California ISO

Energy Storage Enhancements

Straw Proposal

December 9, 2021

Market & Infrastructure Policy

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1 Introduction

Storage developers are rapidly deploying new utility-scale resources onto the California grid to provide replacement capacity for retiring resources and to meet procurement mandates imposed by the California Public Utilities Commission. These additional storage resources will help the state meet clean energy and climate goals. Ultimately, storage resources will be available to meet energy needs during most periods when renewable resources are not available to generate. Today, there are just over 2,200 MW of installed storage capacity on the market and the ISO observes these resources primarily charging during the lowest priced periods of the day (when solar is abundant) and discharging during the highest priced periods of the day. Today the ISO relies on storage resources for the critical operation of one local capacity area. The ISO anticipates that storage resources will also be necessary for the reliable operations in many other local capacity areas in the future. In the ISO's annual local capacity technical report, the ISO is proactively estimating the amount of energy storage that can be added to each local capacity area based on charging restrictions due to anticipated load, other local generation capability required to meet mandatory standards and transmission capability under applicable contingency conditions.[1]

The ISO market models are evolving to address storage requirements. The fourth phase of the energy storage and distributed energy resources (ESDER) initiative, which was recently implemented, included development of market power mitigation for storage resources and tools to help scheduling coordinators manage state of charge. Measures targeting storage in the resource adequacy enhancements (RAE) initiative include counting rules and bidding obligations for storage resources and the introduction of real-time end of hour market constraints to ensure day-ahead discharge schedules are feasible in the real-time market.[2]

In comments to this initiative, prior initiatives, and through other avenues, storage developers and operators expressed concern with existing market rules, optimization algorithms, and settlement processes as applied to the energy storage resources. A principle concern raised by the storage community is a lack of compensation during critical periods when the ISO must retain state of charge on limited energy storage devices, which may preclude their active participation

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[1] These studies assume storage is fully charged exactly when needed based on area specific load profiles, and will operate precisely as required to meet those needs.

[2] Resource adequacy enhancements stakeholder initiative: https://stakeholdercenter.caiso.com/StakeholderInitiatives/Resource-adequacy-enhancements.

in the real-time markets. The existing bid cost recovery rules, which are designed based on traditional energy generation resources, do not consider energy storage charging and discharging cycles. A primary objective of this initiative is to develop a set of solutions to enhance the optimization of storage resources and to allow additional flexibility for storage operators to manage state of charge in the real-time markets. The ISO proposes a new model, called the energy storage resource (ESR) model, which is unique from existing models because bids are predicated on state of charge values, rather than a dispatch instruction for power. This proposal is outlined in section 3.1.

In response to the summer 2020 outages, prior to summer 2021, a number of new market features were implemented to help the ISO manage the grid under stressed conditions. One of these measures included a new feature called the minimum state of charge requirement, which is imposed on storage resources on days when the day-ahead market has insufficient supply to match demand. These measures help ensure sufficient state of charge across the storage fleet during conditions when supply is tight. These measures were approved by FERC as temporary measures in place for a two year period, while the ISO develops new policy to manage storage resource state of charge during critical periods. These measures were implemented partly to ensure reliable operation of the large influx of new storage resources coming onto the system. In this proposal, the ISO proposes new mechanisms and improvements to existing mechanisms meant as permanent market features. These proposals are outlined in section 3.2.

Finally, the ISO acknowledges concerns regarding investment tax credits and property taxes and proposes changes to the existing co-located model that can be used by these resources. These proposed changes are outlined in Section 3.3.

As a quick reference and summary, this policy includes the following proposals:

- (3.1) New ESR model to allow storage to submit bids in incremental SOC
    - Storage may elect to use either the ESR or NGR model
    - ESRs must submit a bid curve for charging and for discharging
        - Each bid curve can include up to 10 bid segments
    - Pmin/Pmax can decrease at low/high state of charges
    - Transition times between charging and discharging will be modeled
- (3.2.1) AS awards for storage will require corresponding energy bids
- (3.2.2) Storage resources may be issued EDs to hold state of charge
    - Storage may receive a traditional ED or an SOC ED, but not both
- (3.2.3) Compensation will include lost opportunity from not generating
- (3.2.4) The ISO may procure state of charge for DA contingencies

