Stakeholder Comments

Submitted by	Company	Date Submitted
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Introduction:

CESA appreciates the opportunity to comment and review the preliminary results of the California Independent System Operator's (CAISO) statutorily-directed SB 350 Study (Study).[1] While seeking to be generally informative, the study may also inform the state's views on regionalization and potentially even on renewable deployments as well as on renewables integration solutions. Accordingly, the study warrants a serious and critical review.

CESA has concerns that the Study may include several flaws causing the study's conclusions to be potentially misleading. Primarily, CESA's concerns focus on how potentially flawed study assumptions or methodologies will yield flawed study outcomes. CESA recommends the study team further revise the study to reflect this updated round of stakeholder input. If the Study is deemed final, the concerns of stakeholders should be well documented in any final Study report.

CESA recognizes efforts taken by the CAISO and the study team to incorporate feedback and to explain the study approach. Despite this, CESA still feels that some elements of the study process remain opaque or unclear as documentation of the study methods and input assumptions have been difficult to ascertain. Given these perspectives on the study methods and assumptions – and the CAISO takes a neutral and conservative approach in this study despite an apparent interest in regionalizing – CESA believes further extensive efforts to conduct a transparent and clear study review process and additional sensitivity studies are appropriate.

While supporting the goals of regionalization, CESA's comments focus on key assumptions made by Energy and Environmental Economics (E3) and The Brattle Group. In some instances, CESA finds some study decisions and assumptions may result in study outcomes that possibly overstate the benefits of regionalization while simultaneously underestimating practical benefits of developing in-state resources to support the achievement of SB 350 requirements. The Study also fails to quantify a number of political and operational uncertainties, exacerbating the potential for overstatements of the benefits of regionalization. In the case of this latter issue, the Study should reflect how a reliance on out-of-state resources

[1] *Clean Energy and Pollution Reduction Act Senate Bill 350 Study: Preliminary Results*, presented at the CAISO on May 24, 2016, pp. 92, 121.

may create challenges and deviate from the State's core in-state reliability approach as established following the 2001 energy crisis.

CESA therefore believes that there should be a greater balance of advancing toward increased regionalization while continuing to deploy in-state resources that hedge against the challenges and risks of regionalization. These risks should include and apply to any study determinations that suggest California to fund out-of-state transmission projects. This approach protects California against localized reliability risks that cannot be sufficiently mitigated by out-of-state resources while not guaranteeing costs in the face of perhaps uncertain benefits.

CESA's Comments:

A core part of the study process required E3 to develop three different portfolios for meeting California's 50% Renewable Portfolio Standard (RPS) by 2030. E3 accomplished this by using its RESOLVE model, which requires many assumptions. The Study's findings show that regionalization could save California ratepayers roughly 2-3% in retail rates, resulting from $1-1.5 billion in lower RPS-related capital investments, collected grid management charges, lower production and sales costs, and load diversification. To achieve these benefits, RPS portfolios would involve: (1) reduced in-California solar (in Portfolio 3) and wind (in Portfolios 2 and 3) and increased in solar imports from the Southwest (Portfolios 2 and 3) and wind imports from New Mexico and Wyoming (in Portfolio 3); and (2) substantial construction of new long-distance transmission to the Southwest and Wyoming (in Portfolio 3).

CESA's comments detail areas of this work where assumptions may be unclear or flawed and offer recommendations to correct these assumptions. CESA strongly recommends additional analyses with revised assumptions that more realistically reflect market conditions and operational constraints.

1. Current and future energy storage costs are still assumed to be too high

CESA appreciates that the CAISO updated some of its energy storage capital cost assumptions based on previous input provided by CESA and other stakeholders. Originally, E3's low-end capital cost assumptions were $590/kWh for lithium-ion batteries and $390/kWh for flow batteries. At the assumptions and scenarios review phase of the study process, CESA recommended that E3 and the CAISO adopt the low-end levels for lithium-ion batteries ($347/kWh) and flow batteries ($290/kWh) from Lazard's *Levelized Costs of Energy Storage* study.

