Storage Considerations in Slice of Day Framework

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Questions posed throughout 3B2 workshops

- Is there a risk of inability to charge the storage fleet in advance of a period with risks of loss of load?
  - Not in the foreseeable future
  - Long-term concerns can be managed through scenario analysis to establish the planning reserve margin

- What operations should be anticipated from the growing storage fleet when considering behavior in RA Year 2024 and beyond?
  - Multiple partial charge and discharge cycles across the day as well as at least two possible full charge and discharge cycles.

- Are storage RA resources accurately being valued for the reliability contribution they provide in their contracts and showings?
  - Not if Net Qualifying Capacity ignores roundtrip efficiency and point of interconnection limits

No near-term concerns that storage may not have sufficient charge system-wide

Entities' concerns with rapid storage growth

- Concerns have been raised over the ability to sufficiently charge BESS to meet the peak and net peak demands

- These concerns have largely stemmed from fears that on a day with risks of loss of load the system will simultaneously experience low energy conditions such that excess energy is not available for the storage to charge
  - 6 slice or 24 slice proposals propose to "address" this issue through directing procurement to ensure capacity available to mitigate this risk
  - 2 slice proposal proposes that IRP should capture these concerns and that uncertainty scenarios in LOLE studies should reflect operational risks to set RA requirement

Addressing risks raised on storage growth

- There is sufficient energy to charge batteries in aggregate as far out as we have reliable data as seen in CEC mid-term reliability report

- Long-term concerns can be addressed by establishing the planning reserve margin needed to meet 1:10 based on a LOLE study that includes scenarios for extremely limited energy supply conditions

- Additional procurement directives for solar RA resources would increase over-procurement without ensuring benefits being pursued can be realized in operations
  - Does not guarantee reliability improvements desired
  - There are many factors that could result in limited energy supply conditions not just solar output (discussed further)

- A source that can be used to inform the second concern is the CEC adopted Mid-Term Reliability Analysis Report

CEC shows there is limited risks of limited energy for charging storage

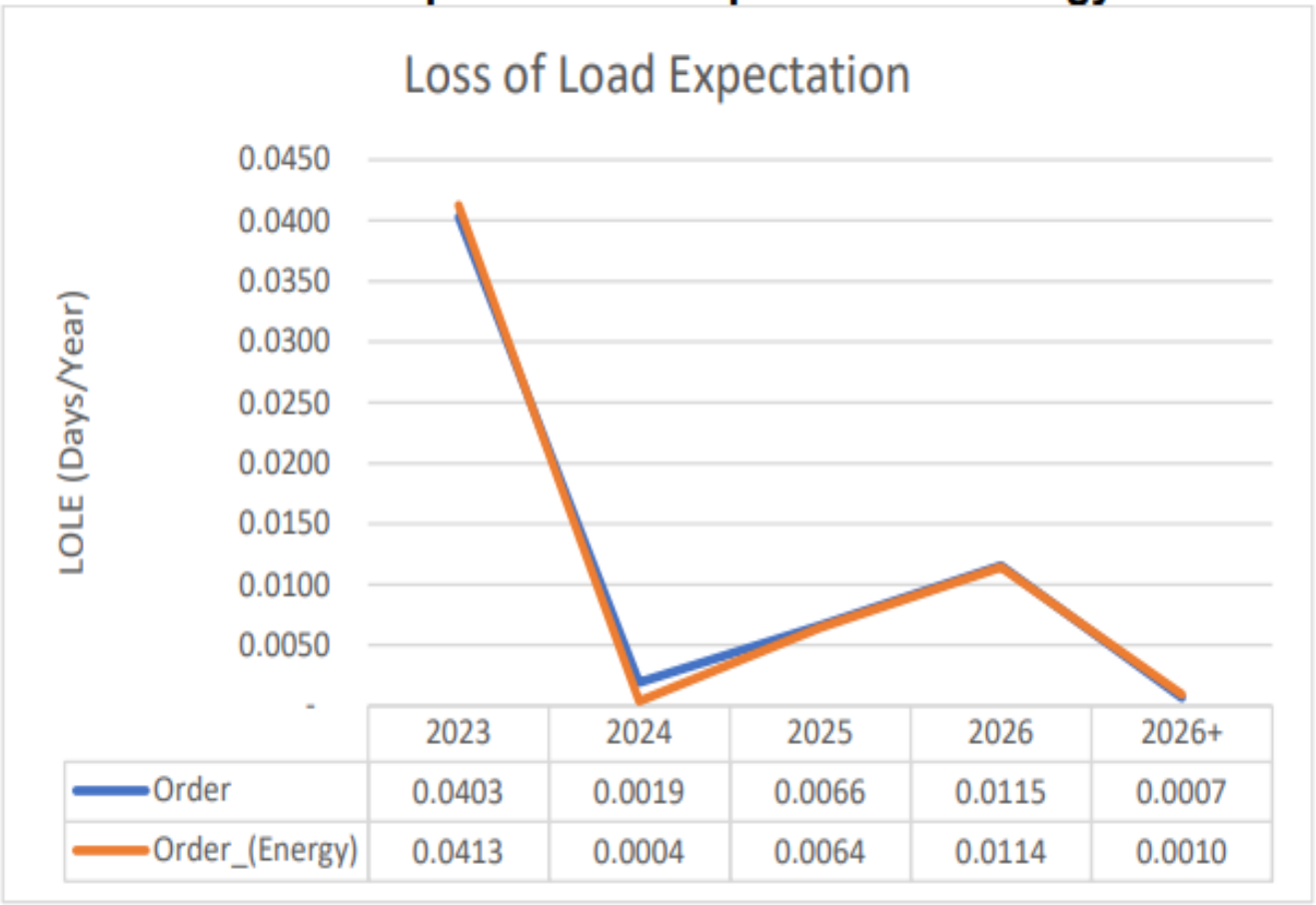
- CEC analyzed scenarios to test whether there is sufficient grid energy ahead of net peak to charge BESS sufficiently to provide services during net peak under increasingly constrained conditions