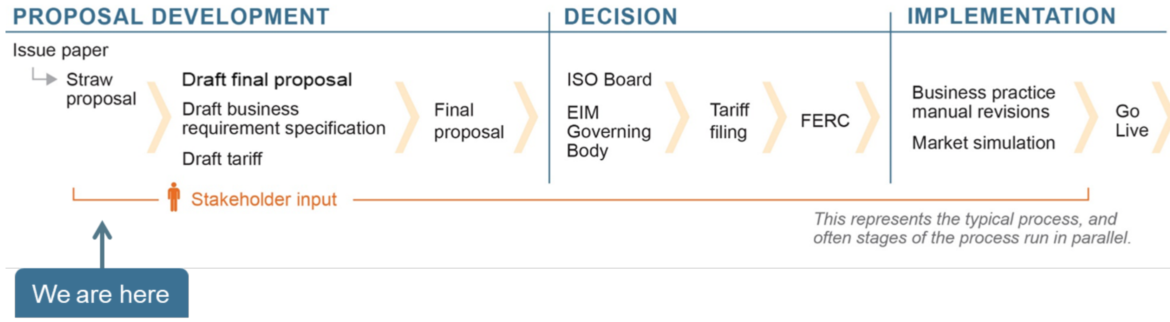
- (3.3.1) Implement electable co-located model
  - Storage is not dispatched above co-located renewable schedule
  - If instructed, storage must charge when renewables are curtailed
  - Storage may deviate down to match solar, when less than forecast
  - Deviations will be subject to imbalance energy charges
  - Storage submits outages when depleted and no ability to charge
- (3.3.2) Allow for co-located pseudo-tie resources to apply ACC
  - Resources under an ACC must be pseudo-tied from the same BAA

2 Stakeholder Process

The ISO is at the "straw proposal" stage in the energy storage enhancement (ESE) stakeholder process. Figure 1 below shows the status of the overall energy storage enhancement stakeholder process.

The purpose of the straw proposal is to include detailed solutions for resolving issues related to the integration, modeling, and participation of energy storage in the ISO's market. The ISO will publish a number of straw proposals, and solicit stakeholder feedback after each iteration. The ISO will publish a draft final straw proposal, solicit stakeholder feedback and then conclude with a final proposal. As appropriate, the ISO 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 ESE Stakeholder Initiative



3 Straw Proposal

The ISO introduced the non-generator resource (NGR) model in 2012 to allow for wholesale market participation of energy storage resources. Although the ISO believes that the non-generator resource model effectively integrates energy storage resources today, the increasing number of storage devices participating in the wholesale market warrants investigation of further market model enhancements to ensure that storage is efficiently compensated and the model can accommodate the unique features of storage resources. Stakeholders identified a number of potential enhancements for the ISO to help better model the resources. While the ISO's day-ahead market optimizes all resources over a 24-hour period, the real-time market has a shorter optimization horizon, which can make it more difficult to capture periods when it is critical that the storage resources have state of charge for several hours to meet system needs. The goal of this initiative is to explore additional enhancements that could help storage scheduling coordinators improve their control over the state of charge and continue to ensure that the overall market produces optimal and least cost dispatches and efficient market clearing prices.

