Energy Storage and Distributed Energy Resources Phase 3

Revised Straw Proposal

April 30, 2018

Market & Infrastructure Policy

Table of Contents

1 Introduction 3
2 Stakeholder Process 4
3 Energy Imbalance Market Classification 4
4 Changes made to the February 15 straw proposal 5
5 Demand Response Resources 8
5.1 Demand response modeling limitations 8
5.1.1 Proposal 9
5.2 Removal of the single LSE requirement and default load adjustment 13
5.2.1 Proposal 14
5.3 Load Shift Product 16
5.3.1 Proposal 16
5.4 Recognition of behind the meter EVSE load curtailment 23
5.4.1 Proposal 23
5.5 Multiple-Use Applications 25
5.6 Non-Generator Resources 26
5.6.1 Throughput management and use limitations 26
5.6.2 State of charge management 28
6 Next Steps 30
Appendix A Acronyms 32

1 Introduction

The focus of the California Independent System Operator's (CAISO) energy storage and distributed energy resources (ESDER) initiative is to lower barriers and enhance the abilities for energy storage and distribution-connected resources[1] to participate in the CAISO markets. The growing number and diversity of these resources are beginning to represent an increasingly important part of the future grid.

The ESDER initiative is an omnibus initiative with annual phases covering several related but distinct topics. The second phase of ESDER developed enhancements to demand response (DR), non-generator resources (NGR), multiple-use applications (MUA), and station power for storage resources.

The CAISO published a straw proposal on February 15, 2018 identifying the scope for ESDER 3 along with potential solutions. Since the release of the straw proposal, the CAISO has held a conference call along with a technical working group to develop the proposal. This revised straw proposal provides further details along with changes in response to stakeholder feedback. The following describes the scope of the ESDER 3 initiative:

- Demand Response – Four demand response enhancements will be in ESDER 3: (1) new bidding and real-time dispatch options for demand response resources, (2) removal of the single load serving entity (LSE) aggregation requirement along with need for application of a default load adjustment (DLA), (3) development of a load shift product, and (4) recognition of sub-metered electric vehicle supply equipment (EVSE) load curtailment.
- Multiple-Use Application (MUA) – The CAISO will identify potential tariff and market design changes that may be needed to facilitate the MUA framework set forth in the commission's final decision on Multiple-Use Application Issues[2], under proceeding R.15-03-011, and CAISO staff will actively participate in the CPUC's MUA working group meetings to further influence actions to be taken within ESDER3.
- Non-Generator Resource (NGR) – The CAISO will develop a process to identify whether an NGR may qualify for use-limited status.

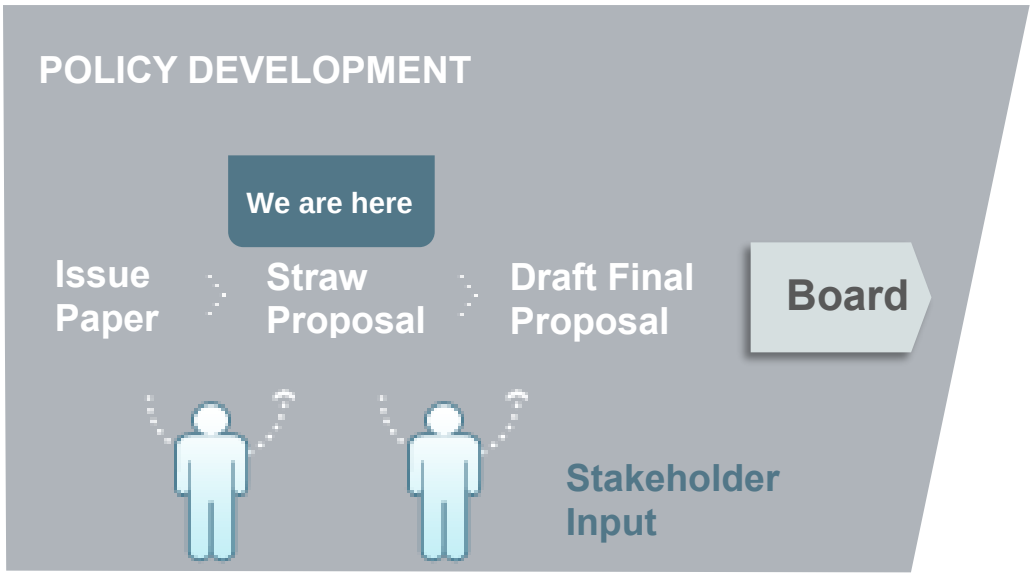
[1] DERs are those resources on the distribution system on either the utility side or the customer side of the end-use customer meter, including rooftop solar, energy storage, plug-in electric vehicles, and demand response.
[2] http://docs.cpuc.ca.gov/SearchRes.aspx?DocFormat=ALL&DocID=206462341.

2 Stakeholder Process

The CAISO is at the "Straw Proposal" stage in the ESDER 3 stakeholder process. Figure 1 below shows the status of the straw proposal within the overall ESDER 3 stakeholder process.

The purpose of the straw proposal is to present the scope and solutions of issues related to the integration, modeling, and participation of energy storage and DERs in the CAISO market. The CAISO has reviewed stakeholder feedback through comments and working group meetings to identify the priority proposals the CAISO will pursue in this initiative. After publication of the straw proposal and a stakeholder call, the CAISO will continue to hold working group meetings as necessary to refine the proposals. As appropriate, the CAISO may organize focused working groups to address issues of a complex nature or those that have cross-jurisdictional concerns as we move through the initiative process.

Figure 1: Stakeholder Process for ESDER 3 Stakeholder Initiative



3 Energy Imbalance Market Classification

CAISO staff believes that ESDER 3 involves the Energy Imbalance Market (EIM) Governing Body's advisory role to the Board of Governors (Governing Body – E2 classification). This initiative proposes four changes to the proxy demand resource (PDR) and reliability demand response resource (RDRR) model with the aim of reducing barriers to participation and enhancing their ability to provide services in the day-ahead and real-time markets. There are no changes specific to EIM balancing authority areas. The changes would allow PDRs to bid into the hourly and 15-minute markets, provide

real-time dispatch enhancements, and add a component to allow the resource to increase consumption by charging behind the meter energy storage (battery). Additionally, the initiative adds a new performance measurement recognizing Electric Vehicle Supply Equipment as an independent load curtailment contributor participating under the PDR model, and eliminate the requirement for PDR and RDRR resources to be composed of service accounts under one LSE while maintaining the single sub-Lap requirements. All of the new proposed features would apply generally throughout the ISO market, and thus be advisory for the EIM Governing Body.

4 Changes made to the February 15 straw proposal

The following section provides a summary of major changes to the proposal and response to stakeholder comments since the posting of the straw proposal on February 15, 2018.

The CAISO reorganized each proposal under three sub-headings:

1. **Pre-market –** Describes all changes needed before a resource participates in the CAISO market (i.e., Master File, DRRS, etc.).
2. **Market –** Identifies potential modeling and bidding rule changes.
3. **Post-market –** Identifies settlement implications including performance calculations such as customer load baselines.

Appendix A is a list of acronyms used within the proposal. Stakeholders are encouraged to reference this section while reviewing the proposal.

Section 5.1 – Demand response modeling limitations

The CAISO updated the proposal to offer an hourly and 15-minute bid option for PDRs and removed the proposal to offer an hourly bid option with the ability to change the bid once within the hour. Details on registration of the additional bid options and day ahead/real time bidding rules are included. In addition, the proposal references the Day-Ahead Markets Enhancement (DAME) initiative, which is proposing to replace the residual unit commitment (RUC) with an Imbalance Reserve Product (IRP). Due to the proposed replacement of the RUC, the proposal redefines the issue around infeasible real-time dispatches.

Stakeholders such as the Joint DR Parties are in support of the proposal but do not believe the expanded bid options fully resolve the issue of infeasible dispatches. OhmConnect and Olivine requested clarification on the economic bid submission in real time. The CAISO agrees and reflected changes in the proposal that a scheduling

coordinator (SC) will submit an economic bid and not a self-schedule in the real-time market.

Section 5.2 – Removal of the single LSE requirement and default load adjustment

No major changes were proposed in this iteration of the paper but further details are provided in removing the LSE designation within the Demand Response Registration and Master File systems.