In the preliminary study results, however, the 2015 capital cost assumptions for Lithium-Ion batteries have been lowered closer to CESA's recommended levels ($375/kWh), but higher cost assumptions are used for flow batteries ($700/kWh) rather than Lazard's estimate or even the mid-range assumption by Energy Strategies Group ($540/kWh) in its peaker study analysis.[2]

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[2] *Guide to Procurement of Flexible Peaking Capacity: Energy Storage or Combustion Turbines?* Energy Strategies Group, Oct 2014, p. 14. http://www.energystrategiesgroup.com/wp-content/uploads/2014/10/Guide-to-Procurement-of-New-Peaking-Capacity-Energy-Storage-or-Combustion-Turbines_Chet-Lyons_Energy-Strategies-Group.pdf

This collection of assumptions needs further explanation, and the use of a higher-than-documented flow battery costs appears to be flawed.

CESA represents over 70 energy storage and renewable development companies and can support study efforts through informational interviews with storage and renewable development companies on costing, if needed. CESA believes E3 may benefit from such information gathering. CESA also requests E3 to refrain from oversimplified statements about energy storage. In the recent stakeholder meeting, an E3 speaker declared energy storage "too expensive" without sufficient qualification from the speaker – e.g. to clarify the energy storage application, technology, year, comparison solution, etc.[3]

Assumptions about energy storage cost trajectories (i.e., declines) also warrant review. In the preliminary Study results, E3 uses capital cost assumptions of $183/kWh for lithium-ion batteries and $315/kWh for flow batteries by 2030. While better than before, CESA believes that the energy storage costs are still assumed to be too high for 2030. A host of expert firms have predicted much more significant cost declines than E3. Deutsche Bank has predicted future battery prices at $150/kWh, while AECOM[4] and DNV GL[5] have predicted a 60-70% drop in battery prices, respectively (which translates to roughly $112-150/kWh by 2020 using E3's $375/kWh estimate for 2015). Bloomberg New Energy Finance (BNEF)[6] and consulting firm, ASE,[7] expect the lithium-ion battery technology to cost $120/kWh and $125/kWh by 2030, respectively.

CESA's own analysis using projected installed capacity and learning rates also points to much steeper cost declines than those assumed by E3 and CAISO. A review of the Department of Energy's *Global Energy Storage Database* reveals approximately 337 MW of US-installed and operational capacity of lithium-ion battery storage systems, as of June 2016.[8] By 2021, GTM Research estimates that an additional 5,715 MW will be deployed in the US, adding up to a cumulative installed capacity of 6,568 MW of energy storage.[9] Based on learning rates[10] for lithium-ion batteries that have ranged from 15-21% by the Electric Power Research Institute (EPRI) and BNEF[11], lithium-ion battery storage capital costs should fall to around $146-195/kWh

[3] E3 speaker at May 24 CAISO Stakeholder meeting on SB 350 Study.

[4] *Energy Storage Study: Funding and Knowledge Sharing Priorities*. AECOM, Jul 2015, p. 10. http://arena.gov.au/files/2015/07/AECOM-Energy-Storage-Study.pdf

[5] *E-storage: Shifting from cost to value 2016*. World Energy Council, 2016. https://www.worldenergy.org/publications/2016/e-storage-shifting-from-cost-to-value-2016/

[6] *New Energy Outlook 2016 Executive Summary*. Bloomberg New Energy Finance, Jun 2016.

[7] "Stored electricity heads to $0.05/kWh by 2030." RenewEconomy, 30 Sep 2014. http://reneweconomy.com.au/2014/stored-electricity-heads-to-0-05kwh-by-2030-39889

[8] *Global Energy Storage Database*. Department of Energy. Accessed on 20 Jun 2016. http://www.energystorageexchange.org/

[9] *U.S. Energy Storage Monitor: Q2 2016 Full Report*. Energy Storage Association (ESA) and GTM Research, Jun 2016, p. 24.

[10] Learning rates refer to the cost declines attributed to increased 'learning' experience and economies of scale as production increases. For example, a 15% learning rate means that costs decline by 15% for every doubling of production volume.

[11] Presentation by Michael Liebreich at Bloomberg New Energy Finance Summit 2015, 14 Apr 2015, p. 13. http://www.bbhub.io/bnef/sites/4/2015/04/BNEF_2014-04-08-ML-Summit-Keynote_Final.pdf

by 2020. There should be further substantial cost declines by 2030. While these estimates are crude, considering not all new additions will be lithium-ion battery storage and how there are 'soft' costs as well that contribute to the cost of energy storage installations, it illustrates why E3's energy storage cost trajectory assumptions should be steeper to accurately value energy storage in future portfolios.

