



Day-Ahead Market Enhancements Phase 1: Fifteen-Minute Granularity

Second Revised Straw Proposal

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1. Purpose

The purpose of this initiative is to improve grid reliability and the efficiency of the California ISO's (CAISO) day-ahead market. The CAISO proposes an enhancement to the day-ahead market by introducing fifteen-minute granularity instead of hourly. The introduction of fifteen-minute granularity will better position the system to accommodate net load ramp that occurs in real-time. Currently the real-time market must dispatch resources to manage granularity differences between the day-ahead market and the real-time dispatch (RTD). Fifteen-minute scheduling granularity will also allow the day-ahead market to commit resources with sufficient ramping capability that more closely aligns with anticipated real-time conditions.

1.1. Changes from Revised Straw Proposal

The CAISO appreciates the written stakeholder comments that were received in response to the DAM Enhancements Revised Straw Proposal, as well as issues discussed during the June 19th stakeholder workshop. In response to this input, CAISO is phasing the policy development and implementation of this initiative.

The first phase of the initiative proposes changing the day-ahead scheduling granularity from hourly to four fifteen-minute intervals. Policy changes pertaining to day-ahead market fifteen-minute scheduling granularity are discussed in this paper. Unless otherwise noted, the proposed enhancements discussed in this initiative will be implemented in the fall of 2020.

The second phase of the initiative will involve combining the integrated forward market (IFM) and residual unit commitment (RUC) process into a single optimization while adding a day-ahead flexible ramping product to address uncertainty. The stakeholder engagement schedule and implementation timeline for phase 2 will be discussed during the September 4th stakeholder call. The CAISO plans to update to the technical appendix describing integrated IFM/RUC and day-ahead flexible ramping product with the publication of the phase 2 straw proposal.

The following changes from the revised draft proposal are proposed:

- Allow scheduling coordinators to submit bids with 15 minute granularity in both the day-ahead and real-time market. Given this level of granularity, the CAISO proposes changing the bid submission deadline for the day-ahead market from 10:00 AM to 9:00 AM to allow for additional processing time. The deadline will remain at 75 minutes prior to the operating hour for the real-time market. Introduction of fifteen-minute bidding eliminates the need to allow load and interties to shape their hourly bids using a forecast. The fifteen-minute bids submitted by scheduling coordinators can reflect changes in the upper economic limit of their bid curve.
- Inter-scheduling coordinator (inter-SC) trades can be submitted with fifteen-minute granularity. In addition, inter-SC trades can be submitted 45 minutes prior to each fifteen-minute interval in

real-time. Currently, inter-SC trades are submitted once for the entire operating hour at 45 minutes prior to the hour.

- Currently real-time market bidding at interties includes an option to have a single schedule change in the operating hour. Market participants currently seldom use this functionality. The CAISO proposes no longer to eliminate this intertie bidding option so that it does not need to be added to the day-ahead market.
- Ancillary services procurement and obligation will move to fifteen-minute granularity. The CAISO has proposed clarifications to ancillary services to align with the granularity change and to address operational improvements.

1.2. Background & References

The purpose of the CAISO's day-ahead market is to provide price certainty and schedule resources to ensure operational reliability of the bulk electric grid in real-time. Historically, day-ahead procurement of resources in hourly blocks was adequate and the real-time market could manage deviations that materialized in real-time. Grid infrastructure has advanced, the resource fleet has changed, and the policies regulating operation of the grid have evolved (*i.e.*, FERC mandated fifteen-minute scheduling in real-time energy markets). As a result, hourly scheduling granularity is no longer the most efficient way to schedule resources.

The CAISO market's security constrained economic dispatch (SCED) is responsible for dispatching resources up or down based on system constraints. The day-ahead market commits sufficient energy and capacity in advance of the fifteen-minute and real-time markets to economically balance supply with load. However, intra-hour net load changes have increased to a point in which the day-ahead market's hourly schedules do not align with the real-time load curve; this results in a need for the real-time market to make up for granularity differences and uncertainty.¹

The CAISO has successfully implemented several real-time market enhancements to ensure reliability of the bulk electric grid and enhance economic efficiency; however, there have been limited improvements to the day-ahead market. Therefore, the purpose of this initiative is to improve the day-ahead market to ensure that sufficient resources are committed and adequate available capacity is procured ahead of time to ensure the success of the real-time market and high reliability of the bulk electric grid.

The Day-Ahead Market Enhancements (DAME) initiative is a core element in the CAISO's strategic vision. The CAISO has a three-fold strategic vision, which is broken down into the following strategies:

- 1) Lead the transition to a low carbon grid

¹ Net load is defined as load less variable energy resources output.

- 2) Reliably manage the grid during energy industry transformation
- 3) Expand collaboration to unlock regional benefits

In order to work towards the strategic vision, the CAISO develops a three-year roadmap based on stakeholder input. The Day-Ahead Market Enhancements initiative assists in the achievement of all three elements in the strategic vision.²

Additionally, successful implementation of the DAM Enhancements will enable the CAISO to extend this functionality to Energy Imbalance Market (EIM) entities. Extension of the CAISO's DAM (with fifteen-minute scheduling granularity) will allow for more efficient unit commitment of resources and more effective integration of renewable resources across a larger footprint.

2. Fifteen Minute Scheduling Granularity

2.1. Fifteen-Minute Scheduling

The CAISO proposes to move from hourly to fifteen-minute scheduling in the day-ahead market. This will allow resources to be scheduled in intervals that more closely follow the load curve as predicted by the CAISO forecast of CAISO demand (CFCD). As shown in Figure 1 and further explained below, the current day-ahead market procures in hourly blocks making it challenging to ramp between operating hours, especially when load increases in the morning and evening.

² The 2018 Policy Initiatives Roadmap is located at:
<http://www.aiso.com/Documents/2018FinalPolicyInitiativesRoadmap.pdf>

Figure 1: Day-Ahead Market hourly procurement in comparison to real-time demand curve.
California ISO Trade Date February 5, 2018.



When resources are scheduled in hourly blocks in the day-ahead market, the real-time market must dispatch resources to make up for uncertainty as well as granularity differences that occur within the hour.

Granularity differences

Table 1 presents day-ahead market data from Figure 1, in which resources are correctly procured to meet the load for the middle of the operating hour for HE24. However, the real-time market must address granularity differences that occur throughout the operating hour. For example, at the beginning of the operating hour, the real-time demand is approximately 650 MW greater than the day-ahead forecast. Granularity differences throughout the operating hour can be addressed by moving to fifteen-minute day-ahead scheduling.

Scheduling supply and demand in fifteen-minute intervals, as shown in Table 1 below, will allow the day-ahead market to more closely follow the net load and be prepared for real-time conditions.

Table 1: Hourly Day-Ahead Market procurement and approximated Fifteen-Minute Day-Ahead Market procurement in comparison to real-time demand curve. California ISO Trade Date February 5, 2018.

Interval	DA Hourly Interval Procurement	DA Fifteen-Minute Interval Procurement*	Real-time Demand
1 (23:00 – 23:15)	21,500 MW	22,000 MW	22,150 MW
2 (23:15 – 23:30)	21,500 MW	21,750 MW	22,000 MW
3 (23:30 – 23:45)	21,500 MW	21,500 MW	21,600 MW
4 (23:45 – 24:00)	21,500 MW	21,000 MW	21,200 MW

By providing fifteen-minute granularity in the day-ahead market, energy scheduling more closely matches the real-time demand throughout the operating hour.