- Tested ability to support reliability even if significant levels of energy are unavailable by reducing energy available in model by ~100,000 MWh daily, assuming:
  - Restricted hydro to HE 17-22
  - Restricted max imports to CPUC assumed levels (5,000 MW)
  - Sensitivities on solar output (P15, P30, P45 reduced output)

- Report found energy sufficiency to support charging unlikely to be constraint with the IRP portfolio directed for Mid-Term Reliability
  - Results of energy-limited scenarios were very similar to non-energy limited scenarios

CEC study testing sufficient charging on system

Figure 8: Loss of Load Expectation Comparison for Energy Limited Cases



	2023	2024	2025	2026	2026+
Order	0.0403	0.0019	0.0066	0.0115	0.0007
Order_(Energy)	0.0413	0.0004	0.0064	0.0114	0.0010

Source: CEC Mid-Term Reliability Analysis Report

"Order" = IRP base case

"Order_(Energy)" = energy limited case

Ensuring battery operating risks are considered

- Proposal to incorporate risks as they evolve associated with resource unavailability or risks of limited energy supply for charging in Loss of Load Expectation study

- Recall, proposed to include the following uncertainties in LOLE

- Our proposal to use probabilistic approach for uncertainties to produce distribution of outcomes (X_i) includes the proposed operational uncertainty scenarios

- By including the probability of the operational risk occurring triggering a loss of load hour, the LOLE will address risks due to storage fleet growth

Ensuring battery operating risks are considered

- Loss of Load Expectation study would produce total generation capacity needed to meet the 1 in 10 as result of modeling the risks associated with storage unavailability due to limited energy supply

- Risk management requires managing various drivers impacting energy limited scenarios including:
  - Risks of low hydro production
  - Risks of reduced solar or wind production
  - Risks of loss of intertie transfer capability reducing import deliverability into the system

- By including probability distribution of various uncertainties as well as sensitivity scenarios as needed in LOLE, each iteration of the LOLE can capture expected risks more accurately than making oversimplified assumptions