A majority of stakeholders supported the proposal. Olivine suggested that the SIBR rule to reject all bids below the NBT price threshold may result in default energy bids (DEBs) being rejected. The CAISO will ensure as part of the initiative, through SIBR rules developed, that all appropriate validation rules are in place to maintain compliance with FERC order 745. As mentioned above, ESDER 3 is considering changes anticipated with the parallel efforts of as the DAME initiative, with coincident implementation, which is proposing changes to the design of DAM combining the IFM and RUC processes and introducing an IRP procurement. These changes effectively replaces RUC with imbalance reserves eliminating the concerns regarding DEBs.

Section 5.3 – Load Shift Product

The CAISO provided further details on the design of the proxy demand resource - load shift resource (PDR-LSR). The PDR-LSR is a demand response resource providing both load curtailment and dispatchable, compensated consumption to provide "energy shift." To participate, a resource will register two separate resource IDs containing the same service accounts (Resource ID – curtailment, Resource ID- consumption). The performance measurement of the load consumption will be calculated via the Metered Energy Consumption (MEC) methodology, introduced below.

Stakeholders such as CESA, are in support of the current design for the PDR-LSP but believe the metered energy consumption (MEC) and metered generator output (MGO) calculation needs to account for a resource's charge and discharge during non-event hours. PG&E, within its comments, does not believe in accounting for both consumption and curtailment. The CAISO is proposing that under the PDR-LSP, the MEC and MGO will consider both the consumption and curtailment of non-event hours to determine a typical use measurement. Olivine expressed concern over establishing two separate resource IDs, which removes the ability for the CAISO to manage SOC and doubts the "verification of actual load shift." Olivine also stated that it strongly recommends, "…taking a longer view to implement an actual shifting product – not just a consumption product…" The CAISO understands Olivine's concerns but does not agree the separation of two resource IDs results in the development of a consumption only product. The requirement that an PDR-LSR must have a directly metered energy

storage will guarantee that the energy being charged and discharged will result in a load shift.

SDG&E commented that the CAISO should not limit the load consumption resource ID of the PDR-LSR to negative bids. Additionally, SDG&E was concerned of bid cost recovery (BCR) of both resource IDs resulting in "over-payment." The CAISO does not agree with SDG&E on allowing load consumption bids in the positive range. The purpose of the negative only bid rule is to prevent conflicting dispatches since the PDR-LSR will not be optimized across positive and negative generation. Additionally, a PDR-LSR will still consume and pay for energy under the relevant retail rate meaning a non-negative PDR-LSR bid would result in increased cost for the PDR-LSR providing the load shift. The CAISO views the PDR-LSP as an option under the demand response participation model to take advantage of negative prices and provide a load shift during periods of over-generation. Because the proposal creates two distinct resource IDs, the CAISO is proposing to calculate BCR separately for each resource and does not believe that it will result in the over-payment of PDR-LSRs. The CAISO proposes to monitor BCR allocations to PDR-LSRs to determine if over-payment is occurring.

Section 5.4 – Measurement of EVSE performance

The CAISO provided details on the registration of EVSE measurement and established a distinction between an EVSE located in a residential and non-residential setting. The CAISO has also proposed to keep the submetering standards consistent with current requirements listed in the CAISO's Metering Business Practice Manual (BPM) Appendix G.

A majority of stakeholders supported the EVSE proposal. SDG&E commented that it did not understand how an EVSE mixed with traditional load curtailment (facility load) would be dispatched. The CAISO is not proposing a method in which an aggregation of EVSEs will be dispatched separately from the facility load. The CAISO is proposing to allow for the distinct measurement of an EVSE's performance similar to the recognition of energy storage resources load curtailment contribution utilizing the MGO methodology. In response to Olivine's comment of the CAISO's justification for proposing a measurement for EVSEs, the CAISO believes that EVSEs are similar to an energy storage device and have unique characteristics in performance to a request for load curtailment that is not observed under current performance methodologies utilizing load measurement at the retail meter. An EVSE is a distinct device that is not only physically separated from a facility but also performs very differently from the performance of the host's load curtailment resources (i.e. EVSEs are not temperature sensitive, for example).

Section 5.6 – Non-Generator Resource Model

The CAISO is no longer considering commitment costs associated with a non-generator resource through the CCDEBE initiative. Per the CAISO Market Instruments BPM NGRs are modeled as resources that do not have start-up, minimum load, and transition costs.[3]

5 Demand Response Resources

In the Issue Paper, the CAISO identified enhancements to the Proxy Demand Resource (PDR) and Reliability Demand Response Resource (RDRR) participation models.

5.1 Demand response modeling limitations

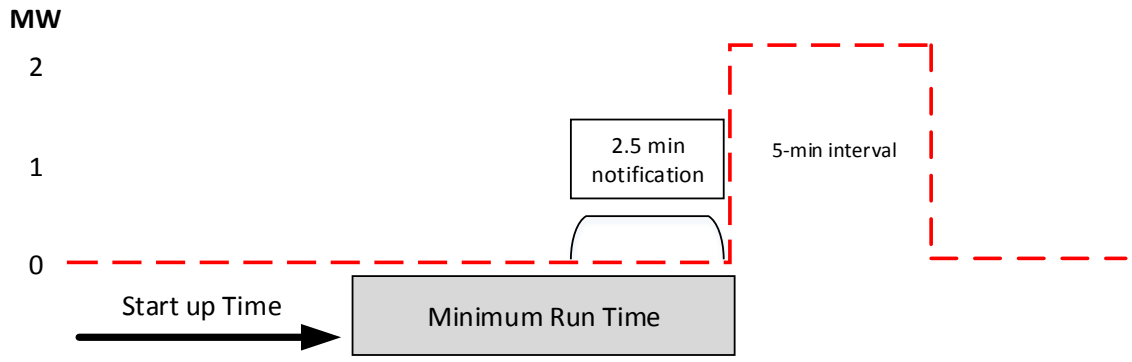
DR resources are successfully integrated into the CAISO market and aide in meeting system reliability. The CAISO is looking to continue market design enhancements to provide DR resources options to inform the CAISO of its operating characteristics to align the market optimization of these resources in the day-ahead and real-time market processes.

Minimum and Maximum Run-Time Constraints

As mentioned above, the CAISO is aware of the misalignment between a DR resource's Pmin of 0 MW and the CAISO market optimization. Today, the CAISO market systems will issue a start-up instruction to a DR resource to their Pmin, often 0 MW, well in advance of the commitment hour in the real-time market. This commitment ensures both start-up and minimum runtime constraints are met, however, since the resource is now "running" at a Pmin of 0 MW, it is available for dispatch whenever the resource's energy bid is economic. This can result in 5-minute dispatch instructions that have only a 2.5-minute notification time. Certain affected stakeholders have explained that this notification time is infeasible for many PDRs. Figure 2 below represents this scenario.

[3] CAISO Market Instruments BPM (page 42): https://bpmcm.caiso.com/Pages/BPMDetails.aspx?BPM=Market%20Instruments

Figure 2: Commitment of DR resource with a Pmin of 0 MW



The CAISO respects the resource's minimum run-time constraint when committing at Pmin, represented in Figure 2 as the gray horizontal bar. However, the minimum run-time constraint at times may be met while the resource is at a Pmin of 0 MW, which is dispatched above its Pmin, represented as the dashed red line above. [4] Stakeholders have suggested that the PDR participation model does not effectively recognize two constraints:

(1) Recognition of the minimum run time when the resource is dispatched above its Pmin of 0 MW

(2) Limitation in using the maximum daily energy limit instead of a maximum run time to recognize daily use limitations.

5.1.1 *Proposal*

Reflecting Commitment Costs Identified in CCDEBE and Day-Ahead Markets Enhancements Straw Proposal

Outside this ESDER 3 initiative, the CAISO is finalizing the Commitment Cost and Default Energy Bid Enhancements (CCDEBE) initiative.[5] With a projected Fall 2018 implementation, CCDEBE introduces the ability for resources with a 0 MW Pmin to reflect minimum load and startup costs. Additionally, the initiative clarifies the definition of start-up costs as those "costs incurred by a resource for bringing a resource

[4] Definition of minimum run time
http://www.caiso.com/Documents/Section34_RealTimeMarket_asof_May2_2017.pdf
[5] CCDEBE Initiative Website
http://www.caiso.com/informed/Pages/StakeholderProcesses/CommitmentCosts_DefaultEnergyBidEnhancements.aspx

online or to a state capable of providing energy." Table 1 below represents the pending changes from CCDEBE and the calculation for minimum load and startup costs.