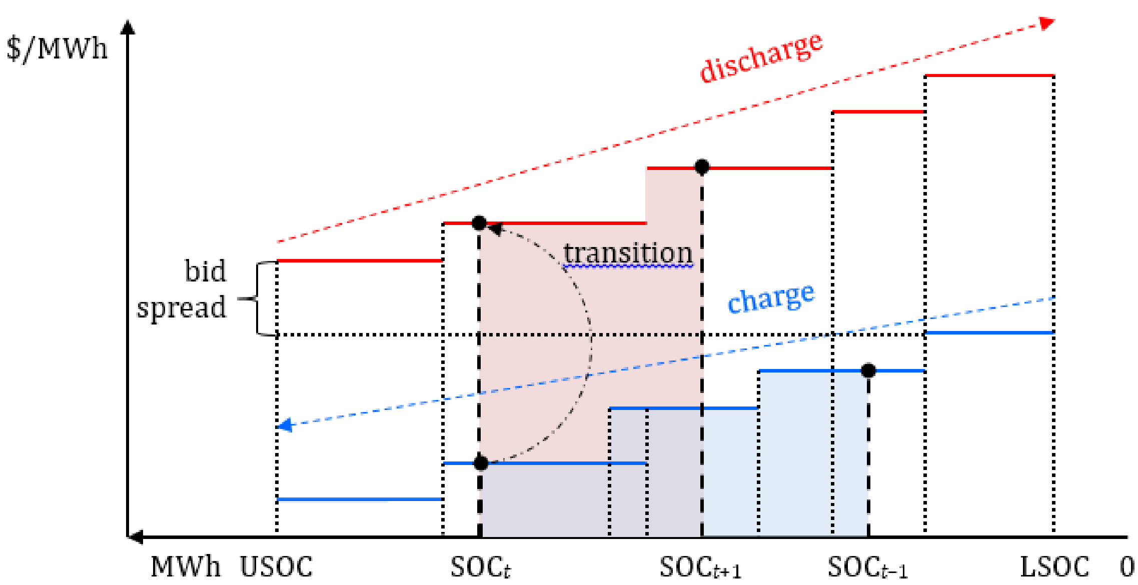
3.1 Energy Storage Resource Model

During this stakeholder process and other previous stakeholder processes, the ISO received feedback that storage resources would like additional capability to manage state of charge and potentially have bids that change based on the state of charge. To address this concern and others raised by stakeholders the ISO proposes a new model, called the energy storage resource (ESR) model, which storage resources may elect to use instead of the non-generator resource (NGR) model that is already in place today. The energy storage resource model will require scheduling coordinators to submit bids in terms of incremental state of charge instead of traditional bids submitted in terms of incremental energy. This model will allow storage resources to clearly represent that incremental costs to charge and discharge are different at different levels of state of charge. Specifically, the energy storage resource model will allow storage resources to offer lower prices to provide energy when a battery has a nearly full state of charge and higher prices when it is nearly depleted. This new model would be employed in the ISO's market software for both the day-ahead and real-time markets and could be used by participants in the energy imbalance market.

The energy storage resource model would include two different incremental SOC bids, one for charging and one for discharging, each with up to 10 segments. Each bid curve will span a state of charge range from a biddable minimum state of charge to a biddable maximum state of charge. An energy storage resource will be scheduled to charge, discharge, or remain at the same state of charge according to the cost reflected by its charging and discharging bid curves.

Figure 2 illustrates how bids could look for the energy storage resource model. The horizontal blue lines represent the bid segments to charge the storage resource, while the horizontal red lines represent the segments to discharge.

Figure 2 Energy Storage Resource Bid Curves



At any given time t, the market software will issue an instruction for the resource to hold state of charge, to charge, or to discharge. The software will consider the cost to charge or discharge at the current state of charge, SOC_t, on the charging (blue) and discharging (red) bid curves. For charging, the SOC increases, whereas for discharging the SOC decreases between consecutive intervals. The example in Figure 2 shows a dispatch instruction to charge between intervals *t–1* and *t*, where the storage resource receives a negative energy schedule to increase state of charge from SOC_{t-1} to SOC_t. During the following interval the resource receives a positive energy schedule to charge, which implies a decrease in state of charge from SOC_t to SOC_{t+1}.

The market software will charge the resource when the charging benefit, shown as the blue-shaded area under the charging bid, is higher than the cost of the required energy from other resources. Essentially, when prevailing market prices are below the bid to charge the storage resource will receive a schedule to charge. The market will discharge the resource when the discharging cost, shown as the red-shaded area under the discharging bid, is lower than cost of the displaced energy from other resources. Essentially, when prevailing market prices are above bids to discharge the storage resource will receive a schedule to discharge. Note that as the state of charge increases, the benefit to charging the resource decreases because of the downward sloping bid curve. Similarly, as the state of charge decreases, the cost to discharge the resource increases.

Scheduling coordinators could use the energy storage resource model to specify that discharging the resource to very low levels or charging the resource to very high levels of state of charge is less effective and has a higher cost or lower benefit.

The ISO is not proposing any changes to the timing of bid submissions or scheduling for energy storage resources. Similar to other resource models, the energy storage resource model would require bids submitted for each operating hour of the day. These bids would be due at 10:00am prior to the day-ahead market run and 75 minutes prior to the start of each trading hour in the real-time market.

The ISO notes that developing the energy storage resource model may obviate the need for some of the improvements to the non-generator resource model. However, this would assume migration from the current non-generator resource model to the energy storage resource model. The ISO welcomes comments on whether the energy storage resource model is attractive to storage resources, and why they may prefer to use one model over the other.

The storage community noted several improvements that could help better model storage resources during this and previous stakeholder processes. Some of these improvements include the ability to set and bid a specific ‘bid spread’ and the ability to show reduced charging capability when a storage resource is near full state of charge. Additionally, the ISO learned that many long duration technologies may require transition times to switch from charging to discharging. The ISO believes that all of these improvements are addressed with the energy storage model.

Bid Spreads

The energy storage model will require storage resources to bid two independent bid curves into the model that cover the same operating range. One of these curves is specific to charging and one is specific to discharging. The gap between these two curves could be used to represent a 'spread,' or the difference between a price the resource would be willing to charge at and the price the resource would be willing to discharge at. The concept of two bid curves for the same operating range is unique to the energy storage resource model.

Variable Charging and Discharging Rates

Battery storage developers and storage operators note that charging and discharging rates can degrade as resources reach very high or very low states of charge. This can lead to a resource being unable to meet schedules if the modeled rate that it can charge (Pmin) or discharge (Pmax) is constant across the entire range of state of charge for the resource, and that Pmin. Stakeholder feedback indicates that some storage resources can charge at a very high rate when state of charge is below a given high value, but beyond that the resource can only charge at a diminishing rate. Similarly, some storage resources can discharge at a very high rate when state of charge is above a given low value, but beyond that the resource can only discharge at a diminishing rate.

