Energy Storage and Distributed Energy Resources Phase 4 - Stakeholder Comments

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Southern California Edison (SCE) appreciates the opportunity to offer comments on the California Independent System Operator's (CAISO) Energy Storage and Distributed Energy Resources Phase 4 (ESDER 4) Revised Straw Proposal[1] presented on October 28, 2019. SCE encourages the CAISO to ensure that proposals offered in relation to energy storage and distributed energy resources as well as variable output demand response resources satisfy reliability and resource adequacy requirements while ensuring effective participation of the resources.

Consistent with that position, SCE offers comments in relation to the following:

- Resource Constraints and End-of-Day State of Charge
- Market Power Mitigation of Energy Storage Resources – Formulation of the Default Energy Bid
- Variable Output Demand Response
- Parameters to Reflect Demand Response Operational Characteristics

Resource Constraints and State of Charge – End-of-Hour versus End-of-Day

SCE acknowledges the CAISO's proposal to allow Scheduling Coordinators (SCs) to submit end-of-hour state of charge (SOC) parameters for energy storage resources in the real-time market only. While the parameters may be submitted as a single SOC value or a range for the SOC value, SCE seeks clarification on whether the CAISO will actively manage the resource's SOC when ancillary services and energy are awarded to the resource. In addition, SCE seeks to understand whether the end of hour flexibility will be extended to resource adequacy (RA) resources. SCE offers that end-of-hour parameters for RA resources, if allowed, should require the SOC values to align with the must offer obligations of the resource. The specification of SOC values that restrict flexible operation of the RA resource consistent with the resource's RA obligation must be prohibited. Specifically, the hourly SOC proposal should be further evaluated to ensure its consistency with the proposal of the economic bidding requirement for the full range (both charging and discharging) for an energy storage resource providing flexible RA as currently contemplated in the RA Enhancements Initiative. For energy storage resources providing system RA, the proposal should evaluate potential issues of whether the proposed hourly SOC would impact those resources meeting the grid needs during net load peak hours and whether the proposal

[1] http://www.caiso.com/Documents/Presentation-EnergyStorage-DistributedEnergyResourcesPhase4-RevisedStrawProposal.pdf

should include certain elements to ensure those resources have enough energy to discharge during those hours.

Regarding local RA, additional complexity may be introduced that should further be evaluated if/when the hourly SOC constraint applies to availability limited RA resources. SCE requests that the CAISO explain how the mechanism will work in relation to local RA resources whose performance profile may not lend readily to the expected behavior within the RA framework when end-of-hour SOC parameters are applied. Extension of the end-of-hour mechanism to RA resources must comply with the RA rules that govern resources with must offer obligations in the market.

Currently the CAISO does not propose the end-of-hour SOC mechanism for the day-ahead market. However, SCE expects energy storage resources in the day-ahead market to have access to the end-of-hour mechanism given the 24-hour optimization horizon that the CAISO employs for market clearing. If resources receive awards in the day-ahead market, the CAISO may consider requiring scheduling coordinators to self-schedule the day-ahead awards in the real-time market, which will enable the submission of SOC parameters in the real-time market for those resources with awards from the day-ahead market. In addition, as more energy storage resources enter the market, scheduling coordinators need the ability to manage the daily availability of their energy storage resources while maintaining operational flexibility throughout the day for the CAISO to optimize the operation of their resources.

Given the proposal for the end-of-hour SOC mechanism, SCE encourages the CAISO to carefully examine the potential for gaming in the market when end-of-hour SOC values are submitted. For example, the submission of a very narrow range for non-RA resources may restrict operational flexibility for the CAISO in relation to resource dispatch which may force the CAISO to continue operation of the resource uneconomically to achieve the target SOC. In addition, setting the SOC value too high, too low or, the SOC range too high or too low and very narrow relative the resource's current operating level, may result in forcing the CAISO to either forego or reduce the award or make the award but dispatching the resource for a longer interval than the resource's offer proves economic. In the circumstance of foregoing the award when economic, the element of economic withholding arises. When the economic award must be reduced to facilitate the end-of-hour SOC request, the element of physical withholding arises. If the resource remains online to achieve its SOC target beyond the corresponding interval for its economic dispatch, and if the resource is beneficial to the CAISO relative to the dispatch of another resource to satisfy the system need, the resource should be eligible for bid cost recovery. If continued operation of the resource requires uneconomic operation to achieve the SOC target with no system benefit to the CAISO, the resource should be ineligible for bid cost recovery.

