CESA
CALIFORNIA ENERGY STORAGE ALLIANCE

October 6, 2022

Email to: IRPDataRequest@cpuc.ca.gov
Proceeding: Rulemaking ("R.") 20-05-003
Subject: CESA's Informal Comments regarding the Inputs and Assumptions ("I&A") Modeling Advisory Group ("MAG") meeting

Re: Informal Comments of the California Energy Storage Alliance Regarding the September 22nd Modeling Advisory Group Meeting on Input and Assumptions

The California Energy Storage Alliance ("CESA") appreciates the opportunity to comment on the Modeling Advisory Group ("MAG") meeting held on September 22, 2022 ("Workshop"), where Energy Division ("ED") staff of the California Public Utilities Commission ("CPUC") proposed updates to the inputs and assumptions that will be used in the 2022-2023 cycle of the Integrated Resource Planning ("IRP") proceeding. CESA recognizes the commitment of ED staff to engage with stakeholders on these fundamental matters since we are convinced that the modeling improvements and tools discussed at the Workshop are vital to the achievement of California's energy and environmental goals.

CESA is a 501(c)(6) organization representing over 120 member companies across the energy storage industry. CESA participates 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 given Senate Bill ("SB") 100 targets.

I. INTRODUCTION & SUMMARY.

CESA appreciates the Energy Division's efforts in updating the inputs and assumptions that will be utilized for the 2022-2023 IRP. In particular, CESA commends the ED for updating the RESOLVE model to accurately reflect the impacts increasing penetration levels of variable energy resources ("VERs") have on the contributions of energy storage. Updating the storage effective load carry capability ("ELCC") curve to a solar-storage ELCC surface finally recognizes the symbiotic relationship between these two resource classes and sends the appropriate market signals for their continued synergistic procurement.

While CESA appreciates this and other improvements, there is still more to be done to ensure that the modeling undertaken as part of the IRP proceeding will identify an optimal portfolio from an environmental, reliability, and ratepayer perspective. As such, in these informal comments, CESA offers ED recommendations regarding the reliability contributions of long-duration energy storage ("LDES") resources, the optimization horizon of the capacity expansion modeling ("CEM") efforts of the IRP proceeding, the representation of paired solar-plus-storage resources within the CEM, and different alternatives to further include emerging storage technologies as candidate resources. Thus, CESA's comments can be summarized as follows:

- On Section 5.2: ED is correct in updating the storage ELCC curve to a solar-storage ELCC surface.
    - The surface should be further developed to consider more durations (4-, 8-, 10-, 12-hour, and 24-hours), as well as different storage round-trip efficiencies and charge/discharge rates.
- On Section 5.2: ED should work with Energy + Environmental Economics ("E3") to ensure RESOLVE is updated in this cycle in a manner that allows it to perform capacity expansion optimization over periods longer than 37 independent days.
- On Section 3.2: ED should reintegrate flow batteries and add other storage technologies as candidate resources based on the cost and performance data published by the Pacific Northwest National Laboratory ("PNNL").
    - Alternatively, ED should leverage the work performed by E3 and the University of California ("UC") for the California Energy Commission ("CEC") to add a technology-neutral variable-cost LDES option as well.
- On Section 4.2: For the purposes of modeling paired resources, CESA recommends consideration of a hybrid asset with a 4-hour storage asset, 1 .1 MW of solar for every MW of storage, deliverability up to the maximum power output of the solar asset, RA value, and lower cost, relative to its standalone counterparts.

II. <u>COMMENTS</u>.

A. On Section 5.2: ED is correct in updating the storage ELCC curve to a solar-storage ELCC curve, but these curves should test different capabilities of storage around duration, roundtrip efficiency, and charge/discharge rate.