CESA requests clarification as to why these higher energy storage cost assumptions are used. CESA is concerned that these high current and future cost assumptions for energy storage will bias the RESOLVE model results to select out-of-state resources to meet system needs instead of in-state energy storage resources, which are decreasing precipitously in costs and are likely to become a greater part of future portfolios. To get a greater understanding of the potential of energy storage to help California meet its flexibility and renewables integration needs, CESA recommends that E3 and the CAISO conduct sensitivity analyses on a 'low-cost storage' scenario that runs the RESOLVE model that includes aggressive cost declines for energy storage. CESA and many industry experts predict significant cost declines in energy storage costs as the industry matures and scales, and therefore it will be important to understand this alternative scenario to guide policy decisions on regionalization.

Furthermore, regarding 'soft' costs, CESA requests clarification on how installation, interconnection, and permitting costs are accounted for in total installed costs for energy storage. E3 accounted for operations and maintenance costs and power conversion system (i.e., inverter) costs, but not these other 'soft' costs.

2. **The use of $0 hurdle rates in Portfolio 3 may overstate power flow liquidity and indifference, potentially overstating benefits in unrealistic ways.**

Adders measured in $/MWh represent 'hurdle rates' which seek to reflect inefficiencies in today's bilateral systems. The SB 350 study uses these rates to inhibit power flow or 'efficient trade' over transmission paths across Balancing Authorities (BAs). Put another way, hurdle rates reflect the real-world market effects from transmission restrictions, import/export restrictions, and/or market 'hurdles' such as illiquid markets and imperfect information. Hurdle rates are also used to assess congestion charges on market transactions exceeding a certain threshold, thereby minimizing potential reliability impacts.

Under Portfolio 3, as CESA understands it, these hurdle rates have been dropped to $0. To vet this assumption, CESA seeks clarification on whether E3 and the CAISO are assuming uninhibited power flows over transmission paths, which would not reflect the reality of market inefficiencies in transmission congestion management. While regionalization would decrease hurdle rates by improving coordination of committing and dispatching resources within a regional ISO, political barriers and conflicting policy objectives may make it unlikely for a regional ISO to achieve zero hurdle rates. By contrast, with in-state energy storage resources, the CAISO would benefit from lower hurdle rates that are located closer to load and therefore minimize transmission congestion.

3. **Cost recovery for transmission should be modeled when de-pancaking is included in models.**

Wheeling charges can serve as a simple mechanism to recover some of the costs of transmission facilities or congestion for use of a transmission system that crosses BAs. The SB 350 study notes that the current breakdown of wheeling charges is $1/MWh to cover administrative costs, $1/MWh to account for the trading margin, and $4/MWh to account for unit commitment. The study assumes that these wheeling charges can be de-pancaked to reduce the costs and barriers to transporting energy across BAs to and from California. In model-speak, this is achieved with a $0 hurdle rate.

De-pancaking of wheeling charges removes a regular and established approach for cost-recovery of transmission. A key question, then, is how are these costs recovered? CESA recommends the model either consider where these costs might alternately be recovered or explain how such information is unimportant. In a pancaked world, transmission costs are collected through wheeling charges and through transmission scheduling transactions. Without reflecting these costs, the model may assume that certain parties or states get a 'free ride' to use new transmission lines to export its renewable generation into California and import California's renewable generation without contributing to its costs. As such, this study aspect is likely unreasonable. If transmission costs are allocated pro-rata to load, what might the increase in TAC costs to Californians be? Alternatively, the study team can explain how modeling of these costs is or isn't applicable.

CESA believes that the de-pancaking of wheeling charges appears to be modeled incompletely because any new cost-recovery needs and effects do not appear to be represented. This matter may be important as merchant transmission owners and Congestion Revenue Rights (CRR) holders may benefit differently from changes to transmission cost-recovery. CESA understands that the use of Nevada transmission in the Energy Imbalance Market (EIM) may highlight how transmission system cost recovery approaches can influence the value of transmission system ownership or rights. Ultimately, CESA recommends a thorough and realistic modeling approach to ensure SB 350 study results are reasonable.

4. Transmission investment costs must be re-examined to see how they compare on a per-kW basis to in-state energy storage resources and/or in-state renewables

CESA is concerned that any potential understatement of transmission system expansion costs and project timelines could lead to less-than-accurate study results and even to misdirected portfolios. Extra scrutiny towards expected transmission system costs is appropriate.

Further insight into the RESOLVE model may help CESA to understand how RESOLVE 'decides' on transmission system expansion. A 50% RPS portfolio, for instance, will not be achieved in a single procurement exercise. More likely, incremental procurements will be made to evolve the system over time to a 50% RPS system. As CESA understands it, RESOLVE assumes and compares paths to achieve a 50% RPS in a single procurement exercise. Such an approach may fail to reflect the option-value of smaller projects.

