CESA
CALIFORNIA ENERGY STORAGE ALLIANCE

December 14, 2021

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

Re: Comments of the California Energy Storage Alliance Regarding the November 17th Staff Workshop on Strategies to Model Long Duration Storage

Dear Sir or Madam:

The California Energy Storage Alliance ("CESA") appreciates the opportunity to comment on the Staff Workshop on Strategies to Model Long Duration Storage ("the Workshop") held on November 17, 2021. CESA recognizes the leadership of the California Energy Commission ("CEC") in assembling a vast group of stakeholders and listening to their concerns and proposals regarding the complexities of integrating long duration energy storage ("LDES") into the models used to plan for the transition to a zero-carbon electric grid by 2045.

CESA is a 501(c)(6) organization representing over 100 member companies across the energy storage industry. CESA is involved in a number of proceedings and initiatives in which energy storage is positioned to support a more reliable, cleaner, and more efficient electric grid. Moreover, CESA has actively engaged in first-in-class modeling studies to better understand the need and opportunity for energy storage, particularly for LDES resources, given Senate Bill ("SB") 100 targets. As such, our background and experience providing technical and policy insights are of particular relevance to this subject.

I. INTRODUCTION & SUMMARY.

CESA appreciates the CEC hosting this workshop and moving forward the conversation of increasingly considering non-conventional and emerging technologies in the state's planning processes. In 2020, CESA commissioned Strategen Consulting to conduct analysis on the future need for LDES given California's ambitious climate goals and resource mix. This study, *Long Duration Energy Storage for California's Clean, Reliable Grid* (2020), leveraged first-class capacity expansion modeling capable of identifying the value of inter-day energy shifting through an 8,760-hour optimization and concluded that California will need between 45 and 55 GW of LDES by 2045 to achieve its decarbonization goals while retaining reliability.[1] In this study,

[1] *See* Strategen Consulting, *Long Duration Energy Storage for California's Clean, Reliable Grid,* 2020. Available at: https://static1.squarespace.com/static/5b96538250a54f9cd7751faa/t/5fcf9815caa95a391e73d053/1607440419530/LDES_CA_12.08.2020.pdf

CESA was able to integrate several modeling architecture elements and candidate resources that are not currently considered in California's planning venues. The results of this study demonstrate that consideration of emerging technologies, increased inter-temporal arbitrage opportunities, and extreme weather events have a substantial effect on incremental capacity buildout decisions. To this end, CESA finds this effort by the CEC to be extremely valuable to inform planning processes across the state, including but not limited to the Integrated Resource Planning ("IRP") proceeding and the SB 100 implementation process. Our comments are focused on the following areas:

- **The University of North Carolina, Chapel Hill's ("UNCCH") exploration of LDES technologies should be considered when creating new candidate resources for RESOLVE:** The findings regarding the types of LDES available and the key drivers behind specific business models (*e.g.*, land footprint, idle losses, and average capital costs) should be utilized by Energy + Environmental Economics ("E3") in order to develop new, technology-neutral, candidate resources for the RESOLVE model. These updates should be incorporated as soon as possible to the planning venues where RESOLVE is used, such as the California Public Utilities Commission's ("CPUC") IRP proceeding and the Joint Agencies' SB 100 reports.

- **Including geographic specificity for renewable generation candidate resources should be considered for the next round of RESOLVE updates:** The results presented during the workshop confirm that the generation mix, particularly the variable energy resource ("VER") mix, has a significant impact on the amount and type of storage required on a systemwide basis. Given the role of the IRP proceeding in the procurement of new assets, CESA echoes the researchers' recommendation of including geographic specificity for VERs in order to ensure the market is incented to procure the resources that best contribute to reliability.

- **The iterative process proposed by the University of California ("UC") Merced can provide significant insight regarding the cost targets for emerging storage technologies:** CESA supports UC Merced's proposed approach to better understand the cost targets storage resources with different characteristics must achieve in order to successfully enter the market. This technology-neutral approach is consistent with what CESA has advocated for by pointing out to *Long Duration Energy Storage for California's Clean, Reliable Grid* (2020), as well as recent research from the Massachusetts Institute of Technology ("MIT").

- **The results from modeling that covers all of the Western Electricity Coordinating Council ("WECC") modeling demonstrate the importance of extending RESOLVE's optimization horizon:** During the workshop, UC San Diego underscored that utilizing longer optimization horizons (*i.e.*, using increasingly longer ranges of consecutive days for storage balancing) in capacity expansion models results in the selection of higher and higher storage durations. These findings demonstrate the urgency of improving E3's RESOLVE model, which currently looks at 24-hour snapshots and is utilized in the key planning venues across California.