CESA thanks the Energy Division for its continued pursuit to improve the representation of the reliability contributions of different resource classes within the IRP proceeding. Specifically, CESA commends updates to the RESOLVE model's assumptions to reflect the interdependent effects increasing penetrations of VERs have on the reliability contributions of energy storage resources. This update finally addresses some of the concerns CESA had previously shared regarding the methodology and assumptions used to derive storage ELCC values,[1] where we urged staff to reevaluate its storage ELCC curve as it did not account for variations in renewable resource availability and the duration of storage assets. ED's adoption of a solar-storage ELCC surface properly recognizes that storage peaking capacity contributions are a function of the penetration of storage and the availability of other renewables, just as noted by a 2019 National Renewable Energy Lab

[1] *See* CESA's comments: https://docs.cpuc.ca.gov/SearchRes.aspx?DocFormat=ALL&DocID=387951294

("NREL") study.[2] In said study, NREL demonstrated that higher solar penetrations increase the amount of four-hour energy storage that can be added at 100% ELCC. The Commission's new assumptions are consistent with findings from NREL and others, appropriately capturing the diversity benefits of storage plus storage.

While the changes adopted by ED are timely and valuable, the limited set of values developed should be expanded upon. In the Workshop materials, ED only presented ELCC values for storage based on the solar-storage ELCC surface for 4- and 8-hour lithium-ion resources. While CESA understands that these assets may be the ones ED considers enjoying the most commercial interest and activity at the moment, other technologies (both mature and emerging) would benefit from being considered in the context of a solar-storage ELCC surface.

First, CESA urges ED to consider developing ELCC values based on the aforementioned *surface for storage assets with longer durations, such as 10-, 12-, and 24-hour resources*. Consideration of longer durations is timely given that in prior IRP cycles, RESOLVE, despite its methodological shortcomings, already identified the need for LDES resources.[3] Moreover, Strategen Consulting's *Long Duration Energy Storage for California's Clean, Reliable Grid* (2020), a study that employs a model that remedies the aforementioned limitations of the RESOLVE model as further explained in Section B of these informal comments, revealed that 45-55 GW of long duration energy storage will be required to support California's electric grid by 2045.[4] Modeling durations in excess of 24-hours is necessary, but will only yield material results in modeling once ED and E3 update RESOLVE to optimize over periods longer that 24-hours, as noted in Section B of these informal comments.

Considering the increasing need for LDES, ED should also commence developing ELCC values for storage resources with round-trip efficiencies ("RTEs") different that those assumed for lithium-ion resources. The values presented at the Workshop were derived with the underlying assumption that the storage side of the solar-storage surface is lithium-ion. CESA believes that this assumption will not hold up in the mid-term as a variety of storage solutions are becoming increasingly attractive due to a combination of supply chain and commodity risks regarding lithium-ion, and technology-neutral incentives at the federal level (*i.e.,* the Inflation Reduction Act ["IRA"]) that can potentially bolster emerging, US-made, storage technologies. In this context, CESA urges ED to develop the solar-storage ELCC surfaces needed to determine the ELCC values of 10-, 12-, and 24-hour storage resources, *as well as those applicable to storage technologies with RTEs different than those assumed for lithium-ion batteries*. Over time, ED should *strive to develop these curves as a function of charging and discharge rates as well*. Today, consistent with CESA's recommendations to the CEC, CESA recommends consideration of resources with CESA recommends modeling RTEs across the 35%-85% range, as this better represents the diversity and heterogeneity of existing and emerging LDES technologies. As such, at

[2] *See* NREL, The Potential for Battery Energy Storage to Provide Peaking Capacity in the United States, available at: https://www.nrel.gov/docs/fy19osti/74184.pdf

[3] *See* PSP (R.20-05-003) https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M434/K547/434547053.PDF

[4] *See* Strategen Consulting's Long Duration Energy Storage for California's Clean, Reliable Grid, available at https://www.storagealliance.org/longduration

minimum, *E3 should consider RTEs of 35%, 50%, 70%, and 85%,* although modeling more points within said range would be desirable.[5]

B. On Section 5.2: ED should work with E3 to ensure the current IRP cycle is able to do capacity expansion optimization over periods longer than 37 independent days.