Transition Times

The ISO received comments from stakeholders asking the ISO to consider the additional features in a model for storage resources to help accommodate new storage technologies that are expected to come onto the system in the future. One feature that may be more common in new storage technologies is the inability to seamlessly switch from charging to discharging. Today, the ISO models storage resources as continuous resources with the ability to switch between charging and discharging from one dispatch instruction to the next, which is common for lithium-ion batteries. The proposed energy storage resource model will include the ability to enforce a minimum transition period, in minutes, between charging and discharging.

Market Power Mitigation

Today the ISO applies market power mitigation for storage resources using the non-generator resource model. The ISO developed a default energy bid calculation specific to these resources. If the ISO implements the energy storage resource model, similar default energy bid calculations will need to be developed. This formulation will be discussed in future iterations of the proposal.

3.2 Reliability Enhancements

3.2.1 *Ancillary Services*

Today the ISO requires all supply resources that provide ancillary services to have sufficient energy if called upon by the market. Specifically, the ISO requires that resources be capable of providing energy continuously for 30 minutes for regulation, spin and non-spin awards. This means that a storage resource with a 10 MW award for upward regulation up, must have at least 5 MWh of state of charge going into that period.

A number of issues have been identified around the ability of storage resources to provide ancillary services to the market and the feasibility of awards from the day-ahead market into the real-time market. Today, when the real-time market requires a state of charge sufficient so that storage is capable of delivering at least 30 minutes of sustained energy delivery for each ancillary service award. If a storage resource has insufficient state of charge, a portion or all of the award may be rescinded in the real-time market. If an award is rescinded for any resource, the 15-minute market may procure additional ancillary service capacity. Unfortunately, the 15-minute market runs 38 minutes prior to the start of an operating interval and a storage resource may have a depleted state of charge at the actual time it is providing the ancillary services.

Day-ahead ancillary service awards over multiple consecutive hours may not be feasible in the real-time market because the state of charge could be potentially depleted by use of the resource providing these services. The ISO observed cases when storage resources were completely committed for ancillary services for multiple hours, leaving no ability to charge or discharge the resources. If the state of charge of these resources is depleted while providing these services, they may not be available to meet their day-ahead ancillary service schedules in the real-time market. This could lead the ISO to be significantly short of ancillary services in the real-time operating horizon. This could also be challenging for scheduling coordinators that were counting on revenue from ancillary service awards in the day-ahead market, but instead have those awards rescinded and subject to no pay.

To prevent these concerns, the ISO may potentially propose that in the future all ancillary service awards for storage resources be accompanied with bids for energy. For example, a storage resource with a 10 MW regulation up award, could be required to provide a bid to charge for 10 MW.[3] Similarly, regulation down awards could require accompanying energy discharge bids. Imposing a requirement like this will ensure that the ISO energy market can charge or discharge a resource while it is providing regulation services at the same time, and prevents situations where a storage resource is fully encumbered and cannot be charged or discharged by the market.

If adopted, these requirements will help ISO markets charge or discharge a storage resource as needed, ensuring sufficient that of charge to support ancillary service awards in the real-time market.

3.2.2 *Exceptional Dispatch*

ISO operators can exceptionally dispatch resources on the grid to ensure reliability. This includes dispatch instructions to provide energy to the grid and dispatch instructions for storage resources to charge from the grid. If a resource is dispatched for energy delivery to the grid, then the resource will receive compensation at the higher of their bid or the prevailing price for the dispatched (MW) amount.

The ISO proposes new functionality that will allow the ISO operators to dispatch storage resources to hold a certain state of charge (MWh), in addition to the traditional (MW) exceptional dispatch.[4] The ISO operators will have a tool that allows for dispatch of storage resources to charge to and hold a specific level of state of charge for a specific duration of time. For example, a specific exceptional dispatch may require a storage resource to charge to 500 MWh and hold that state of charge through the end of hour ending 17. When that energy may be needed later in the day, operators may subsequently issue a dispatch for

[3] These bids must be economic, and not self-scheduled energy.

[4] Actual signals for exceptional dispatch to resources will continue to be transmitted to storage scheduling coordinators via a dispatch instruction in terms of (MW). While exceptional dispatches are issued to storage resources to hold state of charge, these instructions will be at or very close to 0 MW .

the resource to provide energy through a typical exceptional dispatch, or simply release the resource from the exceptional dispatch with a state of charge target.