CESA believes the assumptions on out-of-state transmission expansion should be checked to avoid any understatements on costs, difficulty, and risks. A comparative analysis should be conducted on the transmission investment costs and project development timelines as compared to in-state energy storage resources, which CESA expects may be more quickly deployable in some instances and may cost less on a per-kW basis, particularly if risk-adjusted. Overall, CESA recommends that the costs and timing for transmission build-outs be conservative since these larger infrastructure projects can experience delays due to permitting, regulatory approval, and construction that can lead to cost overruns. CESA has not found a comprehensive data analysis of transmission development cost overruns, but anecdotally, the Edison Electric Institute (EEI) highlights Southern California Edison's Devers-Colorado River (DCR) transmission line project as one example where an initial cost estimate of $543 million ballooned to $701 million due to various permitting and regulatory approvals needed to begin developing the project.[12]

Even though the CAISO believes that transmission construction/expansion is attainable over the next 14 years, CESA recommends that transmission investment costs account for these potential regulatory barriers and apply additional costs to transmission project costs for Portfolio 3 – i.e., those connecting California to wind resources from New Mexico and Wyoming. If the study team has already accounted for these matters, information on how study assumptions were adjusted would help to clarify CESA's understanding.

5. Electric vehicle charging does not just represent additional load but a renewables integration solution

CESA requests that the Study include electric vehicle (EV) energy storage in their analysis. As CESA understands it, E3 includes EV charging demand in load forecasts but does not include EV charging as a grid service in its Study. CESA is therefore that the RESOLVE model will underestimate EV-sourced grid services, such as frequency regulation, which can be done through controllable charging. Particularly with CAISO efforts to support Distributed Energy Resources (DERs) participation and Distributed Energy Resource Participants (DERPs), modeling should assume that EVs can provide regulation down by increasing charging of the EV fleet or regulation up by curtailing charging. As a large number of EVs will reside and plug-into California's grid, modeling the use of these resources may show that California is more able to integrate renewables cost-effectively. In fact, California has a policy goal of reaching 1.5 million zero-emission vehicles (ZEV) by 2025, representing up to 9 GW of charging demand (assuming each ZEV requires up to 6 kW). Moreover, EV charging capability may be available with lower capacity costs – i.e., these resources will largely exist without ratepayers directly paying to build them.[13] This potential finding is very applicable to the Study and should be included.

To support any study updates, the study team should re-run the RESOLVE model and include EV-sourced grid services as part of any future portfolios.

6. In-state solar-plus-storage solutions should be modeled as a combined resource rather than having solar and energy storage solutions modeled separately

[12] *Transmission Investment: Adequate Returns and Regulatory Certainty Are Key*. Edison Electric Institute, Jun 2013. p. 8. http://www.eei.org/issuesandpolicy/transmission/Documents/transmission_investment.pdf
[13] EV charging also has the potential to provide resource adequacy (RA) through advanced algorithms that aggregate EV resources with statistical precision in any sub-LAP at any given time.

E3 modeled the lowest-cost resources that were 'picked up' in three regionalization scenarios (Portfolios 1a, 2, and 3) as California progressed toward its SB 350 requirements, as well as conducting several sensitivity scenarios, such as a 'high rooftop PV' scenario. As CESA understands the RESOLVE model, the model runs do not account for solar-plus-storage resources as a combined resource but rather separate resources that are 'selected' independent of one another. For example, in E3's 'high rooftop PV' sensitivity scenario where the CAISO's rooftop PV deployment reaches 21 GW by 2030 (instead of 16 GW), the model shows significant solar-driven curtailment and additional battery storage selected only in Portfolio 1a where imports/exports are limited. Portfolios 2 and 3 where regionalization assumptions are increased show significant reductions in curtailment in E3's model.[14]

If CESA's understanding is correct that rooftop solar and energy storage are modeled as separate resources, then CESA believes that the E3's model may be overstating the benefits of regionalization in addressing rooftop solar-driven curtailments. With many Self-Generation Incentive Program (SGIP) funded behind-the-meter energy storage projects coming online, solar-plus-storage deployments are likely to increase and reduce the prevalence of rooftop solar-driven curtailments from the onset. Rather than having storage 'selected' in the model, storage paired with rooftop solar may be an input assumption worth testing, which reflects a possible 2030 scenario given the new energy storage focus in SGIP and the California Public Utilities Commission's (CPUC) work in the Distributed Resources Plan (DRP) proceeding to determine locational values of distributed energy resources. This sensitivity scenario is important to consider because of the benefit that solar-plus-storage systems can provide in terms of reduced curtailments, distribution system optimization (e.g., deferral, local congestion, voltage support), and additional local reliability (e.g., to mitigate the current or avoid future Aliso Canyon situations). Therefore, CESA requests that E3 conduct a sensitivity analysis also testing a high solar-plus-storage scenario.