Table 1: Changes to CCDEBE that apply to DR resources

Cost	Description	Example
Minimum Load Costs	Costs that reflect run hours at minimum load, including costs incurred if sitting at 0 Pmin.	Ex) Identifying costs to keep DR resource at 0 Pmin.
Startup Costs	Cost to bring a resource to a point where it is capable of providing (curtailing) energy.	Ex) Costs incurred to call DR customers and prepare to curtail load.

The CAISO's day-ahead market enhancements (DAME) initiative will be replacing the RUC process with the imbalance reserve product (IRP). The IRP will allow a resource to reflect its marginal cost of its Must Offer Obligation (MOO) in the real-time market. With the implementation of the DAME initiative, resources will no longer submit a $0/ MWh bid. The replacement of RUC and the ability for a PDR/RDRR to submit a non-zero dollar bid for a real time market commitment will resolve the infeasible dispatch issue.

Hourly and 15 minute bidding option for PDRs

As mentioned above, although the DAME initiative is replacing RUC, the CAISO is proposing to offer bidding options for PDRs that will provide longer notification times and extended real-time dispatch intervals, very similar to what the CAISO currently offers intertie resources. The CAISO introduced this option and its application to PDR in a joint workshop with the CPUC on October 4, 2017.[6]

[6] Link to presentation from CAISO-CPUC joint workshop introducing CAISO's 15-minute market and bidding options for real-time imports and exports, slides 51- 59. http://www.caiso.com/Documents/Presentation_JointISO_CPUCWorkshopSlowResponseLocalCapacityResourceAssessment_Oct42017.pdf

The CAISO believes applying an hourly economic bidding and real-time dispatch model to PDRs will give PDRs, which require longer notification time or cannot respond to 5-minute dispatches, an opportunity to viably participate in the market. The CAISO's goal is to leverage existing market functionality where possible to enable resource like demand response to participate more effectively and efficiently in the market.

Pre-Market

The PDR will register in Master File if it will submit an hourly block bid. The process to change Master File characteristics will remain the same under the existing BPM in which changes can take anywhere from 5 to 11 business days.[7] Once the PDR has elected the bidding option, it will be required to submit bids accordingly.

Market

Once the resource elects its bid option in Master File, the PDR resource will follow one of the processes below:

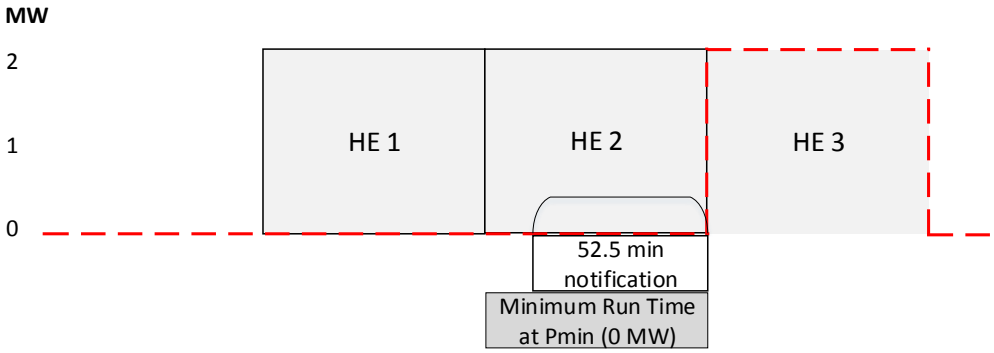
1. **Hourly block** –the SC submits a day-ahead market bid for an entire hour. In the real-time market, the resource will submit an economic bid and receive a binding price for the first 15-minute interval but be a price taker in the next three 15-minute market intervals because the energy schedule is represented for the entire hour. The binding schedule is communicated to the SC at 52.5 minutes before the flow of energy. In the example below, the resource is a 2 MW resource that opted to bid hourly. The CAISO respected the minimum run time parameter (1 hour) in HE 2 and 3. In HE 2, the CAISO sent a dispatch notification 52.5 minutes before the flow of energy for HE 3.

   Following the market design principle laid out in CAISO's FERC 764 tariff compliance, the CAISO will not allow for bid cost recovery for PDRs that elect an hourly bid option.[8]

[7] CAISO BPM for Market Instruments, "Master File Update Procedures" Attachment B (https://bpmcm.caiso.com/Pages/BPMDetails.aspx?BPM=Market%20Instruments)

[8] CAISO's tariff compliance filing on FERC Order 764 (see pg. 30-32)

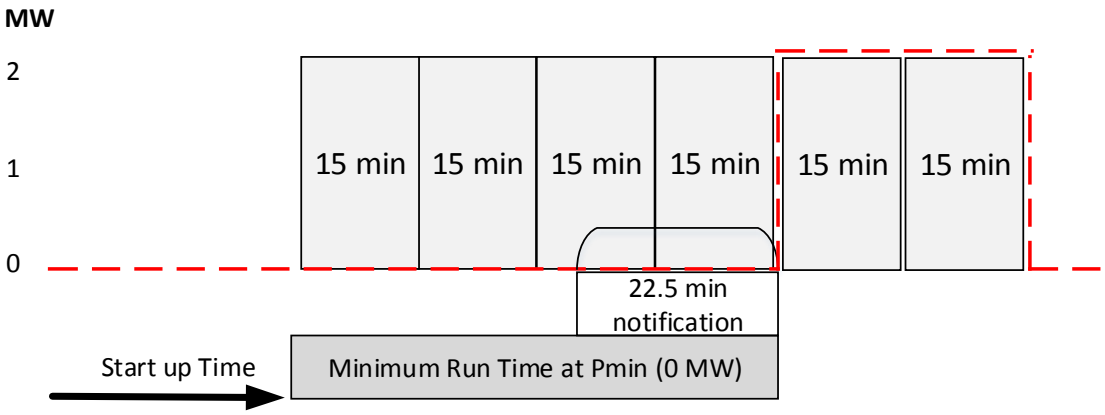
Figure 3: Example of hourly bid option



2. **15 minute dispatchable** – The SC will submit supply bids in hourly increments in the DAM. In the real time market, if the 15-minute bid is economic, it will be dispatched and receive a binding schedule at the fifteen-minute market (FMM) price. The dispatch notification is communicated 22.5 minutes before the flow of energy is expected.

   PDRs electing the 15-minute bid option will be eligible for BCR. Bid cost recovery allows a resource committed by the CAISO to recover its startup costs, minimum load costs, ancillary service bids, and energy bids over the course of the day (the 24 hours of that day). In the case that the FMM price does not cover the dispatched resource's bid-in costs, the CAISO will ensure that the resource is compensated for providing energy.

Figure 4: Example of fifteen minute bid option



Post-Market

Currently, PDRs are settled on the five-minute real time Locational Marginal Price (LMP). If a PDR elects an hourly or fifteen-minute bid option, the CAISO will settle the resource

under the FMM LMP. The CAISO established the process for FMM settlement under its FERC Order No. 764 proposal.[9] The day-ahead energy schedule will be settled at the day-ahead LMP. Any imbalances between the FMM energy schedule and the day-ahead energy schedule is settled at the FMM LMP.

5.2 Removal of the single LSE requirement and default load adjustment

The CAISO currently requires DR resource aggregations consist of locations under a single LSE, represented by one demand response provider (DRP), and within a single sub-LAP. The CAISO originally established the single LSE requirement in its PDR policy, later replicated in the RDRR policy, to facilitate the settlement application of a LSE specific DLA [10]. This adjustment eliminated the double payment for a decrease in demand when it was not net beneficial to all purchasers in terms of a wholesale market price reduction based on a demand response net benefits test. [11] This design feature required segmenting a DR program into different aggregations by LSE within a single sub-LAP. DR market participants claimed this segmentation could potentially strand some willing customer participants and affect the ability for some PDRs to meet the minimum PDR size requirement. In more specific cases, DRPs establishing new resource aggregations, or are in the process of developing new ones, have expressed difficulty meeting, or maintaining, the 100 kW minimum participation requirement as customers within their resource aggregations are defaulted or move to new LSEs, such as to a Community Choice Aggregation (CCA).