Compensation for traditional exceptional dispatch is based on the 'bid or better' paradigm where resources receive compensation for energy delivered in response to exceptional dispatch instructions at the higher of bid prices or prevailing market prices. This ensures that resources receive compensation at least at marginal costs to provide energy. Today, if the ISO operators want a resource to hold state of charge, they would issue an exceptional dispatch at or near 0 MW, and would result in almost no compensation for the exceptional dispatch. At the same time the storage would miss opportunities to participate in the real-time market during these periods and potentially earn significantly high market revenues than they would otherwise earn.

Resources below target state of charge levels, when exceptionally dispatched to a certain state of charge, will initially be required to charge up to the target levels. These will be issued from the ISO similar to traditional exceptional dispatch instructions today. For example, if a storage resource is exceptionally dispatched to be at 100 MWh of state of charge, but is currently only at 70 MWh, the resource will receive traditional exceptional dispatch instructions to charge while moving from 70 MWh to 100 MWh. Once at 100 MWh the resource will receive exceptional dispatch instructions to hold state of charge.

3.2.3 *Compensation for EDs to Hold State of Charge*

Storage resources receiving exceptional dispatch instructions to hold state of charge will be compensated using a different methodology than traditional exceptional dispatch. This compensation will be based on an opportunity cost methodology and will capture the revenues that the resource would have missed if it had been allowed to participate in the market. The ISO will calculate the expected revenue the resource would have made, if not for the exceptional dispatch, and compare that value to the amount that the resource could have made optimally in the market if the exceptional dispatch was not in place.

The ISO will use realized prevailing locational marginal prices to determine the opportunity costs for exceptionally dispatching storage resources. The ISO will not re-run and generate new prices anticipating the storage discharge during high priced intervals when the resource was prevented from discharging because of the exceptional dispatch to hold state of charge. The ISO acknowledges that this solution could therefore reflect deviations from true opportunity costs. However, because this analysis would be computationally difficult and very burdensome the ISO is not intending to undertake it at this time.

The ISO proposes that resources issued exceptional dispatch to hold state of charge will be compensated at the difference between the prevailing price during the exceptional dispatch and the reference interval discharge price. The reference interval discharge price will be the period when the storage resource actually discharges and sells energy. This period will have a time limitation. If a resource holds state of charge for an hour because of an exceptional dispatch between 15:00 and 16:00 and does not discharge energy that evening, despite higher prices, the reference interval discharge price will be set at a low level, possibly at $0/MWh. The ISO recognizes that some exceptional dispatches could last from one operating day to the next. In these cases the reference interval discharge price will include ample opportunity for the resource to discharge energy and be included in this calculation.

Examples

If the ISO issues an exceptional dispatch to a storage resource to hold state of charge for an hour, and prevailing prices at that resource's location are $100/MWh, and the resource sells energy later in the day, after the exceptional dispatch, for $80/MWh. In this instance the reference interval dispatch price is $80/MWh, and the ISO will compensate the resource for the $20/MWh, or the difference between prices during the exceptional dispatch and reference interval dispatch.

Similarly, if the ISO issues an exceptional dispatch to a storage resource to hold state of charge for an hour, and prevailing prices at that resource's location are $50/MWh, and the resource sells energy later in the day, after the exceptional dispatch, for $80/MWh, then there is no lost opportunity and the resource will not receive any additional compensation.

3.2.4 *Tools for Local Areas*

Local areas can require additional effort to ensure reliable operation. Today, the ISO uses tools to ensure that there is sufficient resources commitment in local areas during periods when conditions are particularly tight. In the future, as storage becomes more prevalent, the ISO will rely on storage resources even more to ensure reliable local operation. To do this the ISO may need to ensure state of charge availability from storage resources in local areas. The ISO proposes the ability to automatically secure state of charge for local needs in addition to system needs through the day-ahead market process.

Today, the ISO takes a number of steps to ensure local reliability prior running the day-ahead market. Not only does the ISO ensure that the model of the grid matches real conditions as closely as possible, but also can include the loss of the certain critical elements in the local area. For example, the loss of the most critical electrical element, or an N-1 condition, could be included in the day-ahead market run. These conditions imposed in the market ensure voltage stability and prevent thermal overloads should the grid actually lose these critical elements. When the day-ahead model solution is generated, it includes these conditions and includes prices generated congestion from including these contingencies.

Further, the ISO also has the ability to impose second tier constraints, known as minimum on-line commitment constraints, in the market to ensure against further losses, which do not impact prices or congestion. For example, these could include the loss of the second most critical element, or an N-1-1 condition, in a local area. These additional constraints can result only in commitment of resources, and will not result in energy schedules. Once committed these resources are required to be available in the real-time market, and will serve as a safeguard against key element losses in the local area.