Battery fleet operations illustrate ability for multiple cycles

Battery showings should respect each resource's technical characteristics

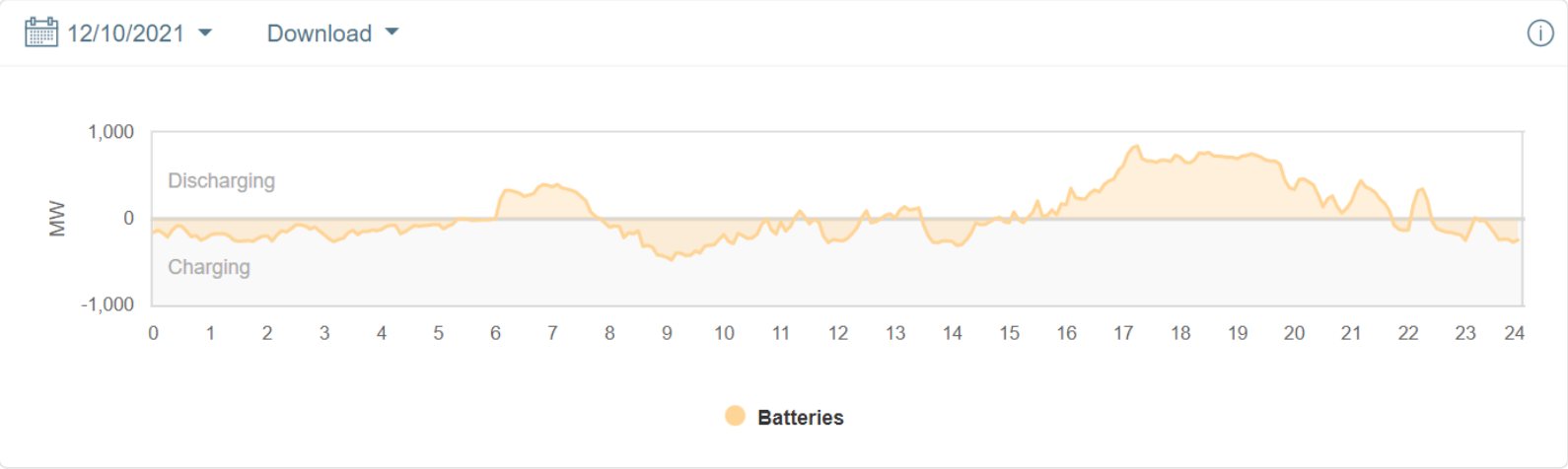
- **Round-trip efficiency:** Resource-specific characteristics should be accounted for in the Qualifying Capacity rules as described prior

- **Use limitations on number of cycles:**
  - While previous contracts included contract limitations on cycles, we believe this practice has stopped or is greatly reduced
    - Market solution will determine number of cycles per day constrained by number of charge hours needed as function of RTE and due to market offers
  - While normal operations would expect multiple partial cycles, it is possible for each battery to identify the number of discharge hours it can provide full NQC and historical data to identify where in the day these should be assumed

CAISO today's outlook shows ~ two cycles

- Today, in aggregate the battery storage fleet is providing more than a single cycle of four continuous discharge hours at full output

- Assuming a single cycle limitation per day is overly constraining on battery storage operations and inconsistent with reality