CESA urges ED to modify RESOLVE *in this IRP cycle* to allow it to perform CEM optimization over a period longer than 24 hours over 37 disconnected days. Today, RESOLVE co-optimizes new resource investment and dispatch for 37 discrete days over a multi-year horizon in order to identify least-cost portfolios for meeting. RESOLVE's 37 representative days are not intertemporally linked with each other and are not modeled in chronological order, therefore storage balancing decisions are limited to a horizon of a single day. Thus, RESOLVE selects incremental capacity additions based on a simplification with no intra-hour or multi-day optimization of dispatch. This seriously limits the potential grid benefit from energy storage since RESOLVE does not capture the potential need for or benefits of LDES given its architecture.

Research from UC Merced shows that most CEMs use a few days during a year to optimize, limiting the value of LDES technologies to the grid. Researchers at UC Merced have found that models with longer optimization horizons better identify the value of LDES and select resources accordingly. When allowing the model to optimize over a period of 7 consecutive days, UCE Merced's modeling selected storage assets with up to 10 hours of duration. When the researchers increased the optimization horizon to 60 consecutive days, storage duration jumped to 200 hours. A time horizon of 365 consecutive days (8,760 hours) yielded storage selections of up to 630 hours in duration.[6] These results demonstrate conclusively that the architecture of the model has a profound impact on need identification and resource selection. As California seeks to rapidly move towards a decarbonized future, waiting to update RESOLVE modeling will continue the underestimation of this need, limiting the growth of emerging and innovative technologies, threatening reliability.

In this context, ED must recognize the importance of longer, consecutive time horizon impacting the selection and optimization of storage resources by increasing the current 37 independent day time horizon to a significant number of consecutive days. E3 and the University of California, Merced's ("UC Merced") research contracts through 20-MISC-01 and EPC-19-056 should serve their purpose and help ED materially improve the contracted modeling tools to enable long-term planning of the resource mix. Specifically, CESA urges the ED to *direct E3 to provide them the version of RESOLVE that allows for 365-day modeling* and has been developed in coordination with UC Merced, UC San Diego and the CEC as part of dockets 20-MISC-01 and EPC-19-056 during this current IRP cycle.[7]

---

[5] See CESA's comments https://efiling.energy.ca.gov/GetDocument.aspx?tn=244209&DocumentContentId=78134

[6] See UC Merced, Effect of Modeled Time Horizon on Quantifying the Need for Long-Duration Storage, available at https://www.sciencedirect.com/science/article/pii/S0306261922004275#fig5

[7] See UC Merced LDES Presentation https://efiling.energy.ca.gov/GetDocument.aspx?tn=244120

C. On Section 3.2: ED should reintegrate flow batteries and add other storage technologies as candidate resources based on the cost and performance data published by PNNL. Alternatively, ED should leverage the work performed by E3 and the UC for the CEC to add a technology-neutral variable-cost LDES option as well.

During the Workshop, ED presented the different cost updates that have been applied to candidate resources. Many of these updates were sourced from NREL's 2022 Annual Technology Baseline ("ATB"). ED also noted that values related to the cost of some storage resources (*e.g.,* lithium-ion batteries) will be further updated once Lazard's updated Levelized Cost of Storage ("LCOS") results are published. CESA supports sourcing the cost data for pumped hydro storage ("PHS") from NREL's 2022 ATB. CESA also supports the continued use of Lazard's LCOS results to inform lithium-ion costs.

ED also presented on the new candidate resources that will be considered in this IRP cycle and underscored that the resources included were identified via a report prepared by E3 regarding the LDES and generation technologies that can provide firm generation capacity with low-or zero-emissions. The technologies studied in the aforementioned report could help maintain low costs in a zero-carbon grid during longer periods of low renewable production and high load. Crucially, parties to this proceeding were not made aware of the existence of this report prior to the Workshop, nor of how it would be leveraged, or the inputs and assumptions included utilized for its development. Overall, CESA is concerned by the lack of transparency regarding the process to consider candidate resource updates and additions; nonetheless, we consider that ED can still cure some limitations in a timely manner.