Constraints that are priced in the market do result in energy schedules, and ensure that the market would operate reliably even in the absence of the key electric element, which is usually in service in the actual real-time market. Today, this might imply a start-up instruction and energy schedule for a gas resource in a local area, even though that gas resource may not be strictly needed – if the electric element is on-line in the market. Similar to gas resources, storage resources may also be used to meet these constraints. They may be scheduled earlier in the day to charge, and provide energy later in the day to meet local demands that no or few other resources can satisfy when the outage is modeled.

Second tier constraints do not result in additional energy schedules, but may result in resource commitment. Essentially, these constraints ensure there is enough capacity in the local area to manage the contingency, but are not necessarily scheduling energy to meet it. For natural gas fired resources that are effective at managing the second tier outage, this could imply dispatch instructions to start units, which will also ensure availability in the real-time market. The market treats storage resources differently. They are always on-line, and therefore automatically qualify to meet second tier 'capacity' requirements. However, even though the storage resources may be on-line they may not have sufficient state of charge to provide energy to maintain reliability, should an outage occur.

The ISO proposes to enhance the logic for second tier constraints to ensure that capacity is available from traditional resources and that energy is available from storage resources to maintain reliability in the event a key gird element is lost to meet local reliability needs.

3.3 Co-located Enhancements

Many stakeholders commented that current investment tax credit (ITC) rules impact the financial incentives for storage resources. The investment tax credit rules can also impact contracting for storage resources. Some of these contracts expressly prohibit ‘grid charging’ for storage resources because grid charging can reduce the revenue stream for a storage or co-located project. At the July 26 ISO workshop stakeholders suggested that the ISO introduce a mechanism to ensure revenue recovery if a storage resource seeking the investment tax credit was to incur losses due to grid charging. Such a mechanism may reduce qualifications in future contracts that prohibit grid charging and may allow storage resources seeking to bid charging capacity into the market to do so more freely.

In response to these requests, the ISO proposes enhancements to ensure co-located storage resources with investment tax credit or property tax limitations to better reflect their availability in the ISO markets. Further, this should incentivize owners to bid more charging capability into the market, as charging would always be compensated, including incidental costs from grid charging.

Investment Tax Credit (ITC) Mechanics

The ISO understands that the US Internal Revenue Service oversees a program for investment tax credit for facilities with storage resources. This investment tax credit is set up as a mechanism to incentivize renewable generation and pair that generation with storage projects for more robust usage. Specifically, the investment tax credit allows for the recovery of up to about one third of the annualized costs of a storage resource in the form of a tax credit for renewable facilities. This credit is reduced by the fraction of energy that the resource uses to charge from non-renewable resources compared to the total amount of energy that the resource uses to charge from all sources. The storage resource is not eligible for any investment tax credit if this fraction exceeds 25%.

The tax credit phases out over a five year period, where resources receive up to 100% of the credit during the first year, 80% during the second year, 60% the third year…, phasing out completely by the sixth year.

For example, a storage resource with $30 million annualized costs would be eligible for up to a $10 million investment tax credit in the first year, an $8 million dollar tax credit the second year, et cetera. If, in the second year of operation, this resource charged 95 GWh from renewable energy and charged 100 GWh overall, they would be eligible for $7.6 million ($8M * 95 GWh / 100 GWh) for this investment tax credit. Figure 3 illustrates this example.

Figure 3: Annual Investment Tax Credit (ITC) Example

Year	1	2	3	4	5
Max Credit (%)	100%	80%	60%	40%	20%
Max Credit ($)	$10M	$8M	$6M	$4M	$2M

If an estimate of total charging can be made for a storage resource, then a value can be assigned on any specific amount of charging where the amount of energy charged by the storage resource is greater than the amount of generation from the renewable resource.

Property Tax Mechanics

The ISO has also been informed about property tax concerns for storage projects. Specifically, that storage projects can potentially be classified as either renewable or non-renewable status. Where storage resource that is classified as renewable may owe very little in property taxes, a non-renewable status may owe significantly more. In some cases, storage resources may be granted a renewable status if the resource only charges at or below levels of generation from on-site renewable resources, such as wind or solar. Thus, if a storage resource subject to these policies charges from the grid at all, the project may owe a significant amount of property tax compared to never charging from the grid. The ISO would like to continue to understand these concerns better to develop the best policy possible to facilitate these resources and assess the prevalence for these kinds of tax implications.

Today, the ISO offers the hybrid resources model which can allow storage+renewable projects to be modeled in a way that completely prevents grid charging.5 The ISO understands that because of contracting and ownership concerns modeling these facilities as a single resource may not be feasible. The

[5] This is accomplished by setting a Pmin = 0 for the resource, to ensure that no energy flows from the grid to the project over the interconnection.

ISO proposes enhancements to the co-located resource model that will completely prevent grid charging for storage resources with these considerations.