II. COMMENTS.

A. UNCCH's exploration of LDES technologies should be considered when creating new candidate resources for RESOLVE.

During the workshop, UNCCH presented on a research manuscript that seeks to answer what roles will the different types of storage pay in the decarbonization of California, and what types of LDES are available to do so. Within their presentation, the research team highlighted that a series of resource characteristics are critical when considering potential business models. Namely, these three key variables or metrics are: (1) the resource's land footprint; (2) the idle losses or equivalent efficiency of the resource; and (3) the average capital cost of a resource, as opposed to its levelized cost of storage ("LCOS"). Notably, UNCCH's analysis is based on a survey of storage technologies that are being developed and commercialized, which is a material step towards better understanding of the factors that contribute for a technology to be marketable.

CESA is appreciates this research approach because it readily enables the modernization of the RESOLVE model. As CESA has noted previously in comments to this docket, technology selection for the purposes of capacity expansion modeling has been unfortunately limited to technologies that are commercially mature and have public data availability regarding their costs, operations, and performance. Thus, this method significantly overlooks storage solutions that may be niche and are seldom deployed, despite their commercial availability. As a result, the planning models used in California consider a very limited subset of storage technologies and do not provide insights into the storage characteristics that the market should develop and procure in order to retain reliability in a cost-effective fashion. In this context, the research presented by UNCCH can mitigate the difficulty of establishing cost and performance characteristics for these niche technologies. In fact, the identification of key variables or factors should be leveraged by the E3 team to move away from a technology-based approach to modeling LDES towards one that captures trends/applications of the technology characteristics and optimizes for generic, technology-neutral resource options.[2] These LDES options, just like the ones CESA and Strategen Consulting developed for *Long Duration Energy Storage for California's Clean, Reliable Grid* (2020), would not be representative of any single technology, but would instead represent a class of storage solutions that have similar performance capabilities, tradeoffs, and cost profiles.

[2] Strategen Consulting, *Long Duration Energy Storage for California's Clean, Reliable Grid,* 2020, at 32.

A similar, albeit more thorough, approach was recently used by a team of researchers from Princeton and MIT in their paper *The Design Space for Long-Duration Energy Storage in Decarbonized Power Systems* (2021).[3] For this paper, the research team modelled a total of 1,280 discrete combinations of cost and efficiency parameters encompassing performance levels that are consistent with projections for existing LDES technologies found in academic peer-reviewed studies as well as domains that are currently infeasible but that could be the focus of technology development efforts in the future.[4] Furthermore, characterizing needs based on resource characteristics will also help guide procurement, not for specific technologies but for specific resource attributes.

As a result, and considering the findings shared during the workshop, CESA recommends the UNCCH's research team collaborate with E3 to consider modeling a series of technology-neutral LDES candidate resources that present variations regarding their land footprint, idle losses (defined as equivalent efficiency), and average capital cost. These efforts should coordinate as soon as possible to ensure that the candidate resources are considered in the next round of IRP modeling, as they would be essential to communicate to market participants which innovation pathways in the LDES ecosystem are critical for decarbonization efforts.

B. Including geographic specificity for renewable generation candidate resources should be considered for the next round of RESOLVE updates.

During the workshop, researchers from UC Merced presented on the impact generation technologies will have on the amount and type of storage required on a system-wide basis. In their analysis, the UC Merced team underscores that, currently, RESOLVE does not consider significant in-state variance for solar and wind resources. Critically, this results in the selection of candidate resources that are sub-optimal matches to load shapes and seldom contribute to resource diversity. This is particularly evident for solar PV, the most prevalent VER in California today, which is modeled in RESOLVE solely as single-axis tracked with 0-degree tilt, even though several other configurations exist and can be developed to provide energy when it is most valuable. A similar situation occurs with wind resources. The UC Merced team noted that, for wind generators, an even wider variety of configurations (*e.g.*, winter peaking, night peaking) must be included as candidate resources.

CESA supports the consideration of increased geographic and configuration specificity for the purposes of modeling VERs within RESOLVE. These modifications are crucial to properly evaluate a series of sensitivities regulators in the CPUC, CEC, and other venues have brought up when discussing deep decarbonization. CESA is particularly

[3] Sepulveda *et al*, *The Design Space for Long-Duration Energy Storage in Decarbonized Power Systems*, 2021.
[4] *Ibid.*

supportive of the UC Merced's team collaborating with E# in the near term to ensure that these incremental candidate resources can be considered in the evaluation of policy sensitivities within the IRP proceeding, particularly those with regards to increased out-of-state ("OOS") transmission/resources and offshore wind deployment. CESA considers that integrating these candidate resources into the planning venues where RESOLVE is utilized would not only better estimate the amount and type of storage needed, but also signal which capital-intensive developments should be more thoroughly analyzed (*e.g.* development of incremental inter-state transmission and/or underwater transmission). As such, we urge E3 to take into account the findings shared by UC Merced's researchers in an expeditious manner.

C. The iterative process proposed by UC Merced can provide significant insight regarding the cost targets for emerging storage technologies.