First, CESA is concerned with the elimination of previously considered candidate resources, such as flow batteries, as well as the exclusion of proven and commercially available technologies, like thermal energy storage (TES). Regarding flow batteries, CESA understands that the newest version of NREL's ATB does not include flow battery costs, which may have limited ED's ability to present the expected cost trajectory of said resource at this time; nevertheless, we urge ED to consider alternate publicly available data sources to avoid shrinking the candidate resource pool. In a moment when the IRA will reduce costs and imminent investments will be made through the Bipartisan Infrastructure Law ("BIL"), there will be massive innovation potential unlocked across the clean energy and storage sector, such that the CPUC would be completely amiss by limiting the pool of solutions in its modeling. If the CPUC wants to take advantage of novel funding incentives and promising emerging technologies, it should not be shortening the list of candidates at all. As such, CESA recommends ED to consider cost estimates from Lazard LCOS *and PNNL's Energy Storage Cost and Performance Database* as sources to reintegrate flow batteries,[8] and add TES and gravitational energy storage as candidate resources. In its consideration of

---

[8] *See* PNNL, Energy Storage Cost and Performance Database, available at https://www.pnnl.gov/ESGC-cost-performance and https://www.pnnl.gov/sites/default/files/media/file/ESGC%20Cost%20Performance%20Report%202022%20PNNL-33283.pdf

PNNL's data, ED should note, first, that PNNL's cost estimates are older than NREL's and thus skew towards overestimation of costs. Second, that the estimates are disaggregated by the expected MW size of assets. Given that the cost estimates are sought for the purposes of CEM, CESA recommends utilizing the 1,000 MW sizing to reflect the impacts of economies of scale.

Alternatively, if ED does not feel as confident in the aforementioned cost estimates, ED should *leverage the work performed by E3 and the UC for the CEC to add a technology-neutral variable-cost LDES option* as well. During a workshop held by the CEC on July 12th, 2022, UC Merced presented an overview of their approach to modify RESOLVE in order to better assess the role LDES will have in a future decarbonized Californian grid. In their presentation, UC Merced noted that feedback to date regarding the modeling of LDES technologies had focused on two factors. First, both potential buyers and sellers of LDES were curious about the optimal duration needed. Second, both potential buyers and sellers were interested in the tipping point, in terms of both cost and duration, at which a particular technology would become cost-competitive relative to lithium-ion batteries.

Recognizing CESA's recommendation to develop a technology-neutral parameter-centered modeling approach, UC Merced proposed the establishment of variable-cost storage candidate resources that would capture different points of the parameter space. UC Merced proposes including new storage candidate resources with a defined duration and RTE, but with variable total costs.[9] The creation of these candidate resources will allow the model to better capture the tradeoffs between storage assets and the cost tipping points by duration and RTE. In addition, this approach would allow for expedited sensitivity analyses as only one variable needs to be modified.

Overall, CESA is supportive of the approach proposed by UC Merced. The proposed approach is consistent with the one employed by Strategen Consulting in *Long Duration Energy Storage for California's Clean, Reliable Grid* (2020). This method offers a technology-neutral alternative to better understand the need for LDES in a context of limited public data availability. We highly encourage the exploration of technology neutral modeling since, today, it is unclear what technologies will ultimately enable LDES. Since there is a wide gamut of plausible long-term solutions. Moreover, the proposed approach will provide important insights for both public and private investments regarding the price points LDES should strive for in the coming years. While supportive of the proposed methodology, CESA recommends that the variable-cost LDES candidate resources modeled consider RTEs in addition to those presented in the Workshop. If ED considers this route, CESA recommends modeling RTEs across the 35%-85% range, as this better represents the diversity and heterogeneity of existing and emerging LDES technologies.

---

[9] UC Merced, Materials for Long Duration Energy Storage Public Workshop #3, July, 2022, available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=244120

D. On Section 4.2: For the purposes of modeling paired resources, CESA recommends consideration of a hybrid asset with a 4-hour storage asset, 1 .1 MW of solar for every MW of storage, deliverability up to the maximum power output of the solar asset, RA value, and lower cost, relative to its standalone counterparts.