Currently, the CAISO demand forecast is calculated in hourly increments. In order to accommodate fifteen-minute scheduling, the forecast will need to be calculated in fifteen-minute increments for use in the residual unit commitment (RUC) process.

Pacific Northwest Hydro

The large amount of hydroelectric generation in the Pacific Northwest can be economically bid into the CAISO markets to help address large ramps between intervals. Currently, the flexibility of the Northwest hydro fleet is underutilized, partially because it has limited participation in the real-time market. The fifteen-minute market publishes notification of schedule changes 22.5 minutes prior to the corresponding fifteen-minute interval. However, hydro resources in the Pacific Northwest are unable to respond to dispatches with only 22.5 minutes of notice and therefore cannot participate in the CAISO's real-time fifteen-minute market. Although fifteen-minute static intertie resources participating in the real-time market can be used to address uncertainty between the integrated forward market and real-time market, far more ramping capability is available if the Pacific Northwest hydro resources can be scheduled in the day-ahead timeframe.

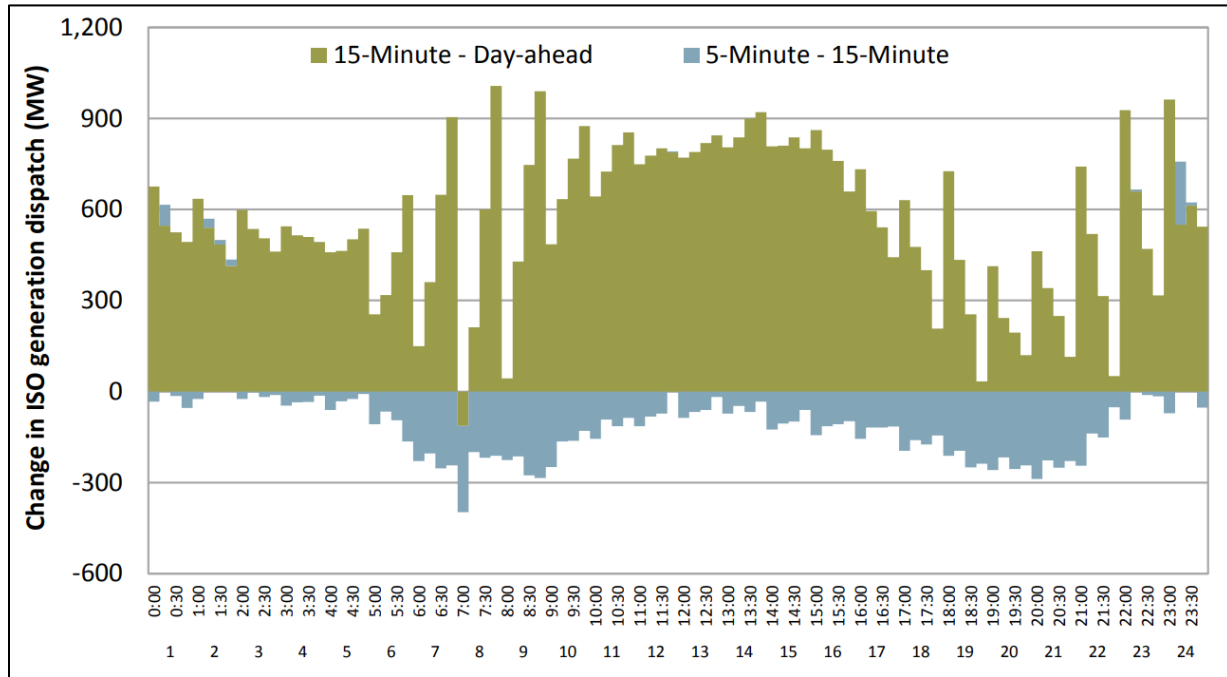
Intertie schedules shaped in fifteen-minute intervals can more accurately match the actual ramping needs of the CAISO, compared to hourly day-ahead schedules. Dynamically scheduled resources can also be used to address uncertainty between the integrated forward market and the real-time market; however, there may be physical limitations on dynamic transfer capacity that prevent the hydro resources from being scheduled dynamically in the real-time market.³ Thus, the ability to shape the most flexible of intertie schedules in the day-ahead timeframe increases the flexibility available to the CAISO. By moving to fifteen-minute granularity in the IFM, CAISO can better utilize available hydro resources to meet the forecasted steep ramps in the CAISO and help address granularity differences that occur throughout the operating hour.

Impact on Internal Resources

The impact of day-ahead hourly scheduling on internal resources was published by the Department of Market Monitoring (DMM). Figure 3 displays the average incremental change for internal resources between the day-ahead and real-time market. The green bars represent the change between the day-ahead and fifteen-minute market. The blue bar represents the change between the fifteen-minute market and the 5-minute market.

³ A small portion of hydro from the Northwest is scheduled through dynamic transfers and can be dispatched in 5-minute intervals. Additionally, some resources are scheduled in the fifteen-minute market through static imports and exports. However, the majority of the hydro fleet is scheduled in the day-ahead market.

Figure 3: Imbalance generation dispatch volume, CAISO 2018.



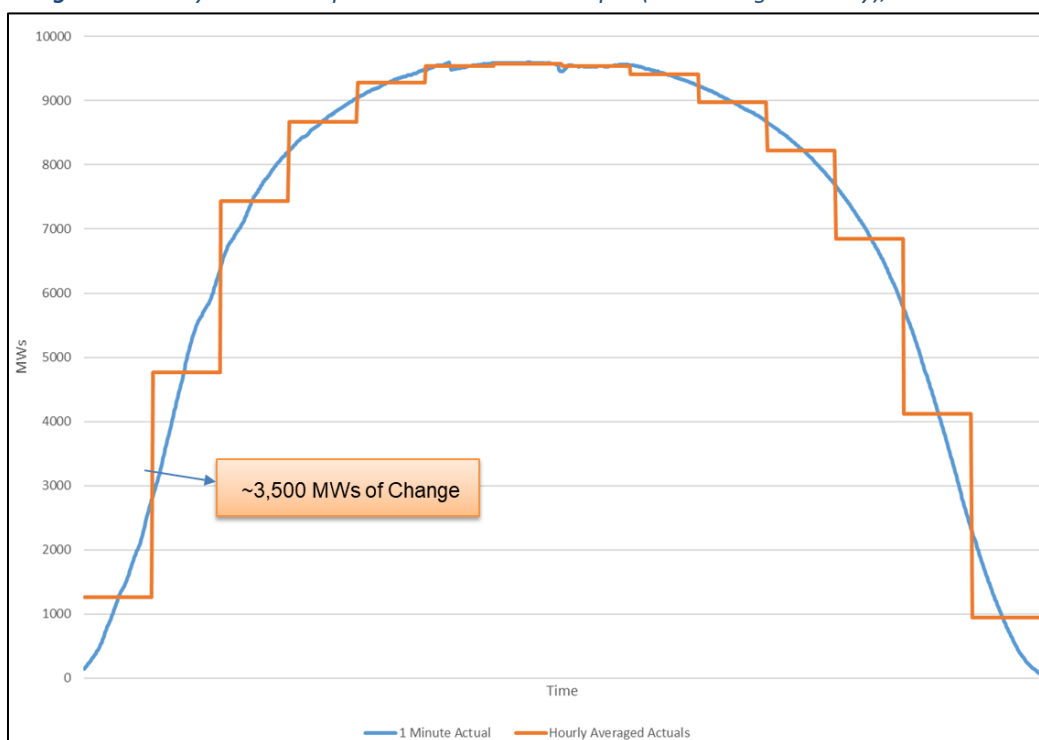
Source: Annual Report on Market Issues and Performance⁴

This data shows the real-time FMM is largely responsible for dispatching generators to compensate for under- or over-procurement from the hourly day-ahead market. For example, HE22 (the end of the evening load pull) on average requires the FMM to dispatch an additional 1,500 MW for the first interval of the operating hour. This is because the day-ahead market procures energy for the hour based on an average load value for the hour. However, load changes dramatically during the ramps, and hourly procurement does not set the real-time market up for success. Moving to fifteen-minute scheduling granularity in the day-ahead market will allow resources to be scheduled to follow the load curve more closely; this will result in less strain on the real-time market.