The DLA settlement mechanism requires PDR and RDRR aggregations to be under a single LSE. The DLA originated from FERC Order 745, which required the CAISO to

[9] CAISO Draft Final Proposal on FERC Order 764 (see pg. 18-19). http://www.caiso.com/Documents/DraftFinalProposal-FERC-Order764MarketChanges.pdf

[10] The DLA represents the amount of load curtailed, based on a PDR or RDRR demand response energy measurement, within a Default LAP specific to the LSE when the real-time LMP is below the threshold price.

[11] CAISO Net Benefits Testhttp://www.caiso.com/Documents/IssuePaper_DemandResponseNetBenefitsTest.pdf

implement a net benefits test (NBT).[12] The NBT establishes a price threshold at which demand response resources are deemed cost effective. If the real-time market LMP is below the threshold, the DLA is triggered; resulting in the adjustment of the metered load used in the uninstructed imbalance energy (UIE) settlement of the LSE's default load aggregation point (DLAP). This mechanism is utilized to mitigate double payment for demand response services provided in intervals where the threshold price is not met but payment to the PDR or RDRR is made.

5.2.1 *Proposal*

The CAISO proposes to remove the single LSE requirement for DR aggregations and application of the DLA. The CAISO believes by removing the single LSE requirement, the application of the DLA becomes too complex to implement and manage across multiple LSEs under a single PDR. Additionally, the settlement implications of the DLA have historically been *de minimis* relative to the benefits achieved by eliminating the one LSE per PDR requirement (see Figure 5 and Figure 6 below).

As requested by stakeholders, the CAISO conducted an analysis of the total DLA affected MWs, their settlement impacts, and how frequently the DLA was applied in 2017. On average, the DLA calculation was triggered 4% of the month over the course of a year.[13] The monthly total of MWs and settlement charges resulting DLAs applied to the LSEs are shown below in Figure 5 and Figure 6. The CAISO's DLA settlement impact analysis, in part, supports removal of the calculation and that its removal results in *de minimis* settlement impact. The CAISO maintains that removal of the DLA is necessary to institute an aggregation requirement allowing multiple LSEs to be represented within a single PDR.

[12] FERC Order 745 https://www.ferc.gov/EventCalendar/Files/20110315105757-RM10-17-000.pdf

[13] Based on the number of intervals DLA was triggered/ total number intervals in a month.

Figure 5: 2017 Total Monthly DLA Impact

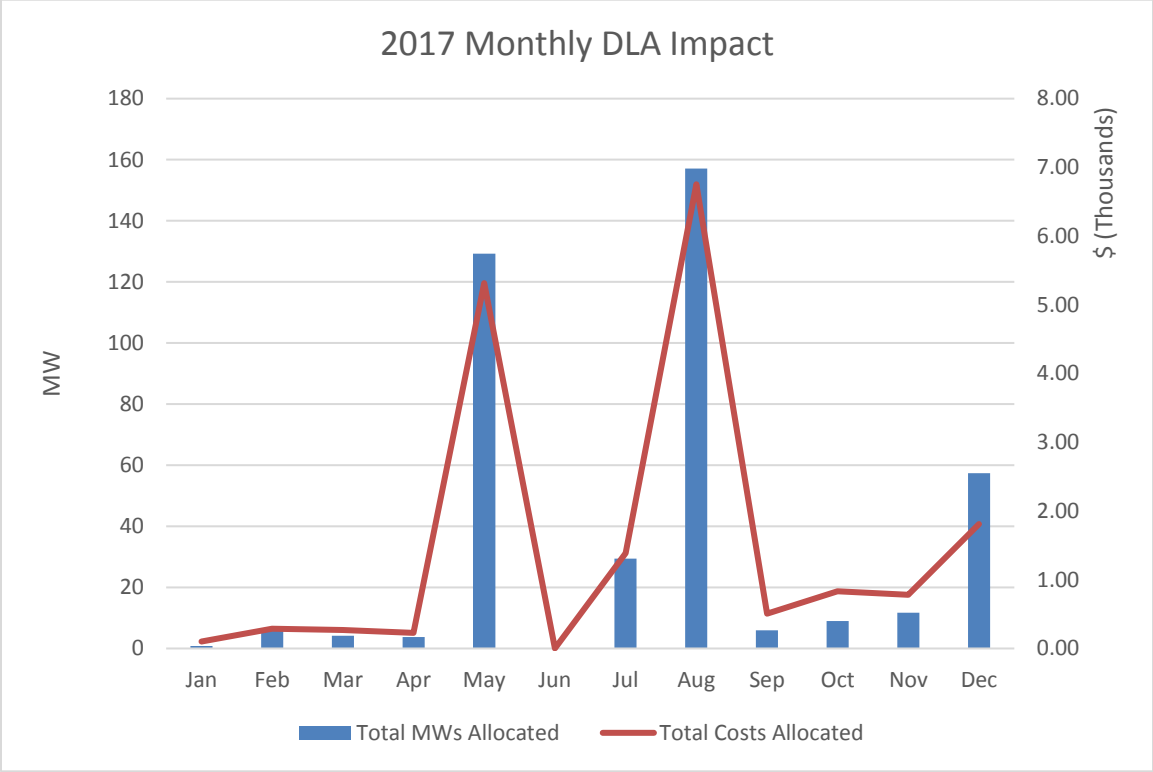
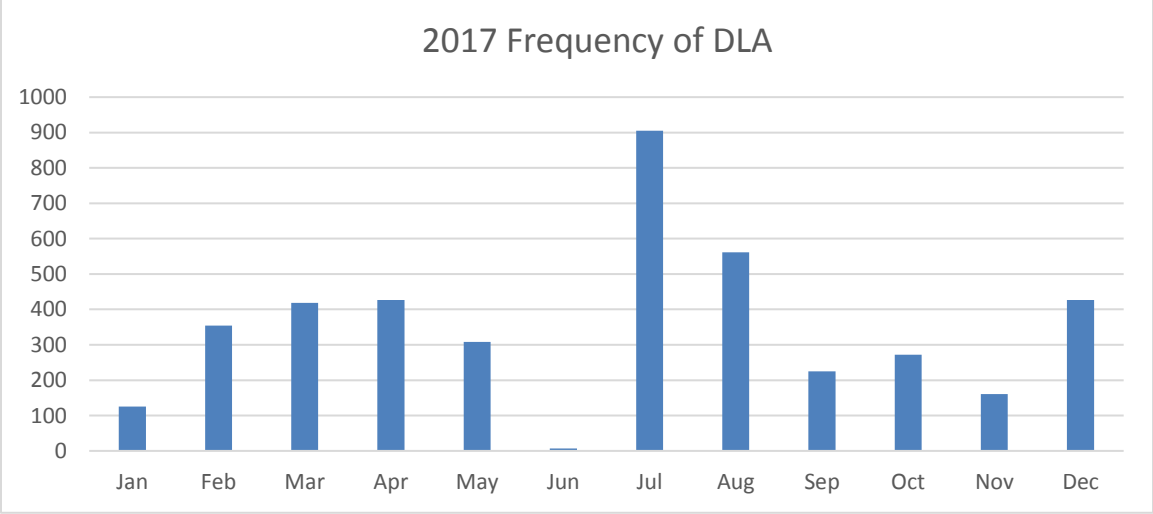


Figure 6: Number of intervals a DLA was triggered per month



Pre-market

Currently, the demand response registration process (DRRS) requires a registration for a PDR or RDRR to be composed of locations with the same LSE service accounts. The CAISO proposes to remove the single LSE aggregation rule and make appropriate

changes to the DRRS to recognize this rule and remove enforcement of the prior single LSE registration requirement.