During the workshop, UC Merced researchers described their proposed approach to determine what price target must a storage asset with a particular duration and efficiency reach in order to successfully enter the market. UC Merced noted that this question is in the interest of both the CEC and storage developers/market participants, as it tries to estimate the necessary price points and characteristics to have a viable business model. To perform this analysis, UC Merced proposes using a technology cluster approach in which technology-neutral assets with a particular efficiency, duration, and idle losses would be offered as candidate resources to the RESOLVE model. Once these characteristics are defined, researchers would vary the cost until the model selects the technology, thus obtaining the market entry cost target. Methodologically, the UC Merced team noted that it would utilize an updated version of RESOLVE capable of doing full 8,760 hours per year optimization.

Overall, CESA considers that this type of modeling greatly contributes to the body of planning analyses that have been done in California since deep decarbonization was considered. The methodological approach proposed appears to be consistent with the most recent IRP modeling while being inclusive of some of the recommendations echoed by CESA in the sections above – namely, the inclusion of more solar and wind candidate resources, and the technology-neutral consideration of LDES. During the workshop, UC Merced researchers mentioned some of the proposed sensitivity analyses they would like to evaluate under the new, updated model. These sensitivities include a series of electric vehicle ("EV") charging scenarios, a scenario with high geothermal development, a scenario with natural gas plus carbon sequestration, and a series of scenarios in which the price of hydrogen is varied. In addition to these sensitivities, CESA recommends that the research team should also consider specific cases that reflect extreme weather events.

In this context, CESA recommends the UC Merced team collaborate with E3 to develop cases that reflect the possibility of adverse renewable supply conditions. As noted in comments filed July, 2021, for *Long Duration Energy Storage for California's Clean,* *Reliable Grid* (2020), Strategen explored how multiple days of low solar irradiance and corresponding reductions in solar generation will affect grid operations and LDES deployment.[5] To test this sensitivity, Strategen extracted renewable generation profiles from 2010 from the historical SERVM dataset. Across all the historical SERVM weather years, the winter of 2011 saw the lowest contiguous solar generation across the year due to a particularly active storm season in California, and the associated cloud cover sharply reducing solar PV production. This sensitivity analysis showed that planning on the expectation of periods of low solar irradiance has a significant impact on the LDES requirement, increasing it from 46 GW in the Base Case to about 49 GW.[6] As such, CESA supports the iterative approach proposed by UC Merced and recommends incremental sensitivity modeling considering extreme weather events. The findings of this exercise should also be considered to develop technology-neutral storage candidate resources, as mentioned in the sections above.

D. The results from WECC-wide modeling demonstrate the importance of extending RESOLVE's optimization horizon.

During the workshop, UC San Diego presented on the SWITCH model, a capacity expansion model that covers the whole WECC, including approximately 50 load areas from British Columbia, Canada, to New Mexico, US. During their presentation, UC San Diego researchers noted that the SWITCH model's temporal resolution is highly simplified, focusing only on about 4 hours per day, for a sample of days per year. This temporal simplification is directly related to the added geographic complexity, two factors that, combined can significantly affect computational runtimes.

In the context of this ambitious model, researchers wanted to better understand the effects of increased optimization horizons on the selection of LDES. Since most capacity expansion models only focus on a subset of days or hours to optimize building decisions, the research team wanted to model longer ranges (*i.e.*, number of consecutive days) for storage balancing and see what type of storage gets selected. In their preliminary results, researchers note that, for their lowest storage cost scenario the model with up to 7 consecutive days for storage balancing (*i.e.*, the optimization horizon is 7 consecutive days), the model selected up to 10 hours of duration. When they extended the number of consecutive days for storage balancing to 60, the storage duration jumped to 200 hours. Even longer timeframes (180-365 days for storage balancing) yielded storage selections of u to 500 hours in duration.

These results are consistent with CESA's experience with *Long Duration Energy Storage for California's Clean, Reliable Grid* (2020), where Strategen Consulting

[5] CESA, *Comments of the California Energy Storage Alliance Regarding the June 30th Staff Workshop on Proposed Development for Long Duration Energy Storage Scenarios*, July 14, 2021, at 5.
[6] *Ibid.*

employed 8,760 capacity expansion modeling to better model and approximate the value and need for LDES. It is logical that models that are unable to leverage seasonal or even multi-day arbitrage in their optimization could overlook the value of LDES assets. As such, CESA underscores the results shared by UC San Diego team as they highlight the urgency to have RESOLVE do full 8,760-hour optimization in order to ensure resource selection is methodologically sound, aligned with cost-effectiveness goals, and fair in their representation of the value provided by all resources, including all types of storage.

As such, CESA urges the research team closely collaborates with E3 to update RESOLVE's modeling, assumptions, and inputs as soon as possible and in advance of the upcoming IRP cycle. In particular, CESA deems it essential to include, at least, inter-day optimization as Strategen's and UC San Diego's analyses demonstrates these considerations have a substantial effect on the selection and utilization of LDES assets. Hence, CESA urges the CEC, the research teams, and E3 to timely complete the new modeling toolkit in a manner that ensures its utilization in the upcoming IRP cycle.

III. CONCLUSION.

CESA appreciates the opportunity to provide these comments and feedback on the Workshop. We look forward to collaborating with the CEC and other stakeholders in this docket.

Respectfully submitted,

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