Figure 4 presents solar data scheduled in hourly blocks compared to actual solar output (1-minute granularity). It further demonstrates that day-ahead market hourly block procurement does not adequately match the changes of the solar ramp-up during the morning, as well as the ramp-down during the evening.

⁴ The DMM 2017 Annual Report on Market Issues and Performance can be referenced at: <http://www.caiso.com/Documents/2017AnnualReportonMarketIssuesandPerformance.pdf>.

Figure 4: Hourly blocks compared to actual solar output (1-minute granularity), CAISO 2017.



Moving to fifteen-minute granularity in the day-ahead market will allow the CAISO to better reflect renewable schedules. This change eliminates the need for traditional generators (*i.e.*, steam plants or multi-stage generators) to be solely responsible for addressing the granularity differences that occur across the hour.

2.2. Fifteen-Minute Bidding

Day-Ahead Market

The CAISO proposes to introduce fifteen-minute bidding granularity in both the day-ahead and real-time markets. This change from hourly to fifteen-minute bidding will align with the proposed fifteen-minute scheduling granularity. In order to accommodate the fifteen-minute bidding intervals (96 intervals total), the CAISO proposes changing the bid submission deadline for the day-ahead market from 10:00 AM to 9:00 AM to allow additional processing time. At that time, scheduling coordinators will submit 96 bid curves into the day-ahead market. A scheduling coordinator can elect to maintain the same bid curve for all four intervals of the hour. Fifteen-minute bidding will be allowed for all resources participating in the day-ahead market: bid-in load, generation, virtual supply and virtual demand. Market participants requested fifteen-minute bidding granularity during the stakeholder process because it will enable suppliers to reflect fuel costs, particularly for natural gas that may change during an hour. Additionally, fifteen-minute bidding granularity eliminates the need to allow scheduling coordinators to shape load and intertie hourly bids using a forecast submitted to the CAISO. Since the fifteen-minute bids submitted can reflect changes in the upper economic limit of the bid curve, additional forecast information is not needed.

Real-Time Market

The CAISO proposes to also move the real-time market from hourly to fifteen-minute bidding. The bid submission deadline will remain 75 minutes prior to the operating hour. Scheduling coordinators will submit 4 bid curves for the upcoming hour. The same fifteen-minute bid curve that is used for the FMM will be used in the corresponding three real-time dispatch intervals. Variable energy resources will continue to have the upper portion of the bid curve adjusted based upon the rolling 5-minute forecast.

2.3. Fifteen-Minute Residual Unit Commitment

For phase 1 of the day-ahead market enhancements initiative, the residual unit commitment (RUC) process will continue to run after the integrated forward market. The RUC process will move from hourly granularity to fifteen-minute granularity. RUC will ensure physical supply can meet the CAISO fifteen-minute load forecast. In addition, the CAISO compensates for variable energy resources that scheduling coordinators do not schedule in the day-ahead market, but that the CAISO anticipates will produce energy in real-time so that the RUC process does not over-commit resources. Accordingly, this adjustment will use a fifteen-minute forecast of variable energy resource output. For non-resource adequacy resources, the RUC availability bids will be submitted by the scheduling coordinators for each fifteen-minute interval. For resource adequacy resources, the RUC availability bid will remain \$0.00/MWh.

2.4. Intertie Bidding and Scheduling Options

Similar to internal resources, imports and exports will be able to be bid and scheduled with fifteen-minute granularity. Imports or exports will register for either a fifteen-minute or hourly block bid option. The import/export cannot change the bidding option between the day-ahead and real-time market.

The CAISO proposes to continue allowing hourly block bidding of imports and exports. The hourly block bidding option ensures the import or export has the same schedule for all fifteen-minute intervals in the operating hour. Hourly block imports and exports can be re-optimized in the real-time market by the hour ahead scheduling process (HASP). The hour ahead schedule process will result in a binding hourly real-time schedule for hourly block resources; however, the prices at which imbalances from the resource's day-ahead schedule will be settled will be determined by the fifteen-minute market. The CAISO is not proposing any change to the real-time settlement of hourly block schedules.

Imports or exports seeking hourly schedules in the day-ahead market and participation in the fifteen-minute market should register as a fifteen-minute resource and submit the same self-schedule into the day-ahead market for all fifteen-minute intervals in the operating hour. For intertie resources that can be scheduled in fifteen-minute granularity in the day-ahead market, but cannot be re-optimized in the FMM, the scheduling coordinator will have the option to self-schedule the day-ahead awards into the real-time market.

The CAISO is proposing to eliminate the option for single schedule changes within an hour in the real-time market, as scheduling coordinators rarely use it today. This will simplify day-ahead fifteen-minute scheduling implementation as the CAISO will not need to also develop this bidding option for the day-ahead market.

2.5. Inter-Scheduling Coordinator Trades

Inter-scheduling coordinator (SC) trades are a mechanism that scheduling coordinators can use to trade energy, ancillary services, and uplift obligation financial settlements. Inter-SC trades do not affect the market optimization or resource scheduling. Three forms of Inter-SC trades are processed through the CAISO's settlements: Inter-SC trades of energy, inter-SC trades of ancillary services, and inter-SC trades of IFM load uplift obligation. The CAISO proposes to change inter-scheduling coordinator (inter-SC) trades from an hourly trade to a fifteen-minute interval trade.

Inter-SC trades of energy may be either Inter-SC trades at aggregated price nodes (PNodes) or "physical trades." Inter-SC trades of energy in both the day-ahead and real-time markets are currently settled on an hourly basis. In the real-time market, inter-SC trades of energy are settled at the simple average of the four applicable FMM LMPs. Physical trades of energy are subject to adjustments based on the awarded schedules of underlying physical resources, through submittal screening, pre-market validation, and post-market confirmation processes that are detailed in tariff section 28.1.6. These processes seek to limit Physical Trades of Energy, on average, to less than or equal to the generation that is scheduled or dispatched at the same location of the trade. All MWh quantities of Physical Trades that are confirmed through the post-market confirmation are settled at the LMP of the relevant PNode, while all energy quantities (in MWh) of Physical Trades that are reduced during the post market confirmation are settled at the relevant generation trading hub price.