Market

The CAISO proposes to utilize the NBT threshold price to screen submitted PDR bids in the CAISO's Software Infrastructure Business Rules (SIBR) in compliance with FERC Order No. 745. SIBR will accept bids only above the established net benefits threshold price. This SIBR rule bidding requirement will ensure PDR and RDRR resources are net beneficial to the system when submitting bids to the CAISO rather than an after-the-fact assessment in the settlement system. The CAISO will use the existing monthly calculation of the NBT and its resulting on-peak and off-peak threshold prices in SIBR to validate bid submissions in the day-ahead and real-time markets to ensure all energy prices in the energy bid are at or above the threshold price. If this condition is not met, SIBR will invalidate the bid. Invalid bid status will be displayed on the SIBR user interface and identified in bid results retrieved. Opportunity exists to correct and re-submit valid bids until the market closes. An invalid bid cannot overwrite a bid previously submitted within that market. SIBR will continue validating submission of RDRR bids in the real time market against the current rule requiring their bid prices in the energy bid curve to be at or above 95% of the energy bid price ceiling.

Post-market

Today, the DLA application is triggered within an LSE for the intervals in which the real time LMP falls below the NBT threshold price and PDR/RDRR delivers energy. Because the CAISO will accept demand response resource bids only at or above the NBT price threshold, the CAISO will remove the DLA application.

5.3 Load Shift Product

In approving the ESDER 2 proposal, the CAISO Board of Governors requested staff continue working with stakeholders on proposals set out by the original load consumption working group for enhancing the PDR model to provide additional services during oversupply conditions.

5.3.1 *Proposal*

The CAISO is proposing to develop a load shift product for behind the meter (BTM) storage devices under the PDR participation model. The load shift product will fall under existing PDR policy provisions, but may use certain functionalities from the non-

generator resource (NGR) model to bid and be dispatched for both load consumption (charging, negative generation) and load curtailment (discharging, generation) from a BTM storage resource. The initial product will allow a PDR to access day-ahead and real-time energy markets for both load curtailment and load consumption capabilities. Facilitating "shift" services while maintaining the PDR policy principle that injection or export of BTM energy storage beyond the retail meter is not eligible for wholesale market compensation.

CAISO's proposes specifications for this product listed in Table 2 below.

Table 2: Specifications of PDR Load Shift Resource (PDR-LSR)

Load shift features	Identified issues under the PDR participation model (if applicable)	Comments
Enables a load shift capability from BTM storage devices participating as PDR represented as two separate resource IDs.		One resource ID will represent curtailment capabilities and the second resource ID will represent consumption capabilities.
Resource providing curtailment through the PDR-LSR may qualify as RA capacity. Resource providing consumption through the PDR-LSR will not qualify as RA capacity.		If needed, clarify CPUC DR program and Rule 24 language to recognize PDR-LSR representing consumption will not be a RA resource.
Non-exporting product as prescribed under current PDR policy.		Performance evaluation method recognizes that curtailment provided by the PDR-LSR is compensated up to its non-exporting capabilities. Not applicable for PDR-LSR consumption performance evaluation.

Load shift features	Identified issues under the PDR participation model (if applicable)	Comments
Energy storage device manages its own state-of-charge (SOC)		
PDR-LSR consumption will be a directly metered load measurement with removal of "typical use" i.e., non-wholesale use is removed first before performance is compensated	PDR is a curtailment only participation model, therefore MGO does not recognize/settle "negative" generation (intervals in which the storage device is charging and consuming load).	Performance measurement methodology will include use of the energy storage directly metered load and generation. This will be a performance measurement specific to PDR-LSP participation, and include defining how the PDR-LSRs "typical use" will be developed and applied to provision of curtailment and consumption, to ensure incremental provision of service.
All load/energy consumed by the PDR-LSR would be purchased at applicable retail rate settled by the LSE		
Ability to bid a negative cost for energy services, to ensure dispatch at the "right" price	Current application of NBT contemplates curtailment services and not provision of consumption services.	The NBT threshold price bidding rules[14] would apply to the PDR-LSR curtailment bids but would not be applicable to the PDR-LSR consumption bids. The net benefits test establishes a price threshold above which

[14] Bidding rules as described in section 5.2.1, paragraph 4.

Load shift features	Identified issues under the PDR participation model (if applicable)	Comments
		demand response resource bids are deemed cost effective. The net benefit test is estimated based on a representative aggregated supply curve applicable to PDR-LSR providing bids to consume as a pseudo supply resource at a non-zero price. The price threshold does not take into consideration the PDR-LSR that is providing bids to consume at a negative price as a load or negative generation. The CAISO therefore believes that the intended application of a NBT is applicable only to the PDR-LSR curtailment.

Pre-market

The CAISO proposes that the PDR-LSR will facilitate the provision of load curtailment and load consumption by two discrete resources registered in Master File, one resource ID to reflect the operating characteristics of the resources curtailment capabilities and the second resource ID to reflect those of its consumption capabilities. Both resource IDs will be able to register using the same registered service accounts. At least one of the service accounts must have a behind the meter storage to qualify as a PDR-LSR.[15] A resource wanting to participate under the PDR-LSR must register with both resource IDs and cannot opt to register for just the consumption functionality. PDR-LSRs may have

[15] The CAISO at this time, defines "behind the meter storage" as a battery storage resource that can be directly metered.

an RA obligation for the provision of curtailment and will still have a MOO applicable to the PDR-LSR resource ID identified as such.

Market

To ensure that conflicting dispatches will not occur within intervals, the CAISO proposes that the PDR-LSR will be available to bid either as a 15-minute or 5-minute dispatchable resource only. Because the PDR-LSR is a single product with two resource IDs, it must bid both resource IDs consistently and exclusively. For example, if a PDR-LSR elects to be dispatchable on a 5-minute basis under the resource IDs providing consumption, it cannot elect to use the hourly or 15-minute bid option for the resource ID providing load curtailment. The PDR-LSR must maintain symmetric dispatchability for both resources by selecting the same real time bidding options for both load curtailment and consumption resource IDs.

The CAISO also proposes that the load consumption resource ID for the PDR-LSR will only be allowed to bid from the bid floor (-$150) up to $0. Load consumption for the purposes of the load shift product will not be allowed to bid in the positive range to prevent conflicting dispatch signals. The CAISO is proposing to prohibit the load consumption resource ID to provide ancillary services because demand response resources can only provide spin/non-spin services and not regulation which results in movement in the positive generation direction.

A PDR-LSR will be eligible for BCR. The CAISO will calculate BCR as it does today for the load curtailment resource ID. For load consumption, the CAISO will offer BCR because the resource's bid has indicated a price to consume energy in a given interval, and may have foregone revenues of providing a service outside of the CAISO market. In the course of a day, if the resource was not able to recover its bid costs, the CAISO will make the resource whole. The CAISO will calculate the BCR for both resource IDs separately.

For example, a resource is willing to consume and submits a -$50 bid and is scheduled, but the prices are -$20/MWh. In this example, CAISO believes that the PDR-LSR was willing to forego revenue outside of the CAISO market and be paid $50 (-$50 energy bid) to consume energy. Instead, the resource was only able to recover $20 in which it could have realized revenues outside of the CAISO market of up to $50. In this case, the CAISO would recover the difference and pay the resource up to the amount of -$50/MWh.

Figure 7 illustrates a resource's bid stack for both resource IDs and the corresponding award in 5-minute intervals.

