zero carbon electricity system. As mentioned, hydrogen produced from excess renewables can be stored in large quantities and can play a significant role in providing long-term energy storage options.

    Section 3.4.2 Baseline Battery Storage (Attachment A of the ruling) states that the baseline storage resources are assumed to have an average duration of four hours (discharge duration). We ask for clarification on the definition of long term versus short term baseline energy storage resources in the RESOLVE model and that it be included among the assumptions that storage resources providing discharge duration of 4 hours or less be considered as short-term storage. Storage durations of greater than 4 hours to days/months should be assumed as longer-term storage. The RESOLVE model ought to consider including a floor and ceiling for long duration discharge cycles.

IV. COMMENTS TO QUESTIONS ON ATTACHMENT B

1. Are there any emissions factors that should be used instead of those listed in Tables 1 and 2, or sources already cited in party comments referenced, in Attachment B? Please provide the specific factor, category of unit to which it applies, data source, and reason why it should be used.

    No comments on this question at this time.

2. Comment on the suggested steady-state emissions factors for biomass and diesel units in Table 3 of Attachment B. Propose factors for cold, warm, and hot starts, as well as sources for suggested values.

   No comments on this question at this time.

3. Suggest emissions factors for geothermal facilities and provide sources for suggested values.

   No comments on this question at this time.

4. Should out-of-state emission be accounted for as part of criteria pollutant emissions? Why? If so, how?

   No comments on this question at this time.

5. Suggest any methodologies to assist with understanding the impacts of system-level emission on the ambient air quality of local communities.

   No comments on this question at this time.

6. Provide any other comments or suggestions on issues raised in Attachment B.

   No additional comments at this time.

V. CONCLUSION

CHBC appreciates the Commission's consideration of these comments and looks forward to continuing to work with the Commission and other stakeholders to promote a broad range of zero carbon and renewable electricity storage options in California's resource planning efforts.

Respectfully submitted,

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January 4, 2019