Currently, trades are submitted for a single hourly inter-SC trades, no later than 45 minutes before the hour. This proposal will allow energy and ancillary service obligation trades to occur on a fifteen-minute interval basis. Real-time inter-SC trades would be submitted 45 minutes prior to each FMM interval. The grid management charge (GMC) for inter-SC trades is currently \$1.00 per trade. The CAISO proposes to divide this rate into four intervals, resulting in a new GMC rate of \$0.25 per trade.

Allowing fifteen-minute inter-SC trades will address some concerns of variable energy resource owners that if the forecast used in FMM within the hour is lower than the submitted hourly inter-SC trade quantity.⁵ Fifteen-minute inter-SC trades will enable scheduling coordinators of variable energy resources to establish an inter-SC trade quantity using a fifteen-minute forecast closer to the actual flow in a given fifteen-minute interval.

⁵ A financial (*i.e.*, converted physical) trade settles at the trading hub, while physical trades are settled at the resource's LMP.

2.6. Load Meter Submission

Under current market rules, actual load can be submitted by scheduling coordinators in either fifteen-minute or hourly granularity based upon the underlying meter granularity. If the load scheduling coordinator's meters measure with fifteen-minute granularity, the load meter data can be submitted by scheduling coordinators with fifteen-minute granularity. If the load scheduling coordinator's meter measures with hourly granularity, the data can be submitted with hourly granularity. If some of the load scheduling coordinator's meters measure in fifteen-minute granularity and some are hourly, the scheduling coordinator must submit all of the meter data in hourly granularity. For hourly submitted load, the CAISO will shape hourly submissions into fifteen-minute granularity by assuming a linear ramp from mid-point to mid-point between hours. Table 3 below provides an example of this approach.

Table 3: Shaped Hourly Load Meter

	HE 10				HE 11				HE 12			
Hourly Meter (MWh)	1000				1200				1400			
	HE 10				HE 11				HE 12			
	Int 1	Int 2	Int 3	Int 4	Int 1	Int 2	Int 3	Int 4	Int 1	Int 2	Int 3	Int 4
15-Minute Shaped (MW)	-	-	1025	1075	1125	1175	1225	1275	1325	1375	-	-
15-Minute Shaped (MWh)	-	-	256	269	281	294	306	319	331	344	-	-

2.7. Ancillary Services

This initiative proposes that the CAISO will procure ancillary services in fifteen-minute granularity in both the day-ahead and real-time markets. The CAISO also proposes shifting ancillary services procurement, settlement, obligation, and cost allocation to fifteen-minute granularity.⁶ Currently, Appendix K of the CAISO tariff⁷ requires spinning and non-spinning reserves to sustain output for 30 minutes, which applies even if a resource is not scheduled to provide spinning or non-spinning reserves in subsequent fifteen-minute intervals.

Ancillary Services on Interties

The CAISO proposes that ancillary services on the interties can only be procured in the day-ahead market from resources⁸ that can also be scheduled in the fifteen-minute market. Ancillary services procured through an hourly block would require contingency dispatches to be held for the remainder of the hour, even if the additional supply is not needed to address the contingency event.

With this proposal, only resources participating in the FMM would be able to provide ancillary services on the interties. In order to accommodate the delivery of energy if the awarded ancillary services

⁶ AS procurement is currently executed on a 10-minute basis.

⁷ Appendix K of the CAISO Tariff: http://www.aiso.com/Documents/AppendixK_AncillaryServiceRequirementsProtocol_ASRP_asof_Nov1_2017.pdf.

⁸ This would include resources registered as 15-minute intertie resources or dynamic resources.

resource is called upon, the CAISO proposes to automatically update the e-tag energy profile to match the award if it is dispatched for energy during a contingency event.

Non-Generator Resources Providing Ancillary Services

Non-generating resources (NGRs) with a state of charge will be required to be capable of a 30 minute discharge to be awarded regulation-up, spinning reserves and non-spinning.⁹ The CAISO proposes to implement a resource constraint to ensure the state of charge supports ancillary service awards. Similarly, the state of charge will be required to support 30 minutes of charging to be awarded regulation down. This is consistent with existing rules that require the resource to sustain output for 30 minutes after the resource has reached its ancillary services award.

Single Dynamic Ramp Rate

The CAISO proposes that ancillary services and energy will be awarded using a single dynamic operational ramp rate (as provided in the Master File), limited by certified ancillary services capacity. The regulation ramp rate used in the automated generator control (AGC) can be lower than the dynamic ramp rate. If a contingency event occurs, spinning and non-spinning reserves, as well as regulation resources will be dispatched using a dynamic ramp rate. Deviations will only occur as a result of a contingency. Plant operators would be unable to override the ramp rate in the EMS system. If the operational ramp rate has changed, an outage management system (OMS)¹⁰ card must be submitted to allow recognition of the new ramp rate by the market. This will ensure deliverability based on what is awarded in the market.

Self-Provision of Ancillary Services

The CAISO will continue to support ancillary service self-provision, but will eliminate the existing ancillary services self-provision qualification process that takes place before the market run. Instead ancillary service self-provision will be co-optimized with the energy, bid-in ancillary services, and the flexible ramping products, using penalty prices for ancillary service self-provision. This approach will provide the necessary scheduling priority and result in a more efficient market solution and will eliminate an antiquated feature that has increasing CAISO ongoing maintenance costs. Necessary modifications for this enhancement will be conducted through changes to CAISO's internal processes and will not directly impact scheduling coordinators.

2.8. Market Power Mitigation

Market power mitigation will be evaluated on a fifteen-minute interval basis in the new day-ahead market. This will align mitigation with the new 15-minute scheduling in the day-ahead market. The

⁹ These market enhancements will be implemented prior to 2020.

¹⁰ Information on CAISO's outage management system is posted here:
<http://www.caiso.com/market/Pages/OutageManagement/Default.aspx>.

EIM-identified market power mitigation enhancements initiative further explores options for improving local market power mitigation in the real-time market, such as considering to no longer mitigate for the balance of the hour.¹¹

2.9. Modification to Ramping Energy Calculation

Expected energy calculation changes are required as a byproduct of fifteen-minute day-ahead schedules instead of hourly. For the most part, these will be settlement formula revisions to account for the change in scheduling granularity. However there will be more significant changes required to both the standard ramping energy and ramping energy deviation energy classifications the CAISO uses in settlements.