At this juncture, the CAISO has decided not to offer an end-of-day proposal for energy storage resources interested in bidding price spreads in the day-ahead market. The CAISO should define "spread bids" in this context and more broadly, explain in detail how spread bidding works currently and how it would

work under the proposal. Without such detailed information[2] and clear understanding on the subject of "spread bids", it's difficult to assess this aspect of the proposal. The decision and reasoning provided by the CAISO for their decision is confusing though, the possibility remains under an end-of-hour SOC framework for energy storage resources offering spread bids in the market to submit a single value or a range for the resource's SOC. Submission of a single SOC value may require the restriction that the resource's SOC value at the end of the day is equivalent to the SOC value at the start of the day. A similar requirement should be imposed where a range for the SOC value is submitted. In addition, scheduling coordinators should not be allowed to alternate between an end-of-hour single SOC value and a range for the SOC value within the same trading day.

The possibility for submitting an end-of-day SOC parameter with spread bids in the real-time market may be unattractive due to the short-term horizon for which the market software provides a dispatch solution. As a result, SCE offers no comment on the suitability of such a mechanism in the real-time market.

Market Power Mitigation for Storage Resources – Default Energy Bid Formulation

The CAISO's Revised Straw Proposal[3] offers an approach to the formulation of a default energy bid (DEB) for energy storage resources. The proposed DEB formulation reflects the cost of charging the resource inclusive of roundtrip efficiency losses and the variable operations and maintenance (VOM) cost for discharging as reflected in the resource's cell degradation cost. SCE notes the CAISO's assumption of nonlinear, quadratic, costs for the calculation of cell degradation costs. However, SCE wishes to sensitize the CAISO to the fact that the output of energy storage resources is governed by the contracts arranged by market participants. Those contracts were negotiated in a manner that mitigates the risks of suppliers and purchasers in the market. The CAISO should consider the terms and conditions of the contracts in relation to the proposed DEB formulation.

While SCE has no disagreement with the 10 percent adder proposed for the DEB formulation, SCE is interested in understanding how the current proposed formulation captures the contract terms of the agreements that market participants have accepted. In addition, SCE wishes the CAISO to confirm that the specification offered for its DEB formulation is:

$$Storage\ DEB_{i,t} = Max\left[\left(\frac{En_{i,t}}{\lambda_i} + CD_{i,t}\right), OC_{i,t}\right] * 1.1$$

where:

En – cost of charging

[2] Information should include the definition of "spread bids" and how spread bids are treated in the optimization in both DAM and RTM, implicitly or explicitly. If necessary, the CAISO should consider publishing a technical paper to provide additional clarity on this important topic.

[3] Refer to http://www.caiso.com/informed/Pages/StakeholderProcesses/EnergyStorage_DistributedEnergyResources.aspx

CD – cell degradation cost

OC – opportunity cost for resource

λ - round-trip efficiency for resource

i – index for resource

t – index for interval

Cycling Cost Calculation

SCE acknowledges the two proposed approaches offered by the CAISO for the calculation of cycling cost. The approaches offered by the CAISO specifically relate to energy storage resources using the lithium-ion technology. However, SCE finds the proposed constant unit cost for cell degradation inconsistent with the typical economic behavior of marginal costs. Such costs increase as more capacity is utilized to provide a service. In addition, the relevant unit cost that should be used for cell degradation in the formulation should reflect the lifecycle cost of the resource.

The specific lifecycle cost must reflect equality between the resource's calendar and cycle life if the current formulation is to receive further consideration within the stakeholder process. Any failure to introduce the appropriate lifecycle cost to the formulation runs the risk of overestimating the cell degradation cost when the cycle life is less than the calendar life and underestimating the degradation cost when the cycle life is longer than the calendar life. Further, the constant cost may provide incentives for scheduling coordinators to set very high SOC values to avoid the costs when the resource is dispatched depending on the magnitude of the unit cost recommended. Any incentive mechanism structured in this manner is neither good for RA nor non-RA resources since it has the potential to reduce resource availability and the operation flexibility that the CAISO desires. In fact, the mechanism provides resources the incentive to maintain a charge level closer to the resource's minimum operating limit in some situations in order to extract a higher cell degradation payment without necessarily being attracted to maintaining higher levels of charge.