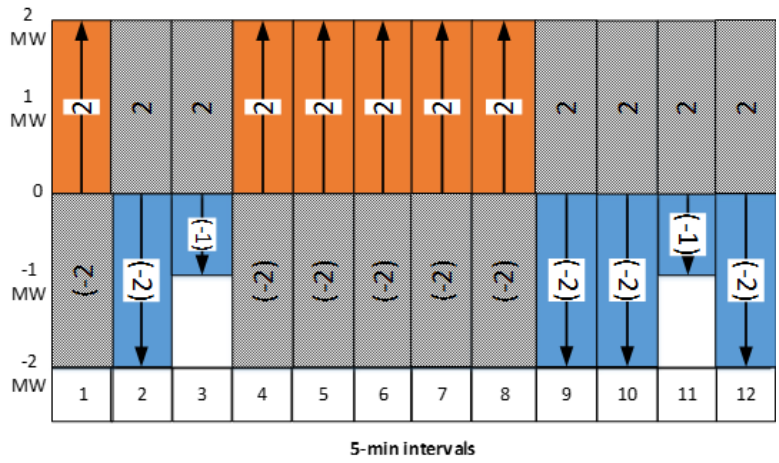
Figure 7 Load Shift Resource bid stack and awards in the market

Resource ID – Load Curtailment

Amount (MWhs)	Bid
1	$40
2	$55

Resource ID – Load Consumption

Amount (MWhs)	Bid
-2	-$80
-1	-$45

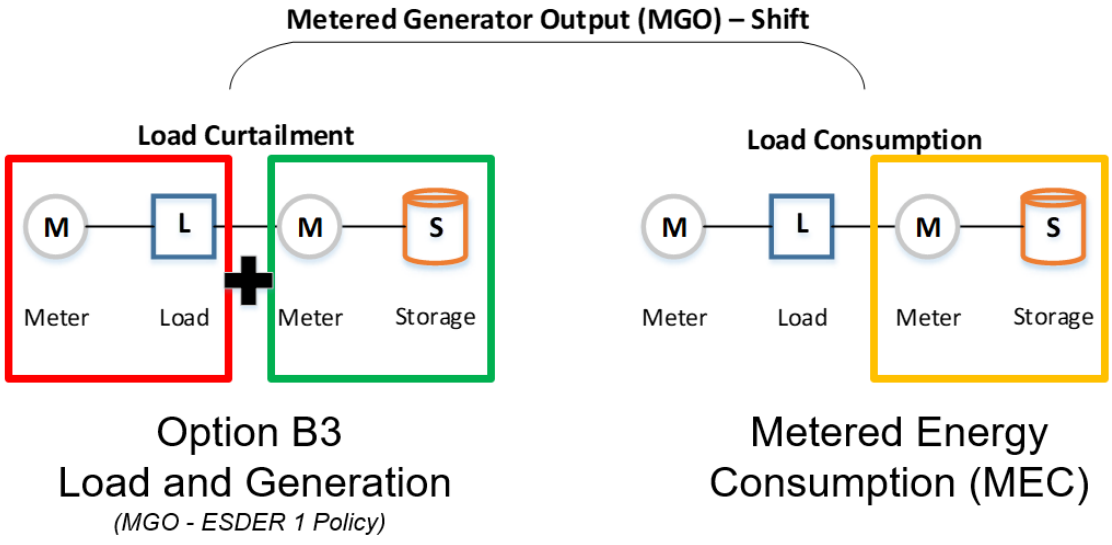


Post-market

The load curtailment resource ID will be settled under the same rules as it is today with slight modifications to how the Demand Response Energy Measurement (DREM) is developed. The load consumption resource ID will follow the same guiding principles under the load curtailment (current PDR settlement); except, the resource will settle as negative generation utilizing a separate performance measurement with resulting DREM. The PDR-LSR will follow the same meter data submission requirements for all PDR/RDRRs.

The SC or DRP of a PDR-LSR will calculate the performance of load curtailment of the facility, load curtailment of the energy storage, and the load consumption from the energy storage (shown below in Figure 8).

Figure 8: Performance calculation for load shift resource



Under the load consumption resource ID, the consumption measurement will employ a "Metered Energy Consumption" (MEC) methodology. The MEC methodology utilizes the same constraints as the Metered Generator Output (MGO) methodology for load curtailment.[16] The MEC methodology will net out "typical usage" to define the incremental load consumption value provided. The development of a typical usage adjustment will include both consumption and curtailment behavior of the PDR-LSR resource IDs. Established through a look back of both of the PDR-LSR resource IDs, the typical usage will take into account the consumption and curtailment values during non-event hours using a 10-in-10 non-event hour selection method for similar days. An event hour is one in which the PDR-LSR was subject to an Outage or previously provided Demand Response Services (other than capacity awarded for AS) for any interval within the CAISO Hour Ending (HE) interval, be it the full hour or a 5-minute interval in that hour. The look-back period will extend to 45 days and calculate the simple average of the energy consumed or curtailed during the 10 most recent non-event hours for the same day type and for the same event hour when the PDR-LSR dispatch event occurred. This simple average will be limited to represent a typical usage for "consumption" used to establish the point at which the resource is providing net load consumption.

Additionally, the CAISO is proposing that under the PDR-LSR, the MGO methodology will mirror the MEC methodology and consider both consumption and curtailment values during the look back of 10 non-event hours but limit the resulting simple average to represent a typical usage for "curtailment" during that period of time.

The CAISO is proposing the following to develop a PDR-LSR typical usage:

1. MGO-Shift (To account for load curtailment of energy storage): 10-in-10 customer load baseline, using 10 non-event hours including both consumption and curtailment in the calculation of the simple average, but only accept a value that is at or above 0 (positive generation = curtailment).
2. MEC (To account for load consumption of energy storage): 10-in-10 customer load baseline, using 10 non-event hours including both consumption and curtailment in the calculation of the simple average, but only accept a value that is at or below 0 (negative generation = consumption).

This PDR-LSR typical usage will be used to adjust the metered output, generation or load, when calculating its performance attributed to a curtailment or consumption

[16] MGO proposal under ESDER Phase 1 (http://www.caiso.com/Documents/RevisedDraftFinalProposal-EnergyStorageDistributedEnergyResources.pdf)

dispatch. Changing the MGO methodology for energy storage participating under the PDR-LSR is to account for a resource that is now responding to dispatches for consumption and curtailment. The CAISO believes the "typical use" of an energy storage resource as a PDR-LSR has to consider movement in both directions. A participant that opts to provide load curtailment only with a directly metered energy storage device will continue to use the current MGO calculation under PDR, which only considers curtailment values in the 10 non-event hours.

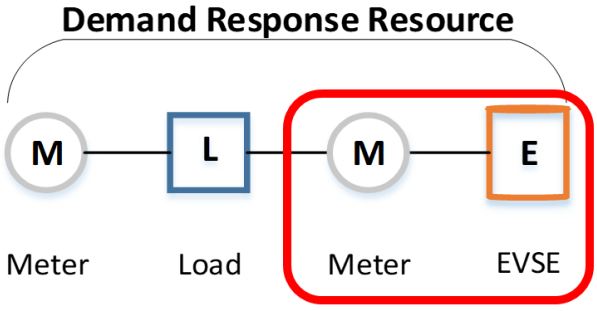
5.4 Recognition of behind the meter EVSE load curtailment

FERC approval of the CAISO ESDER 1 initiative tariff filing resulted in the implementation of the MGO performance measurement, which uniquely recognized a sub-metered storage device's contribution to a facility's overall load curtailment during a CAISO dispatch event. As part of the ESDER 2 initiative process, comments received from certain stakeholders requested that the MGO concept extend to submetered EVSE loads so that load curtailment, achieved by managing the rate of EV charging based on an ISO dispatch instruction, could be recognized and measured distinct from the building load.

5.4.1 *Proposal*

The CAISO proposes to enable EVSEs sub-metering and extend the MGO performance method for EVSE market participation independent of, or in combination with, its host customer. To be sure, EVSEs or any sub-metered device can already participate using the MGO provisions, but the CAISO currently cannot accommodate a sub-metered resource with a different performance methodology than its host facility load, which many desire for EVSEs. Sub-metering resolves the lack of fifteen-minute interval metering at the host facility for measurement of curtailment in five-minute intervals, enables direct measurement of the actual EV load curtailment achieved, and creates a more tailored market participation model for EVSEs.

Figure 9: CAISO's proposal to capture performance measurement of EVSE



Pre-market

The CAISO proposes to differentiate between an "EVSE residential" designation and an "EVSE non-residential" designation in the DRRS.

1. EVSE residential – Will use a 5-in-10 customer load baseline
2. EVSE non-residential – Will use a 10-in-10 customer load baseline

The CAISO is proposing to support flexibility on metering configurations as long as it complies with the standards defined in the CAISO BPM for Metering, attachment G.[17] The CAISO has illustrated in Figure 10 and Figure 11 the potential metering constructs for EVSEs.