3.3.1 *Enhanced Co-Located Functionality*

Co-located storage resources are able to bid economically or self-schedule into the market. Either could result in a certain schedule to charge during a real-time interval. Storage resources, like all non-variable resources, are obligated by the ISO tariff to follow the dispatch instructions and market awards.6 If the onsite solar resource is unable to generate at the schedule for the storage resource, the resource may be required to charge from the grid. This could occur for a variety of reasons such as renewable resource intermittency or the renewable resource being backed down economically by market dispatch. These situations could result in scenarios where a co-located renewable resource cannot produce output at or above the charging dispatch specified by the storage resource.

Some stakeholders suggested that the ISO offer functionality for storage resources to only bid discharge capability into the market, and allow the storage resource to charge from on-site solar without a dispatch instruction or recognition from the ISO. This is currently not accommodated by the current co-located market model for storage resource. If energy is flowing to or from an ISO modeled resource, that energy needs to be accounted for in the market, ideally through dispatch instructions. Storage resources need this energy to be accounted for to track state of charge.

The ISO proposes new functionality for co-located storage resources in the day-ahead and real-time markets to help address some of the concerns voiced by stakeholders. The ISO proposes an electable functionality to limit dispatch instructions for storage resources so that they are no greater than the forecast of co-located renewable resources. For example, a 50 MW storage resource with this functionality enabled will not receive dispatch instructions to charge beyond 30 MW, if the on-site renewable resource is forecast and scheduled at 30 MW during a specific 5-minute interval. This may effectively truncate the lower portion of the bid cure for the storage resource, and make it inaccessible to the ISO dispatch.

This functionality will not prevent storage resources from receiving instructions to charge from the ISO in excess of dispatch instructions issued to co-located solar

[6] The ESDER 4 policy implemented an exception to this rule when on-site renewables are generating above forecast levels.

resources in all instances. If the ISO issues dispatch instructions to economically curtail output from solar because there is more supply on the system than demand, the ISO will not reduce charging instructions to co-located storage resources. During these intervals storage will be critical to help the ISO match supply and demand and these intervals generally correspond to negative prices in the markets, when storage will find it most economic to charge. These intervals also correspond to the intervals when marginal storage will be charging from marginal renewable resources. In other words, if storage was curtailed (to charge less) there would also be curtailment of solar resources on the grid. During these intervals it is crucial that storage resources follow dispatch.

Finally, the ISO proposes that storage resources be allowed to deviate down from dispatch schedules during intervals when co-located renewables are only able to produce less than forecast, and the ISO is not dispatching the solar resource to curtail output. For example, assume a solar resource is forecast to produce 30 MW during one interval matching the forecast and the storage resource is scheduled to charge at 30 MW. Subsequently, the solar resource is only able to produce 25 MW requiring the storage resource to back down and only charge 25 MW. This prevents the storage resource from charging from the grid when it receives a charging schedule that exceeds the total energy awarded to the solar resource. The storage resource may not deviate beyond the difference in scheduled and actual energy from the variable resource and is required to charge at the level of output from the solar resource when deviating from dispatch instructions.

The ISO is not proposing any changes to the settlement system to accommodate these proposed rule changes. Storage resources that elect this alternate co-located model, and do not fully meet dispatch awards to charge will be subject to associated imbalance energy charges for those differences.

This functionality will not automatically apply to all co-located storage resources, but instead will be functionality that can be requested for specific co-located storage resources. At the time of this request to the ISO, market participants will be required to provide documentation that the associated storage resource is part of an energy project eligible and planning to apply for investment tax credits and the expected window that the facility will be eligible to receive investment tax credits (i.e. 5 years). At that time the ISO will implement this logic for the specified eligibility timeframe of the investment tax credit. If a co-located storage resource has this functionality enabled and would like it removed, this may also be accomplished through a request to the ISO.

Storage resources that elect to not charge from the gird, are unable to charge and are not able to discharge because of insufficient on-site generation are required to submit outage cards to the ISO. ISO operators rely on outage cards to know and understand what generation is available and what generation is unavailable. Co-located storage resources that elect to not charge from the grid are required to submit outage cards if they have a depleted state of charge and there is no ability to charge the resource because the on-site solar resource is not generating during the nighttime hours. Outage cards submitted because the resource cannot generate because there is no state of charge and no ability to charge would be subject to the ISO's resource adequacy availability incentive mechanism (RAAIM).