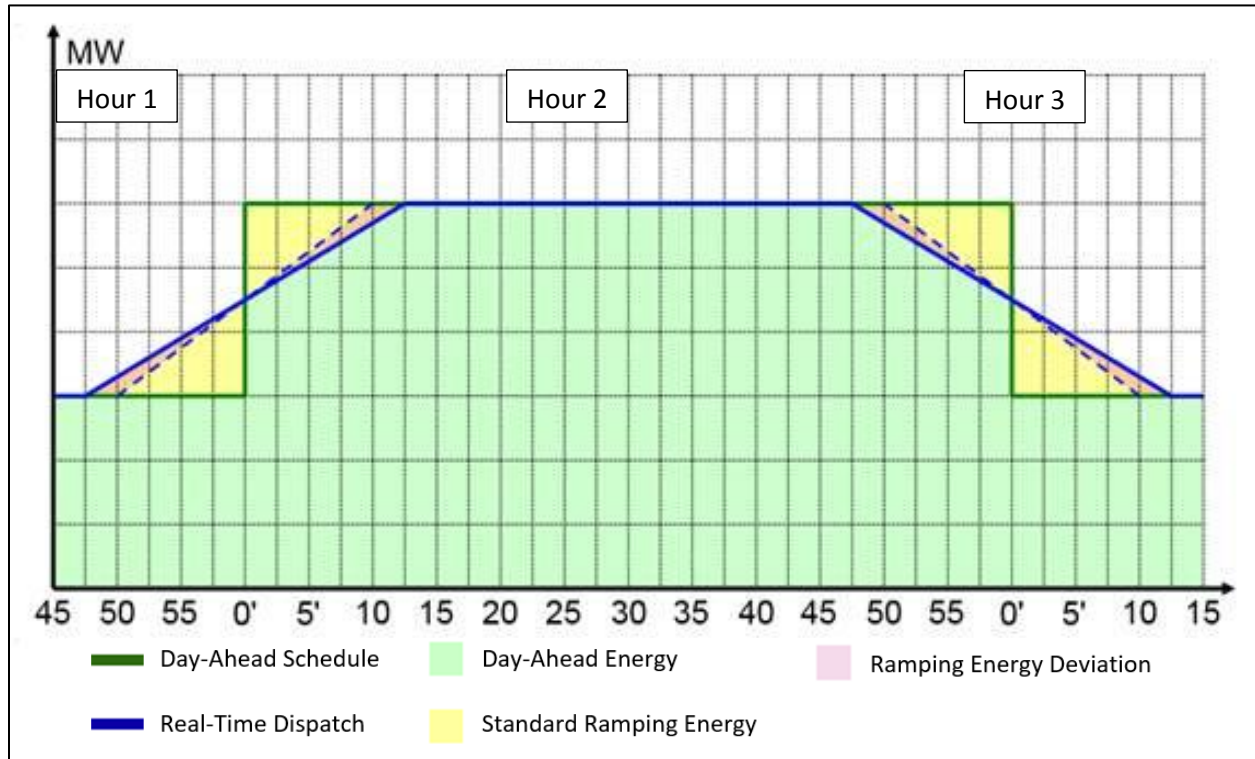
The primary objective of the standard ramping energy is to insulate scheduling coordinators from real-time market charges if they do not participate in the real-time market, but instead follow their day-ahead market schedule. For this reason, the CAISO prescribes schedule change ramps that, if followed, will avoid exposure to imbalance energy charges in the real-time market. Standard ramping energy represents the energy produced or consumed by this “standard” symmetrical ramp of a resource over 20 minutes between two hourly day-ahead schedules.

Ramping energy deviation represents energy produced or consumed if a resource is not able to follow this standard ramp. Standard ramping energy and ramping energy deviation are currently calculated for all resources whose day-ahead energy schedule has changed between two consecutive hours. Standard ramping energy is not settled.

Figure 5 below shows graphically the existing calculation of standard ramping energy and ramping energy deviation for a resource that does not have energy bids and is self-scheduling in order to be dispatched between the day-ahead schedules over a portion of a three hour period. The day-ahead schedule is represented by the green line and the real-time dispatch by the solid blue line. In this example the resource’s ramping capability allows for a change in schedule over a 25 minute period. Accordingly, the symmetrical ramp between the day-ahead schedule starts at minute 47.5 in the previous hour and ends at minute 12.5 in the following hour. Day-ahead expected energy is represented by the light green shaded area, and is beneath the yellow and brown areas below the day-ahead schedule in hour 2. Standard ramping energy is represented by the yellow triangular areas consisting of energy produced or consumed by a dispatch between hourly day-ahead schedules using a 20 minute ramp between minute 50 in the previous hour and 10 in the following hour. Ramping energy deviation is represented by the pink cross sections consisting of the deviation energy produced or consumed by a dispatch between hourly day-ahead schedules at a slower (25 minute) ramp than the standard ramp.

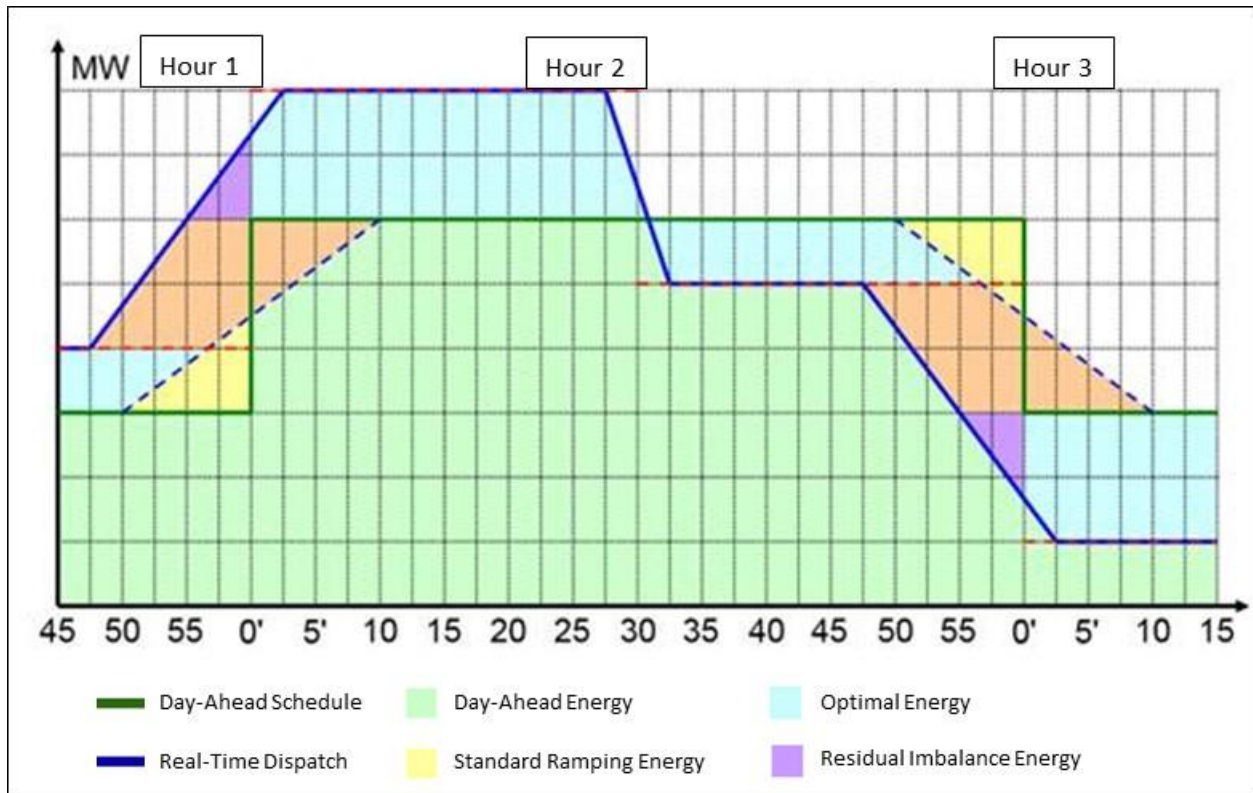
¹¹ The EIM-Identified Market Power Mitigation initiative is posted here: <http://www.caiso.com/informed/Pages/MeetingsEvents/MiscellaneousStakeholderMeetings/Default.aspx>.