Figure 10: Single submeter in front of aggregation of EVSEs

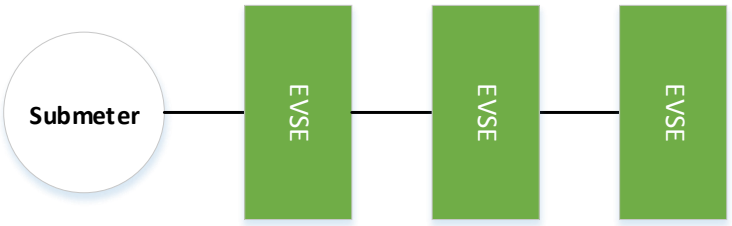
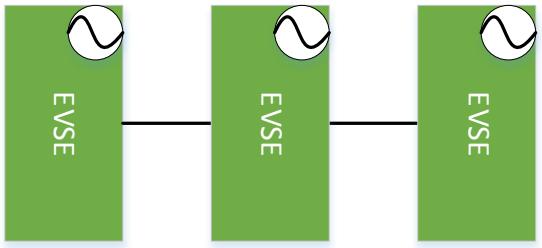


Figure 11: Individual meters embedded in EVSE



Market

The CAISO does not propose any changes to market systems because the proposal is only affecting the performance measurement of an EVSE.

Post-market

The CAISO proposes to apply similar principles of the MGO calculation to the EVSE measurement. The "EVSE residential" will utilize the 5-in-10 customer load baseline (CLB) methodology and the "EVSE non-residential" will utilize the 10-in-10 CLB methodology. Both CLBs will have a look back period of 45 days using either 5 or 10 of

[17] CAISO BPM for Metering (https://bpmcm.caiso.com/Pages/BPMDetails.aspx?BPM=Metering)

the most recent non-event hours. The demand response energy measurement (DREM) derived using the CLB will be in 5-min granularity with the option that if the submetered EVSE generates 15-minute interval data, the SC will transpose the data to three 5-minute intervals. Neither "EVSE residential" nor "EVSE non-residential" will have a load point adjustment (LPA) due to an EVSE's performance not being weather dependent.

5.5 Multiple-Use Applications

Multiple-Use Applications (MUA) are when resources provide services to and receive compensation from more than one entity (e.g., the CAISO and a UDC) or in more than one domain (customer, distribution, transmission). BTM resources, DERs, and DER aggregations (DERAs) particularly seek to engage in MUAs in order to "stack" services and revenue streams and thereby optimize their resource's value. Depending on the points of interconnection of the resources and the specific use-case, the resource may provide services to a combination of end-use customers, the distribution system, and the wholesale market and transmission system.

Since early 2016, the CAISO has supported the MUA policy development by collaborating with CPUC staff in its Energy Storage Proceeding Track 2 (R.15-03-011). CAISO and CPUC staff collaborated to produce a report, "Joint Workshop Report and Framework – Multiple-Use Applications for Energy Storage," which the CPUC issued on May 18, 2017 as part of an ALJ ruling seeking comments. The report was discussed at a CPUC workshop on June 2, 2017, followed by two rounds of public comments submitted in July 2017. The CPUC issued a ruling on January 11, 2018 that set forth principles for MUAs. The order also established subsequent working group meetings scheduled for 2018 to develop implementation details to put MUAs into practice.

Proposal

The ISO proposes to continue working collaboratively within the CPUC to address further development, as identified in the order discussed above. This includes active participation in all workshops where further discussion and additional rules will be developed and recommended on outstanding issues. The CAISO will monitor and evaluate the emerging recommendations to determine if they can be taken up in ESDER 3 or warrant consideration as a separate CAISO initiative. The CAISO will assess the adopted MUA rules and recommendations that emerge from the working groups against changes to tariff and/or market design that can be facilitated as part of the ESDER 3 initiative and those that cannot.

The CAISO acknowledges the comments of several parties[18] recommending the CAISO amend the NGR model to allow for these resources to choose the market intervals in which they want to participate in the CAISO market. Currently, NGRs are presumed to be 24x7 wholesale market resources comparable to all other supply resources except DR. This means that an NGR is subject to financial settlement through the CAISO market settlement system for its consumption or production in each settlement interval save for any outage, just like a participating generator. The CAISO understands stakeholders' desire to allow NGRs to be able to opt out of CAISO metering and settlement at some intervals in order to provide services to other entities. As stated above, the consideration of the non-24x7 rule for NGRs will be evaluated as the CAISO participates in the MUA working groups.

The CAISO believes that the "non-24x7" topic is just one of many potential areas that will need to be included in an assessment of the CPUC's ruling. Throughout the ESDER 3 process, the CAISO will evaluate tariff and market changes needed and keep stakeholders informed on what those changes entail.

5.6 Non-Generator Resources

Under this topic, the CAISO will provide an overview of issues that NGRs face while participating in the wholesale market. The goal in the sections below is to identify clearly the CAISO's understanding of stakeholders' issues and present the CAISO's position on those issues.

5.6.1 *Throughput management and use limitations*

Based on stakeholder feedback, battery storage participating as an NGR is used frequently in the CAISO market, and more specifically in regulation, due to its fast ramping capabilities. Stakeholders have expressed that at certain times the CAISO dispatch cycles the resource too frequently due to its "fast ramping capabilities", causing issues with manufacturer warranties and battery degradation. Stakeholders have tried to alleviate this issue by inputting slower ramp rates but argue that it misrepresents the full capability of the resource. Additionally, at the CAISO's January 2018 working group meeting, PG&E presented to stakeholders its ability to manage excessive cycling through energy bids. Stakeholders have responded to the

[18] CESA, AMS, Sunrun, and SDG&E

presentation, stating that there are limitations to the bidding option to prevent excessive cycling.

In addition, within the same working group meeting, Powin Energy presented a specific scenario in which its actively participating NGR was receiving infeasible automatic generation control (AGC) signals as well as low accuracy scores based on the CAISO's pay for performance calculation.[19]

The CAISO would like to separate the issues described above into two sections:

(1) Storage resources, which by design have high ramp rates, participate in regulation, but have issues with excessive cycling during participation.

(2) Some resources such as Powin Energy are facing infeasible AGC signals, which in turn affects their accuracy scores.

Proposal

The CAISO understands the stakeholders and the various scenarios that battery storage resources be accommodated in the market. However, the CAISO is tasked with the difficult job of balancing system needs with the integration of fast ramping capabilities of battery storage. The CAISO agrees with stakeholders that an artificial "slower" ramp rate is not the right approach because it does not accurately represent the resource's capabilities. The CAISO agrees with PG&E that, "throughput cannot be perfectly managed on a daily granularity, but can be managed over time."[20] To go further, the CAISO believes that throughput limits can be expressed by scheduling coordinators through bidding parameters, as PG&E demonstrated with its battery storage resources.

The CAISO also has heard from stakeholders that battery storage resources should qualify as a use-limited resource to help manage excessive cycling. The CAISO understands that a manufacturing warranty may limit the number of battery storage cycles, but the CAISO has not been provided specific contract provisions that battery storage resources must adhere to and how those provisions may compare to current, actual use-limitations. The CAISO desires to explore this issue further with the storage community and is open to developing the process and qualifications for NGRs to qualify as a use-limited resource under the CAISO's Commitment Cost Enhancements 3 (CCE3).

---

[19] Link to Powin Energy's presentation http://www.caiso.com/Documents/Presentation-BlakeRector-MikeMcGuffinCustomizedEnergySolutions.pdf

[20] Slide 3 of PG&E's Jan 16, 2018 presentation "What Are the Capabilities of the NGR and REM Market Models for Batteries?" http://www.caiso.com/Documents/Presentation-AlvaSvobodaPG-E.pdf

The CAISO requests that impacted stakeholders submit comments that provide potential use-limited qualifying factors and the types of documents a resource owner should provide to the CAISO to justify receiving use-limited status.