7. Bulk storage assumptions should include compressed air energy storage as well

While CESA appreciates the representations of energy storage in the study team's efforts, CESA is unclear if the study sufficiently contemplated and represented the costs and benefits of increased bulk storage procurement as a renewables integration solution to meet California's 50% RPS goals. CESA notes that the preliminary study results seem to conflict with results from other modeling efforts, raising concerns that the SB 350 modeling has potential flaws. To illustrate, CESA notes several California-focused studies that identified a significant need for bulk storage. The E3 *Pathways Study* identified roughly 5,000 MW of long-duration energy storage needed in a 50% RPS by 2030 scenario,[15] while the National Renewable Energy Laboratory's (NREL) *Low Carbon Grid Study* had a similar conclusion on the need for additional bulk storage to minimize curtailments in a high-renewables scenario.[16] These two studies do not directly indicate that bulk storage resources should be pursued in lieu of regionalization, but they do suggest that a comparison should be made on the cost-effectiveness and reliability of

[14] *Clean Energy and Pollution Reduction Act Senate Bill 350 Study: Preliminary Results*, presented at the CAISO on May 24, 2016, pp. 46-47, 62-63.
[15] https://ethree.com/public_projects/energy_principals_study.php
[16] http://lowcarbongrid2030.org/

procuring in-state bulk storage resources versus relying on out-of-state resources in achieving California's energy and environmental goals.

While E3 manually added 500 MW of pumped storage as a study assumption, it is not clear if the Study also includes the potential for compressed air energy storage (CAES). The Pathfinder Phase I CAES project, for example, has plans to construct and operate a 300-MW project in Milford County, Utah, pending regulatory approval. CAES, like pumped storage, provides benefits such as operating reserves, primary frequency response, and frequency regulation. Many bulk storage resources can ramp very quickly to support intra-hour integration while also providing long energy durations, e.g. deep cycling, to integrate excess solar or other renewables.

CESA requests further energy storage sensitivity results. Assumptions of lower energy storage costs or different energy storage resources may meaningfully inform the study results and should be provided.

8. Only 'normal' weather, hydro, generation, and load conditions were modeled for the entire WECC

The Study modeled normal conditions for the entire Western Electricity Coordinating Council (WECC) region, which E3 acknowledges is a key limitation to the Study.[17] These 'normal' assumptions include assumptions of no transmission outages, no extended generation outages, and no operational de-rating of capacity. As evidenced by the situation in Aliso Canyon, CESA believes that unusual or challenging market and system conditions should also be modeled to account for the benefit of in-state resources, such as more localized solar-plus storage resources, in mitigating potential local reliability risks. Modeling for system benefits under predictable 'average' conditions very likely misrepresents true operational conditions and renders the Study results less informative and substantive. CESA recommends sensitivity cases presume more some realistic but challenging operating conditions.

The emphasis on system-wide benefits of expanding the CAISO's operations to a larger regional footprint overlooks the local reliability risks of transmission outages or de-rates, which affect the ability of California to rely on out-of-state renewables for grid reliability purposes.

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1. Are any of the study results presented at the stakeholder workshop unclear, or in need of additional explanation in the study's final report?
Comment: CESA requests clarification on how new energy storage resources are picked up in the sensitivity test results for Scenarios A-H.
2. Please organize comments on the study on the following topic areas: **a. The 50% renewable portfolios in 2030** **b. The assumed regional market footprint in 2020 and 2030** **c. The electricity system (production simulation) modeling** **d. The reliability benefits and integration of renewable energy resources** **e. The economic analysis** **f. The environmental and environmental justice analysis**
Comment: CESA focuses its comments above on (c) the electricity system (production simulation) modeling and (d) the reliability benefits and integration of renewable energy resources, particularly given the unique ability of energy storage to be integrated with renewable energy in dense urban load pockets.
3. Other
Comment: CESA has no other comment at this time.