Therefore, SCE offers the following specification of the formula if this option gains acceptance among stakeholders:

$$Cell\ Depth\ Cost = v_{i,t}\rho_{i,t}\left(Max\ SOC_{i,t} - SOC_{i,t}\right)$$

where:

v – a binary variable that equals 1 when the SOC is decreasing

ρ – unit cost of cell degradation (a constant within the dispatch interval)

SOC - State of Charge

i – index for resource index

t – index for interval

The second approach that the CAISO offers to the calculation of cycling costs contemplates a variable unit cell degradation cost that averages the output of consecutive dispatch intervals for the energy storage resource. This approach contrasts with the first approach. The first approach uses the difference between the maximum SOC and SOC for the relevant dispatch interval in the cycling cost calculation. By setting the two approaches to reflect equivalent cycling costs, the unit cell degradation cost in the second approach must increase significantly to establish the equivalence between the approaches.

SCE remains unsure whether this cycling cost calculation for the second approach adequately captures changes in the resource's SOC as the resource moves from one interval to another with variable sizes of dispatch. Specifically, the two mathematical expressions provided are equivalent only when equal discrete quantities that form a uniform distribution are involved. When either the preceding or succeeding interval has a larger or smaller dispatch, the equality condition is violated between the two approaches, unless the unit cost for cell degradation is adjusted. The mechanism provides the incentive to self-schedule the resource or offer equal segments along the offer curve and can possibly encourage economic withholding in a manner to extract a higher payment for cell degradation.

The formulation for individual cell depth as proposed by the CAISO is:

$$Cell\ Depth_{i,t} = v_{i,t}\rho_i\left(SOC_{i,t-1} - SOC_{1,t}\right) = v_{i,t}\rho_i * \frac{P_{i,t-1} + P_{i,t}}{2} * \Delta t$$

where:

v – a binary variable that equals 1 when the SOC is decreasing

ρ – cost of cell degradation (a constant)

SOC - State of Charge

P – dispatch quantity

i – resource index

Δt – interval size within the hour (1/12 in the RTD market)

As an Illustration of the second approach, here is an example using the above formulation, when the SOC for the preceding interval is 80% and the subsequent dispatch interval is 60% for a 20 MW energy storage resource with 4-hour operating duration, 76 MWh output and 95% roundtrip efficiency. The proposed formulation provides a 20 % SOC difference for the first expression. The second expression results in 15.2 MWh when the first dispatch is 15.2 MWh and the second is 15.2 MWh which result in the average dispatch of 15.2 MWh when the unit cost of cell degradation and the timescale for the duration of the time interval are ignored.

As a contrast, let the second dispatch result in a 50% SOC value, 38 MWh. Then the first mathematical expression in the second approach results in a 30% SOC difference and the second mathematical expression results in 15.2 MWh for the first dispatch and 22.8 MWh for the second dispatch, which yields an average output of 19 MWh for the dispatch interval. With a variable hourly rate used for the cell degradation cost, the dispatch intervals with lower realized output will include megawatt-hours from higher or lower priced periods depending on the structure of the resource's offer curve. This characteristic of the compensation mechanism introduces a cross-subsidy or discount between high-output, high-priced hours and lower output, lower-priced hours.

In other words, when dispatch segments differ along the resource's offer curve, an explicit cost reduction in cycling cost compensation occurs within the mechanism proposed. While for any SOC associated with an energy storage resource, there is a corresponding equivalent MW or MWh value associated with the resource's capability, the formula for cycling costs must be able to track segments of dispatch for which the deeper the discharge, the more costly it should be for the resource's output as one moves from earlier to later operating segments consistent with the resource's decreased ability to supply output.

Variable Output Demand Response

SCE is awaiting more details on the proposed Effective Load Carrying Capacity (ELCC) method that the CAISO is contemplating to develop for variable-output demand response resources before any determination can be made on whether it is an improvement over the current framework.

SCE notes that the CAISO's definition of variable-output demand response ("VODR") is broad, and the CAISO states that a "majority of demand response resources have dependencies that result in having a variable output".[4] SCE contends that certain demand response programs are not variable in nature. For example, behind-the-meter energy storage resources (i.e. batteries) have a predictable curtailment capability. A 1 MW/4MWh battery with availability to curtail load during Hour Ending ("HE") 17 through 21, should be considered a demand response resource with load-curtailing capability that does not vary. SCE wishes to know whether the CAISO agrees, or whether the CAISO considers such battery-based DR to be variable in nature.