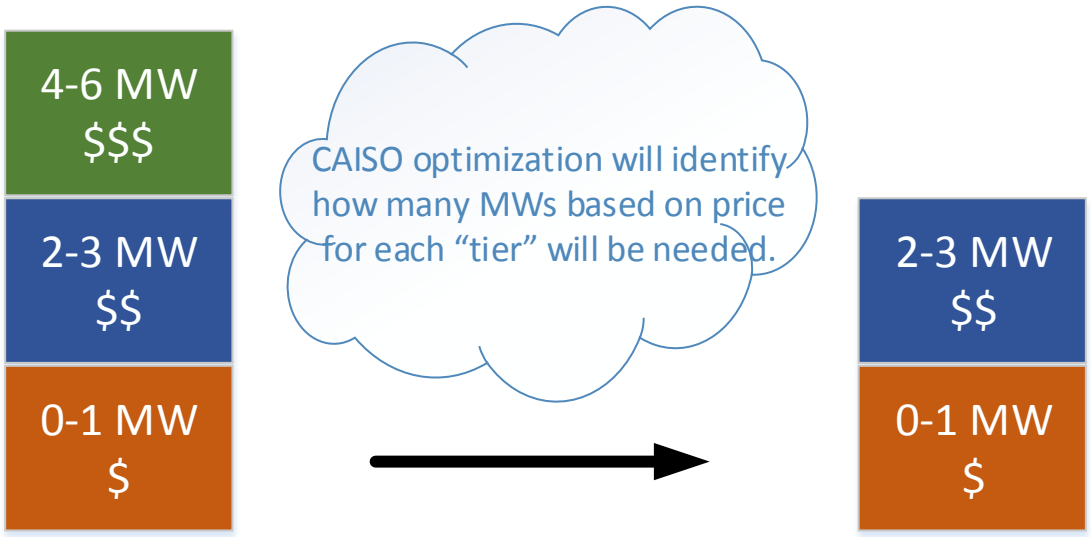
To address the second issue on infeasible AGC signals as well as the regulation performance accuracy measurement being set too low, the CAISO staff is working with individual stakeholders to understand and resolve these issues. If a problem with the AGC signal surfaces based on affected stakeholder feedback and engagement, the CAISO would consider modifications to AGC and regulation performance in a separate initiative since such modification would have market wide implications. However, based on discussions and review of known customer issues to date, the CAISO found incorrect AGC signals were related to resources' own programming errors.

The CAISO stresses the importance of actual data to help demonstrate both throughput and state of charge management issues. The CAISO requests that storage resource operators present data to the CAISO to help CAISO staff understand their specific issues and concerns and to get to the root cause. Such data and specific instances investigated will help the CAISO to determine if issues are isolated to operators, resources, or market design.

5.6.2 *State of charge management*

Stakeholders have expressed difficulty in managing state of charge (SOC). Stakeholders have stated that the requirement to submit a real-time bid 75.5 minutes before the operating hour does not give resource owners sufficient knowledge to alter or correct their bidding strategy to manage a resource's SOC. Stakeholders state that resource owners would like to have a high degree of certainty about how the CAISO will use the resource between bid submission and market dispatch (or AGC control). As shown in Figure 12, stakeholders have suggested the option to submit multi-segment AS bids where the participant would be able to have more control over the amount of regulation service provided to the CAISO based on economic bidding per regulation segment.

Figure 12 Multi-segment AS bid stack



To expand on stakeholders' suggestion on a multi-segment bid stack for AS bids, the resource owner can use a multi-segment bid to clear a specific amount of AS at various price levels and then utilize energy bids for the remaining capacity to manage the real-time SOC. Stakeholders' reasoning is that resource owners do want to provide ancillary services as a portion rather than the entire capacity of the resource. Another reason for the need is the must offer obligation for RA resources. As stated by Boston Energy: "Today, an energy storage resource that is flagged as RA and certified for ancillary services is challenged to price efficiently the desire to get the desired mix of energy and ancillary services awards in the day-ahead market because it's required to offer its full ancillary service capacity for each product at one price."[21] In response, the CAISO disagrees with this justification for developing a multi-segment AS bid product. The CAISO believes that it is the resource owner's responsibility and not the CAISO's to submit the most efficient and competitive price with the resource owner's desired mix of energy and AS into the wholesale market.

Stakeholders also request that the CAISO consider the variable operating costs that differentiate certain batteries from traditional generators. The CAISO's understanding from stakeholders is that certain battery technologies may degrade with use, and may be non-linear with use. Namely, batteries with a deeper charge cycle will degrade faster than if it is discharged in shallow cycles. Stakeholders are asking for an option to

[21] Comments from Boston Energy from January 16, 2018 workshop. http://www.caiso.com/Documents/BostonEnergyComments-EnergyStorage-DistributedEnergyResourcesPhase3WorkingGroup-Jan162018.pdf

represent these opportunity costs through multiple bid offers from which the CAISO could select based on the resource's SOC at the time of dispatch. (The CAISO notes that, this request is different from the multi-segment AS bid stack, presented above.)

Proposal

In response to the multi-segment AS bid stack, the CAISO understands that a resource owner would segment a single AS bid into multiple "tiers" where the CAISO identifies which portion of the resource's capacity it is willing to award based on system needs and economics. As stated in response to Boston Energy's comment, the CAISO believes that it is the market participant's responsibility under the current bidding structure to submit the most economically efficient and competitive bid with the corresponding energy and AS amount into the wholesale market. Similar to the section above on "throughput management," the consideration of a multi-segment AS bid stack would be a fundamental real-time market change that is out of scope under ESDER 3 because it would need to apply to all resources and not just those participating under the NGR model. If stakeholders determine this to be an important change needed in the CAISO market, the topic will need to be submitted in the annual stakeholder catalog process.

In response to stakeholders' request to consider how to best capture the marginal cost of energy storage due to the "non-linear degradation"[22] of its battery storage resources, the CAISO believes that the current NGR model gives a battery storage resource operator the ability to reflect opportunity costs in its bid, and to manage its SOC. The CAISO believes that it is the responsibility of the resource owner/scheduling coordinator, to bid the resource with consideration of its opportunity costs and availability in a competitive marketplace, just as conventional resources do today. As proposed under the throughput management section, the CAISO is proposing to provide a path for NGRs to seek use-limited status. Use limitation will not only provide the necessary outages to pull the resource from the market once limits have been reached, but also, enable additional opportunity costs for the resource.

6 Next Steps

In this revised straw proposal, the CAISO has provided additional details in its proposals. The CAISO has considered comments and feedback from the stakeholder web

[22] LS Power comments from CAISO ESDER 2 straw proposal. http://www.caiso.com/Documents/LSPowerComments-EnergyStorageandDistributedEnergyResourcesPhase2-RevisedStrawProposal.pdf

conference call (February 21, 2018) and the technical working group meeting (March 29, 2018) in the development of this paper. A stakeholder call will be held on May 10, 2018 to review and provide the CAISO feedback on the proposals. If needed, a second technical workshop will be scheduled in June for further policy development feedback.

Appendix A Acronyms

1. **AGC –** Automatic Generation Control
2. **BCR –** Bid Cost Recovery
3. **BPM –** Business Practice Manual
4. **BTM –** Behind The Meter
5. **CCA –** Community Choice Aggregation
6. **CCDEBE –** Commitment Cost Default Energy Bid Enhancements (policy initiative)
7. **CCE3 –** Commitment Cost Enhancements Phase 3 (policy initiative)
8. **CLB –** Customer Load Baseline
9. **DAME –** Day-Ahead Market Enhancements (policy initiative)
10. **DERA –** Distributed Energy Resource Aggregation
11. **DLA –** Default Load Adjustment
12. **DLAP –** Default Load Aggregation Point
13. **DREM –** Demand Response Energy Measurement
14. **DRP –** Demand Response Provider
15. **DRRS –** Demand Response Registration System
16. **EVSE –** Electric Vehicle Supply Equipment
17. **FMM –** Fifteen-Minute Market
18. **IRP –** Imbalance Reserve Product
19. **LMP –** Locational Marginal Price
20. **LPA –** Load Point Adjustment
21. **LSE –** Load Serving Entity
22. **MEC –** Metered Energy Consumption (methodology)
23. **MGO –** Metered Generator Output (methodology)
24. **MOO –** Must Offer Obligation
25. **MUA –** Multiple-Use Application (CPUC Decision)
26. **NBT –** Net Benefits Test
27. **NGR –** Non-Generator Resource
28. **PDR –** Proxy Demand Resource
29. **PDR-LSR –** Proxy Demand Resource-Load Shift Resource
30. **RA –** Resource Adequacy
31. **RDRR –** Reliability Demand Response Resource
32. **RUC –** Residual Unit Commitment
33. **SC –** Scheduling Coordinator
34. **SIBR –** Software Infrastructure Business Rule (system)
35. **SOC –** State of Charge
36. **UIE –** Uninstructed Imbalance Energy