Source: https://www.caiso.com/TodaysOutlook/Pages/supply.html, 12/10/2021

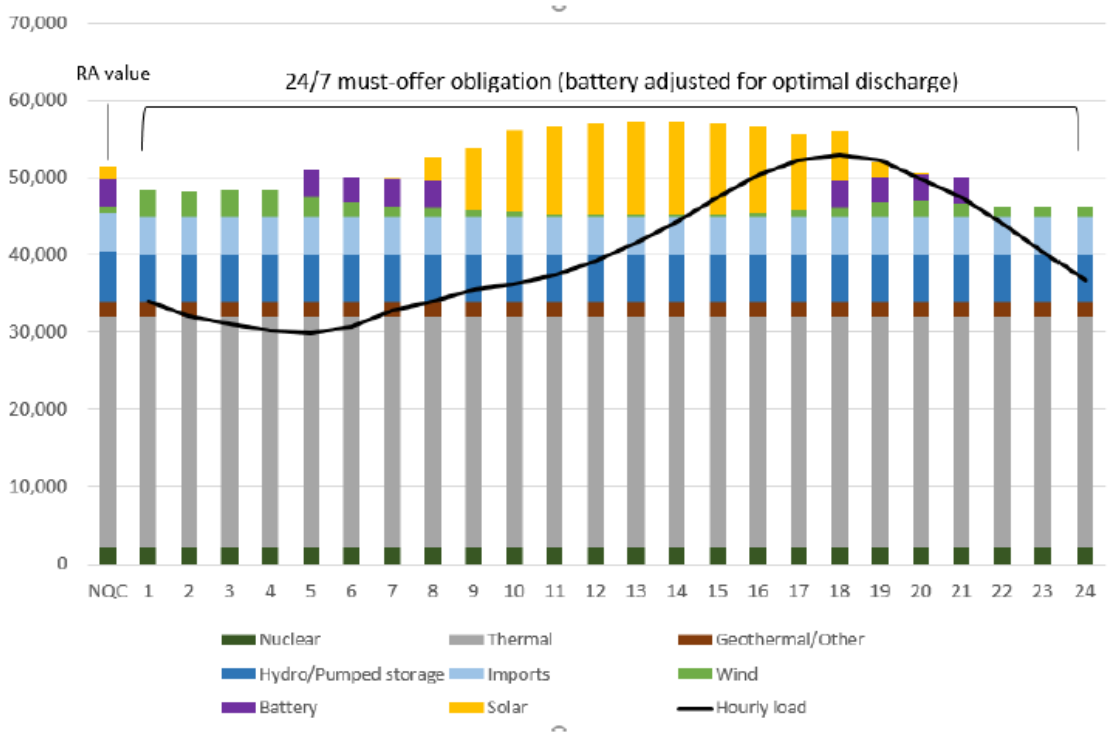
- Today's outlook is aggregate behavior of the fleet but it's important to note that individual batteries may not be dispatched in the aggregate direction masking individual battery's behavior

Gridwell's slice 1 gross peak chart review

- Gridwell illustrative example in Dec. 1st slides shows that batteries adjusted for optimal discharge provide at least two cycles

Slice 1 – peak load requirement with 24/7 must-offer

Illustrative September 2022



Proposal under any framework

- Propose that under any framework a battery asset should be counted during periods up to its maximum number of discharge hours given its physical capabilities and assuming full output cycles

- The proposed rule should be adopted regardless of framework, for example:
  - Under two-slice framework, storage allowed to show up to its max number of discharge hours at full output given physical capabilities and assuming full output cycles by:
    - ELCC includes generation dispatch based on its identified X hour ELCC bucket in gross peak and net peak slices
  - Under either four-slice framework or 24-slices framework, storage allowed to show in “slices” up to its maximum number of discharge hours given its physical capabilities and assuming full output cycles by:
    - 6-4hr slices: Shown for at least 2 slices unless physically limited
    - 24 slices: Shown for up to 12 hours a day respecting round-trip efficiency unless physically limited

RA Qualifying Capacity

Principles

- Local and system RA can be procured from a qualifying resource only up to its Net Qualifying Capacity therefore any proposed changes to Net Qualifying Capacity will apply to all RA products

- Net Qualifying Capacity should be a reasonable estimate of battery energy storage's capability to discharge during periods of need on-demand at full output sustained for up to four continuous hours

- Net Qualifying Capacity rules should not include restricted operation due to warranty and cycling costs as these are economic signals not physical capabilities, where the economic impact of operations should be in market offers and the dispatch reflect the need for the resource at that cost level.

Storage counting rules in any framework

- Net Qualifying Capacity for energy storage should be output level (in MW) at which the resource is capable of discharging at full output for four or more uninterrupted hours limited by POI

- If incremental ELCC were applied to batteries, the ELCC percentage should apply to NQC and EFC