Drawing the lines between variable DR resources, and those that are not variable, may not be an easy exercise. Therefore, one key question is who (e.g. CPUC, CAISO, or market participants) decides whether a specific demand response resource is variable in nature? If the CAISO, CPUC, and other stakeholders are capable of agreement on clear rules for identifying variability of demand response resources, the issue is resolved. However, considering the sheer number of demand response resources, and the relatively small size of each resource, the administrative burden of having more than

[4] Page 30, CAISO ESDER4, Revised Straw Proposal, Oct. 21, 2019

one party involved in deciding the variability designation of each specific resource may not be feasible. Perhaps the market participant (i.e. Scheduling Coordinator on behalf of the demand response provider) is the entity that is better equipped to make this choice. Essentially, the Scheduling Coordinator can choose to define its demand response resources as either 1) variable or 2) not variable in nature, and accordingly be subject to two separate sets of rules for determining Qualifying Capacity (ELCC vs current method/LIP), the must offer obligation (bid to operational near real-time forecast capability vs bid to supply plan quantity) and associated incentive mechanism (no RAAIM vs RAAIM).

The details of how the ELCC is calculated and implemented will have a large impact on how this could work. For example, would a battery-based DR resource, as described in the second paragraph above yield the same Qualifying Capacity under the ELCC method contemplated by CAISO, as under the Load Impact Protocols (LIP), which are currently mandated by the CPUC for determining Qualifying Capacity? If so, a Scheduling Coordinator could be incentivized to designate even a battery-based DR resource as "variable" to achieve the exemption from RAAIM.

CAISO requested feedback[5] on its proposal for must offer obligation for VODR. SCE agrees with the CAISO that SCs may be best situated to provide the updated forecast of variable demand response resources' capability. CAISO presented two options for the type of real-time data submission required to enable VODR to bid to their capability. SCE sees the first option, the option that CAISO describes as being for resources that do not have intra-hour variability, as the most viable. In this option, CAISO states that the SCs would represent their resource's capability through their bids into the day-ahead and real-time markets, with final submission on an hourly basis up to 75 minutes prior to the operating interval. The second option, the option that CAISO describes as being for resources that do have intra-hour variability, while possible to implement, may be more burdensome from a set-up, data communication, and processing standpoint, for a potential marginal improvement in accuracy. SCE thinks the CAISO should consider the first option to be appropriate even if there is some intra-hour variability in the resource's capability.

In its proposal[6], CAISO asked for stakeholder feedback on ways to eliminate any incentives for submitting inaccurate forecasts. Although SCE does not have a proposal on this item at this time, SCE agrees that such a mechanism should be considered to provide proper incentives.

As stated above, SCE is looking forward to seeing more details on how the ELCC factors will be calculated and applied. For example, what would be the "nameplate" capacity used to which an ELCC factor would be applied? Would it be the LIP determined QC quantity, the registered PMax value, or some other number? Also, how would that number be applied across DR resources – e.g. on a program by program

[5] Page 36, CAISO ESDER4, Revised Straw Proposal, Oct. 21, 2019
[6] Page 37, CAISO ESDER4, Revised Straw Proposal, Oct. 21, 2019

basis, resource by resource, or some other grouping? This is important as DR resource registrations can be fairly dynamic and updated many times during the year.

Parameters to Reflect Demand Response Operational Characteristics

SCE supports the CAISO's prioritization of the maximum daily run time parameter. Although, as SCE has described in previous comments[7], both a maximum run time per start parameter and a maximum daily run time parameter would be helpful. SCE supports CAISO's choice to move forward with the creation of the new maximum daily run time parameter. This action facilitates the process for handling bids.

SCE proposes that the CAISO considers moving the implementation of the maximum daily run time parameter forward on an accelerated basis through approvals and tariff development to rollout the implementation. The maximum daily run time parameter portion of the overall ESDER4 scope is well defined at this juncture, with broad stakeholder support, and could therefore move forward independently of the conclusion of the other items still under discussion in ESDER4.

[7] SCE July 11, 2019 comments to CAISO ESDER4 (http://www.caiso.com/Documents/SCEComments-EnergyStorageandDistributedEnergyResourcesPhase4WorkingGroup-Jun27-2019.pdf)