Figure 5: Standard Ramping Energy and Ramping Energy Deviation with No Energy Bids



Standard ramping energy and ramping energy deviation are currently calculated for resources that are dispatched optimally with energy bids, as shown in a more complicated graphic below. In Figure 6 below, the resource is dispatched economically to various operating points based on its real-time market energy bid, taking into account the resource’s ramping capability. In addition to the day-ahead energy, standard ramping energy and ramping energy deviation elements shown in the previous example, optimal energy (shown in light blue), and residual imbalance energy (shown in purple) would be expected for a resource that is participating in the market. The dashed red line shows the economic point of operation if the resource was not ramp limited.

Figure 6: Ramping Capability with Optimal Energy and Residual Imbalance Energy



The CAISO proposes to retain standard ramping energy and ramping energy deviation, but only for those resources that do not want to participate in the real time market. For resources that are participating in the real time market, standard ramping energy and ramping energy deviation will not be calculated. Instead the energy that was previously calculated as standard ramping energy and ramping energy deviation, will be settled and eligible for bid cost recovery by being classified under other existing energy types such as optimal energy and residual imbalance energy. This treatment is appropriate since these resources are participating and should be compensated appropriately for energy produced or consumed for instructed deviations from their day-ahead schedule.

For resources that are not participating in the real-time market, standard ramping energy will continue to be based on a 20 minute ramp for cross-hour schedule changes (15 minute schedules between hours) from -10' to +10'. However, for intra-hour schedule changes (15 minute schedules within the hour) the ramp shall be 10 minutes, from -5' to +5'. The 10 minute ramping period is used in order to match the standard 10 minute ramp for intra-hour intertie schedule changes, thus reducing the potential need for flexible ramping capacity. Ramping energy deviations shall still be calculated for dispatch operating points deviations from SRE due to resource ramp rate limitations. Figure 7 illustrates how standard ramping and ramping energy deviation would be calculated for a resource with intra-hour schedule changes and a ramp rate limitation preventing a 10 minute ramp between the third and fourth interval of hour 2.

Figure 7: Standard Ramping Capability and Ramping Energy Deviation for Intra-Hour Schedule Changes

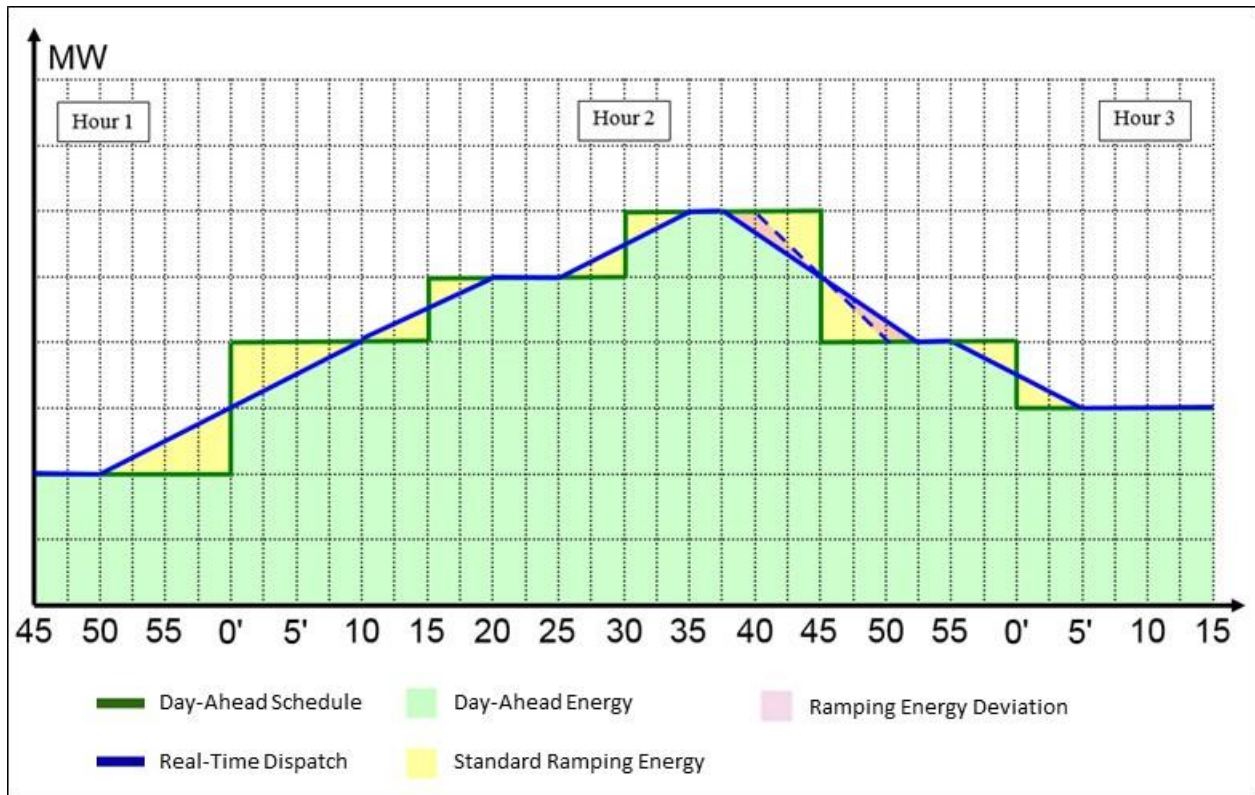
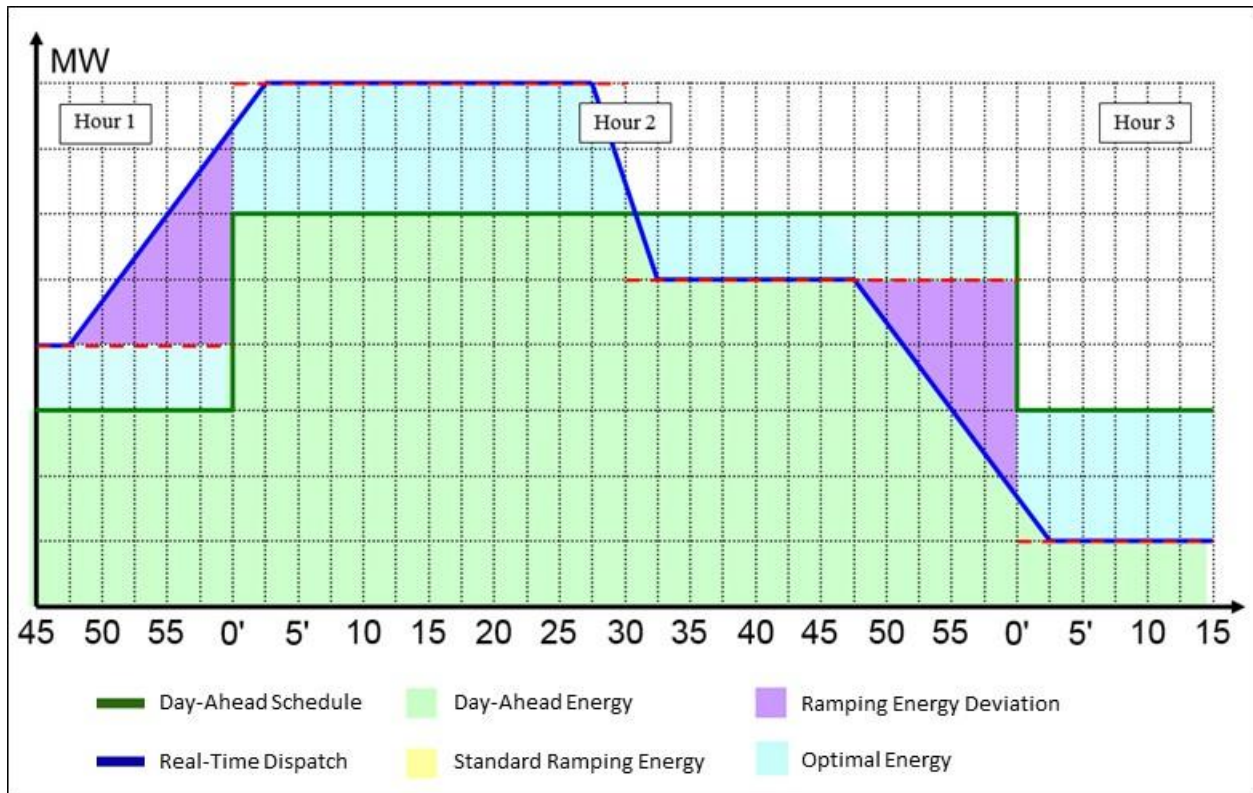