Within the IRP, RESOLVE has not incorporated paired and hybrid resources, limiting our understanding of their cost, value, and system impact. CESA believes it is important for the ED to model hybrid and paired resources because of the economic and operational differences they have relative to standalone batteries. Even as the standalone energy storage investment tax credit ("ITC") passed in the IRA will reduce the pure incentives to pair storage and generation behind the same point of interconnection ("POI"), there is strong commercial interest in solar-storage combinations due to the state's property tax exemption for solar-storage projects and the unknown impacts of such projects qualifying for the IRA's production tax credit ("PTC")

Further, considering there is a large pipeline of such projects in the queue, inclusion of their costs and capabilities in RESOLVE is important and helpful for procurement efforts. Hybrid and paired resources are expected to make up a generous portion of the capacity seeking to connect to the grid in the coming years. Paired solar plus storage resources make up approximately a third of the interconnection requests being processed in the CAISO Queue Cluster 14 ("QC 14").[10] These resources could provide efficiency and cost savings for a future decarbonized grid, but to understand the real value hybrid and paired resources bring to the grid, it is crucial that modeling advance to ensure they are being represented. CESA supports ED adding a candidate resource to represent solar-plus-storage resources. In this context, CESA recommends the following configuration based on our understanding of commercial interest from developers, buyers and sellers of these resources.

Design Parameter	Example Value	Explanation of Choice
Duration of Storage	4-hour	• CESA member feedback
Solar to Storage Ratio	1.1 MW of solar for each MW of storage	• Average value according to QC 14 data.
DC- or AC- coupling	AC-coupling	• CESA member feedback
Solar Inverter loading ratio	1.35, and AC-coupled single axis tracking solar array	• CESA member feedback

[10] CAISO Generator Interconnection Queue for Cluster 14
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwinrtSwt8T6AhWfMEQIHXa_DX8QFnoECBAQAQ&url=http%3A%2F%2Fwww.caiso.com%2FDocuments%2FPreliminaryCluster14ProjectListasofMay20-2021.xlsx&usg=AOvVaw1KPiibqCBy1lwKHm9qK-UJ

Interconnection sizing	Equal to the solar Pmax	• Typically, the solar capacity is greater than the instantaneous storage discharge capability • If the POI capacity is smaller than the solar Pmax, the project would have to curtail solar even when the developer wants to/the grid needs the project to operate at max and the storage is not charging
Representation in CAISO transmission deliverability constraints	FCDS	• RA rules require this (see below)
Resource Adequacy contribution	Assume RA value, additive, with solar de-rated for charging energy	• Industry feedback, CPUC guidance in RA proceeding, 2020 QC Manual
Co-control or independent control	Co-control	• The renewable and storage potions of a resources should be co-optimized together • Solar ITC provisions require 100% onsite charging, this can only be achieved through co-control
Storage charging from the grid	On-site charging	• Solar ITC provisions require 100% onsite charging
Operational Reserves	Yes	• Industry feedback
REC treatment of renewable energy generated & stored	Yes, with no reduction for losses	• Since standalone renewables that charge nearby storage receive full credit for RECs, so should Hybrid and Co-located renewables.
Cost of hybrid or paired resource relative to standalone equivalent	Lower cost relative to standalone	• Cost of hybrid and paired resources are less expensive than their standalone storage and solar counterparts, due to shared infrastructure, permitting, land use, etc. • A 2018 NREL study found that the cost of co-located, DC- and AC- coupled storage-solar hybrid systems are 8% and 7% cheaper, respectively, than systems with storage and solar sited separately.[11] • The ED should discuss implications of the Inflation Reduction Act, as the newly expanded ITC will drive standalone storage costs down.

[11] Fu, R., Remo, T., and Margolis, R. (2018), 2018 U.S. Utility-Scale Photovoltaics-Plus-Energy Storage System Costs Benchmark, November 2018, https://www.nrel.gov/docs/fy19osti/71714.pdf, p. 17.

III. **<u>CONCLUSION</u>.**

CESA appreciates the opportunity to provide these comments and feedback on the workshop held September 22, 2022. We look forward to collaborating with Energy Division and other stakeholders in this docket.

Respectfully submitted,

Jin Noh
Policy Director
California Energy Storage Alliance

Sergio Dueñas
Policy Manager
California Energy Storage Alliance

Alondra Regalado
Policy Analyst
California Energy Storage Alliance