The ISO is actively developing rules for must offer obligations, resource counting, and resource adequacy availability incentive mechanism treatment in the resource adequacy enhancements stakeholder process. These rules will likely result in changes for treatment of storage and hybrid resources within the resource adequacy construct. Specifically, these rules will likely require that storage resources are required to bid both charging and discharging capability into the market, that crediting for these resources will be based on historic availability, and retirement of the resource adequacy availability incentive mechanism.[7]

3.3.2 *Pseudo-Tie Resources Functionality*

During the stakeholder meetings on July 26, stakeholders requested enhanced functionality for modeling pseudo tie resources. They suggested it would be beneficial for additional participation of resources outside of the ISO footprint. Today, the ISO allows co-located resources to have interconnection limits below the aggregate maximum output of on-site generation. This functionality is useful for facilities with solar and storage resources, as the two generally are not producing at full output during the same time.

Today pseudo-tie resources are required to show firm capacity from the resource interconnection to a delivery point on the ISO transmission grid for their full generating capability. Stakeholders requested that the ISO relax this requirement for co-located pseudo tie resources, and that the firm transmission need only be demonstrated for the amount of interconnection capacity that the co-located resources have, rather than the maximum generating capability of the entire facility. With these requirements in place the ISO could then use the aggregate capability constraint (ACC) to ensure that dispatch for the combination

[7] Resource Adequacy Enhancements stakeholder initiative: https://stakeholdercenter.caiso.com/StakeholderInitiatives/Resource-adequacy-enhancements.

of the resources does not exceed the interconnection limits and firm transmission dedicated to the project. The ISO proposes that this change be implemented, but only for co-located resources where all resources are pseudo-tied from the same balancing authority area to the ISO.

3.4 Additional Changes

The ISO understands that there may be additional changes that stakeholders would like to be considered, but are not addressed in this proposal. At this time, the ISO will continue to consider additional changes, but is not currently including them in the proposal. Please include comments on critical additional topics that are not covered in this proposal but should be considered in this initiative.

4 EIM Classification

The core of this initiative proposes to introduce a new market model, the energy storage resource model, for use by storage resources in the real-time market. In addition, it proposes the following six new rules:

1. Awards of ancillary services for storage resources will require corresponding energy bids (3.2.1)
2. Exceptional dispatches may be issued to a storage resource to hold its state of charge (3.2.2)
3. Compensation for storage resources that receive exceptional dispatches will include lost opportunity cost from not generating (3.2.3)
4. ISO may procure state of charge from storage resources in the day-ahead market to address contingencies (3.2.4)
5. Implement model for co-located resources, subject to election of BAA (3.3.1)
6. Allow co-located pseudo-tie resources to apply an aggregate capability constraint (3.4.2)

As explained below, CAISO staff believes that the EIM Governing Body has joint authority with the Board of Governors over the core proposal – the energy storage resource model – plus proposed rules 5 and 6. The EIM Governing Body would have an advisory role with respect to proposed rules 1 through 3, and would not have any role with respect to proposed rule 4.

The role of the EIM Governing Body with respect to policy initiatives changed on September 23, 2021, when the Board of Governors adopted revisions to the corporate bylaws and the Charter for EIM Governance to implement the Governance Review Committee's Part Two Proposal. Under the new rules, the Board and the EIM Governing Body have joint authority over any

proposal to change or establish any CAISO tariff rule(s) applicable to the EIM Entity balancing authority areas, EIM Entities, or other market participants within the EIM Entity balancing authority areas, in their capacity as participants in EIM. This scope excludes from joint authority, without limitation, any proposals to change or establish tariff rule(s) applicable only to the CAISO balancing authority area or to the CAISO-controlled grid.

Charter for EIM Governance § 2.2.1 The market rule changes to implement the energy storage resource model, the co-located resource model (rule 5) and the aggregate capability constraint (rule 6) would all be "applicable to EIM Entity balancing authority areas, EIM Entities, or other market participants within EIM Entity balancing authority areas, in their capacity as participants in EIM." These proposed rules therefore fall within the scope of joint authority.

On the other hand, rules 1 through 3, to the extent they change rules of the real-time market, would be applicable "only to the CAISO balancing authority area or to the CAISO-controlled grid." Along the same lines, rule 4 would not apply to the real-time market at all. Accordingly, these proposed tariff changes fall outside the scope of joint authority.

The "EIM Governing Body may provide advisory input over proposals to change or establish tariff rules that would apply to the real-time market but are not within the scope of joint authority." Id. While proposed rules 1 through 3 would apply only to the California balancing authority area, they would apply to the real-time market and therefore fall within the scope of the EIM Governing Body's advisory role.

Stakeholders are encouraged to submit a response to the EIM classification of this initiative as described above in their written comments, particularly if they have concerns or questions.

This proposed classification reflects the current state the initiative and could change as the stakeholder process moves ahead.

5 Next Steps

The ISO requests additional feedback from stakeholders on the solutions included in this straw proposal. The ISO will host a stakeholder call on December 14, 2021 to review the issue paper, and encourages all stakeholders to submit comments on the issue paper. Comments will be due on January 12, 2022.