Figure 8 shows how expected energy may be calculated for resources that are participating in the real-time market. In this instance, standard ramping energy and ramping energy deviation no longer apply. For illustration purposes the same dispatch scenario is shown in the second diagram.

Figure 8: Real-Time Market without Application of Standard Ramping Capability and Ramping Energy Deviation



2.10. Other Design Considerations

The following design considerations are also included being proposed within this initiative:

- **Administrative pricing rules:** In the event that fifteen-minute market or real-time dispatch is unable to produce market results, the relevant day-ahead fifteen-minute interval price will be used.
- **Make whole payments:** In the event of price corrections, make whole payments will only be made for Load and hourly block exports. Fifteen-minute bidding exports will be eligible to receive bid cost recovery.
- **Load aggregation point pricing in the real-time market:** Currently, the CAISO calculates a real-time hourly load aggregation point price based upon the weighted average of the FMM and RTD prices based upon the load forecast used to clear the relevant market interval in the operating hour. With the move to a fifteen-minute day-ahead scheduling granularity, the CAISO proposes to calculate a fifteen-minute load aggregation point price based upon the weighted average of the FMM and the three relevant RTD prices based upon the load forecast used to clear the market intervals during that fifteen-minute period.
- **CRR Clawback Rule:** Congestion revenue rights (CRR) will be settled for each fifteen-minute day-ahead interval. In addition, cleared convergence bids will be awarded by fifteen-minute

interval and settled at fifteen-minute LMP. Convergence bids are automatically reversed at the FMM price for the corresponding real-time fifteen-minute interval. The CRR clawback rule will be evaluated for each fifteen-minute interval.

- **Hour Ahead Scheduling Process (HASP) Reversal Rule:** The HASP reversal rule (*i.e.*, “HASP clawback”) is intended to address implicit virtual bidding. The HASP clawback will move from an hourly IFM to FMM comparison to a fifteen-minute DAM to FMM comparison. This will allow the clawback rule to compare fifteen-minute forward schedules to fifteen-minute schedules in the real-time market.
- **Resource adequacy resources must offer obligation:** The CAISO will continue to insert bids into the real-time market for resource adequacy resources with real-time market must offer obligations. To correspond with the fifteen-minute scheduling granularity and bidding change, the market will automatically input four bids of equal value for the entire hour to meet the resource adequacy must-offer obligation requirement.
- **Existing Transmission Contract Calculator:** Enable transmission limits to be set for each fifteen-minute intervals. This will allow intertie and path limits to be increased or decreased based on operational needs with fifteen-minute granularity, if needed.

3. Energy Imbalance Market Impacts

The energy imbalance market (EIM) extends the CAISO’s real-time market to other balancing authority areas in the West. Prior to the start of the real-time market, each EIM entity submits hourly base schedules. Hourly base schedules are the reference point from which imbalance energy is calculated and settled through the EIM. The use of hourly base schedules was originally chosen to align with the CAISO’s reference point for imbalance energy which was hourly day-ahead schedules. Since the CAISO is proposing to move to fifteen-minute granularity for the day-ahead market, the CAISO proposes to also change the EIM base schedule granularity from hourly to fifteen-minute. If an EIM entity wanted to continue to submit hourly base schedules, this would be done by submitting the same value base schedule for all four intervals of the operating hour. The change to fifteen-minute base schedules will also require modifications to other elements of the EIM design as discussed below.

3.1. Resource Sufficiency Evaluation

Currently, on an hourly basis, the CAISO performs a series of tests to determine if a balancing authority area (BAA) is not “leaning” on the EIM for capacity, flexibility or transmission. The tests include a balancing test, capacity test, and flexible ramping test. The CAISO proposes to modify the resource sufficiency evaluation from hourly granularity to fifteen-minute granularity.

If the BAA passes the resource sufficiency evaluation, it will have access to other BAA’s resources to meet its load and ramping needs. If the BAA fails the resource sufficiency evaluation for a given fifteen-minute interval, the EIM transfer limits will be set by the market operator such that incremental transfers cannot occur in that fifteen-minute interval in the direction of the BAA that failed the test. Thus the BAA must rely solely on its own resources to meet imbalances and ramping within its balancing

authority area. Specifically, if the BAA fails the upward test for a given fifteen-minute interval, then EIM transfer imports into that BAA are limited during that fifteen-minute interval to the previous FMM transfer. If the BAA fails the downward test for a given fifteen-minute interval, then EIM transfer exports out of that BAA are limited during fifteen-minute interval to the previous FMM transfer.

With the implementation of the fifteen-minute day-ahead granularity, the CAISO will similarly test each BAA for sufficiency in each fifteen-minute interval. If a BAA fails the capacity test, the EIM transfer for that BAA will be similarly limited for the corresponding fifteen-minute intervals. If the BAA fails the balance test, it will be subject to over or under scheduling charges for the corresponding fifteen-minute interval. The changes to the balance and capacity test require base schedules to move from hourly granularity to fifteen-minute granularity.

The CAISO is planning to propose business practice manual changes to modify the flexible ramping sufficiency test. Currently, the flexible ramping sufficiency test evaluates for ramp horizons from the last fifteen-minute interval of the previous operating hour: 15-minute ramp, a 30-minute ramp, a 45-minute ramp, and a 60-minute ramp. If any of the four ramps are not met, the EIM transfers are frozen for the entire operating hour. The CAISO proposes to freeze transfers to the last FMM transfer based upon which ramp test was failed. For example, if the 45-minute ramp test failed, then only the third fifteen-minute interval of the operating would have EIM transfers limited. This change can be implemented without the need for fifteen-minute base schedules and may occur prior to the implementation of fifteen-minute scheduling.¹²

3.2. Over and Under Scheduling Charges

The intent of the over and under scheduling charges¹³ is to ensure that EIM entity balancing authority areas have sufficient supply to independently meet energy imbalances. Currently, if the EIM entity uses the CAISO load forecast and the hourly base scheduled load is within 1% of the CAISO load forecast, the EIM balancing authority area is exempt from charges. If the EIM entity uses its own load forecast or has hourly base schedule load that differs from the CAISO load forecast by more than 1%, the EIM entity is subject to the over and under scheduling charges for that operating hour. If load imbalance exceeds 5% (but at least 2MWh) for the operating hour the EIM entity is subject to the first tier charges. If the load imbalance exceeds 10% for the operating hour the EIM entity is subject to the second tier charges. If load imbalance for the operating hour does not reach 5%, then there are no over or under scheduling charges.

The CAISO proposes to modify the determination of whether an EIM entity's load imbalance reaches the penalty thresholds from an hourly evaluation to fifteen-minute evaluation. The fifteen-minute base

See EIM Offer Rules and Resource Sufficiency Test workshop materials available at: <http://www.caiso.com/informed/Pages/MeetingsEvents/MiscellaneousStakeholderMeetings/Default.aspx>.

¹³ See section 3.3.6 of the EIM Draft Final Proposal for additional details on the over and under scheduling charges. The draft final proposal is available at: <https://www.westerneim.com/Documents/EnergyImbalanceMarket-DraftFinalProposal092313.pdf>

schedule load forecast will be compared to the fifteen-minute actual load. Since the evaluation is now being performed on a fifteen-minute basis the minimum load imbalance level will be reduced from 2 MWh to 0.5 MWh. The CAISO is not proposing any changes to the percentage thresholds or LMP multipliers of the charge.

3.3. Settlement of Regulation Energy

While adding the Sacramento Municipal Utility District (SMUD) to the EIM, the need to automate the calculation and settlement of energy resulting from resources that provide regulation up and down was identified.

Energy resulting from providing regulation is currently settled at the 5-minute real-time dispatch price. The same price is used if the energy is classified as instructed imbalance energy or uninstructed imbalance energy. However, uninstructed imbalance energy is used to determine the amount uplift costs that should be shifted between EIM balancing authority areas. Currently, EIM entity scheduling coordinators can inform the CAISO through a manual dispatch after the market interval has concluded the amount of energy that a resource has provided in response to the balancing authority areas regulation signal. This allows the CAISO to then classify the deviations from dispatch as instructed imbalance energy, which does not result in uplift costs being shifted between EIM balancing authority areas.

The CAISO proposes that the hourly resource plan for resources be expanded to include a MW quantity for both regulation up and regulation down. This will allow the scheduling coordinator to specify the MW quantity that is being used for automated generation control (AGC). This regulation capacity will be protected in the market optimization. Incremental energy dispatches will respect the regulation up capacity. Decremental energy dispatches will ensure that there is sufficient energy dispatched above the resource's PMIN to support regulation down capacity.

The CAISO will use this information to automatically calculate regulation energy which is classified as instructed imbalance energy.¹⁴ This eliminates the need for the EIM entity scheduling coordinator to inform the CAISO through a manual dispatch to ensure the deviations are classified as instructed imbalance energy.

4. EIM Governing Body Role

The Issue Paper/Straw Proposal published February 28, 2018, indicated this initiative would fall entirely within the EIM Governing Body's advisory authority. After additional policy development, the CAISO

¹⁴ Additional information on the calculation of regulation energy is included the BPM-CG PC Real Time Energy Quantity available at: <https://bpmcm.caiso.com/Pages/SnBBPMDetails.aspx?BPM=Settlements%20and%20Billing>

now believes the appropriate classification is **hybrid non-EIM specific**. Accordingly, a briefing will be provided to the EIM Governing Body, requesting support of its hybrid role and approval from the CAISO Board of Governors.

While the majority of this proposal continues to involve changes to the CAISO's day-ahead market, which management is proposing to classify as advisory, the CAISO staff now recognizes that this proposal will also include a change to an EIM-specific rule of the real-time market.¹⁵ Introducing fifteen-minute scheduling granularity in the day-ahead market will require fifteen-minute scheduling granularity for EIM base schedules. This will ensure alignment between the CAISO and the EIM.

This change to the granularity of EIM base schedules is not severable from the remainder of the initiative, because the CAISO would not want to proceed with the remainder of the initiative if this element were not approved as well. Otherwise, there would not be alignment between the EIM and the rest of the CAISO market.

For that reason, the CAISO proposes to classify this initiative as hybrid-non EIM specific. As explained in the EIM classification guideline, a hybrid non-EIM specific initiative is appropriate "when the driver for the initiative is **not** EIM and the policy initiative is a hybrid in that it has **both** a component that would fall within the EIM governing body's primary authority and a component that would fall within its advisory authority."¹⁶

The proposed changes to the settlement of regulation energy is EIM-specific because it eliminates the need for EIM entity scheduling coordinators to inform the CAISO of regulation energy through a manual dispatch. Therefore, this enhancement falls within the primary authority of the EIM Governing Body. However, unlike other elements of this initiative, the proposed changes to the settlement of regulation energy would be severable and do not have to be decided within this initiative.

As the initiative currently stands, the CAISO would expect to ask the EIM Governing Body to approve both fifteen-minute base schedule submissions and the settlement of regulation energy. If the EIM Governing Body approves, the CAISO would ask its Board to approve, with a full discussion, fifteen-minute scheduling granularity changes and fifteen-minute base schedule submission. In addition, the changes to the settlement of regulation energy would be placed on the Board's consent agenda. The EIM Governing Body would also have the option of providing an advisory opinion to the CAISO Board on the initiatives other elements.

¹⁵ The February 28, 2018 Issue Paper/Straw Proposal acknowledged that proposed changes to rules of the day-ahead market would not involve a decisional role for the EIM Governing Body. It nevertheless proposed an advisory classification for the full initiative due the unique foundational nature of this initiative and the intentions of the Transitional Committee, which expected that EIM Governance would have a role in "decisions ... that would ... [a]llow options to expand the functionality of the market to provide additional services ..." *Final Proposal*, August 19, 2015, p. 14.

¹⁶ https://www.caiso.com/Documents/Decision_EIM_GovernanceProposal-AttachA-Proposal-Sep2015.pdf

Stakeholders are encouraged to submit a response to the EIM classification of this initiative as **hybrid non-EIM specific** in their written comments following the stakeholder conference call for the Second Revised Straw Proposal, particularly if they have concerns or questions.

5. Stakeholder Engagement

5.1. Schedule

Stakeholder input is critical for developing market design policy. The schedule proposed below allows opportunity to for stakeholder involvement and feedback. Table 4 includes the proposed schedule for phase 1 of the Day-Ahead Market Enhancements stakeholder process.

Table 4: Schedule for Imbalance Conformance Enhancements Stakeholder Process

Item	Date
Post Second Revised Straw Proposal for DAME Fifteen-Minute Granularity	August 27, 2018
Stakeholder Conference Call	September 4, 2018
Stakeholder Comments Due	September 18, 2018
Post Draft Final Proposal	September 27, 2018
Stakeholder Conference Call	October 4, 2018
Stakeholder Comments Due	October 11, 2018
EIM Governing Body Meeting (hybrid non-EIM specific)	October 31, 2018
CAISO Board of Governors Meeting	November 14-15, 2018

The CAISO proposes to present its proposal to the EIM Governing Body and CAISO Board of Governors on October 31, 2018 and November 14, 2018 respectively. The CAISO is committed to providing ample opportunity for stakeholder input into its market design, policy development, and implementation activities. Stakeholders should submit written comments to InitiativeComments@caiso.com. Next Steps

5.2. Next Steps

The CAISO requests stakeholders to submit written comments on this Second Revised Straw Proposal by September 18, 2018.