

time energy imbalances in both the upward and downward direction. This increased net load uncertainty and variability requires large amounts of energy ramping capability, and real-time energy ramping needs may exceed that accounted for in hourly day-ahead market schedules. The CAISO currently accounts for net load uncertainty and real-time ramping needs in significant part through out-of-market actions. These actions primarily consist of manually increasing the load forecast used by the CAISO's day-ahead residual unit commitment process, which schedules additional capacity not cleared in the CAISO's day-ahead energy and ancillary services market.

The CAISO is exploring an additional day-ahead market reserve product, termed imbalance reserves, to address this challenge. Imbalance reserves would schedule and price both upward and downward energy ramping capability to ensure the real-time market can manage energy imbalances and energy ramping needs. The CAISO's day-ahead market would co-optimize imbalance reserves with energy and existing ancillary services. The CAISO is also exploring enhancing the day-ahead market's residual unit commitment process by adding the capability to procure downward capacity.

In addition to day-ahead market enhancements, the CAISO plans to refine its existing flexible ramping product that is part of its real-time market. This enhancement will schedule and price the flexible ramping product based on the location of the supply resource providing it. This will significantly improve the flexible ramping product's scheduling and pricing, better enable the real-time market to meet net load uncertainty and energy, and improve the real-time market's ability to reflect supply conditions in its prices.

In connection with this proceeding, the CAISO recommends the Commission allow the CAISO to pursue these market enhancements it is designing with its stakeholders to meet its specific market and operating conditions. The enhancements will (1) support real-time market efficiency; and (2) play an important role in extending the CAISO's day-ahead market to participants outside the CAISO balancing authority area. Other organized electricity markets may face different operating and market challenges. Alternative mechanisms, such as refinements to reserve products based on operating reserve demand curves, may be appropriate to meet their challenges, but those changes might not be the optimal means to address the CAISO's unique and specific needs.

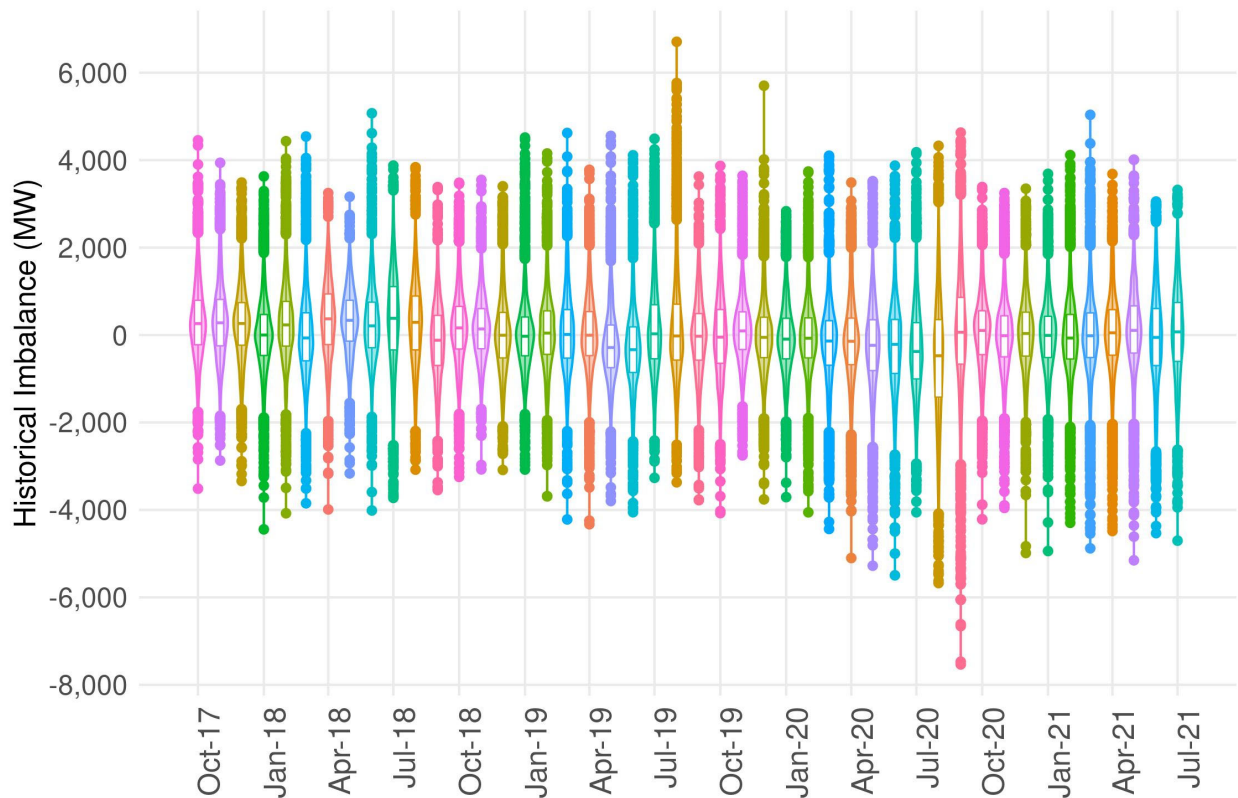
II. The CAISO has observed increasing differences between hourly day-ahead forecasts and real-time load

Energy imbalances occur for two reasons. First, there are time granularity differences between the CAISO's day-ahead market and the real-time market. The day-ahead market clears hourly schedules, whereas the real-time market clears 15-minute and 5-minute schedules. Even if hourly day-ahead schedules could exactly predict real-time net load, there would still be imbalances in the real-time market because actual real-time load is virtually never a fixed quantity over the hour. Ramping needs to meet the real-time market's final 5-minute dispatch may be much greater than ramping needs for hourly schedules optimized in the day-ahead market. Second, forecasting real-time net load in the day-ahead time frame is uncertain in any case. The actual real-time net load can be a lot higher or lower than the forecasted value. As described above, increased amounts of variable energy resources, behind-the-meter solar, and extreme

weather conditions have contributed to large differences between forecasts and actual load in recent years.

Changes between the day-ahead market and real-time market are inevitable, but large energy imbalances between day-ahead and real-time create the risk that the day-ahead market will not commit enough resources with sufficient supply capacity and with sufficient ramping capability to meet uncertainty that may realize in the real-time market. For example, if the load in real-time is significantly higher than forecast then this creates risk that there will be insufficient capacity available in real-time to make up the difference. Figure 1 shows the monthly trend of historical day-ahead imbalances. These imbalances can exceed 6000 MW, requiring large amounts of reserved capacity. These imbalances can also require that the resources providing this capacity provide large amounts of energy ramping capability because the net load imbalances may materialize quickly over short time intervals.

Figure 1 Monthly Trend of Historical Day-Ahead Imbalance²



III. Enhancements to the flexible ramping product are important to ensure it is deliverable and appropriately priced

The CAISO will file a tariff amendment in the first or early second quarter of 2022 to enhance the real-time market’s flexible ramping product. The CAISO plans to implement the enhancements this fall. The flexible ramping product is an important component of the real-time market to manage the supply fleet’s energy ramping

² See CAISO Day-Ahead Market Enhancements Analysis prepared by Guillermo Bautista Alderete, Ph.D and Kun Zhao, Ph.D. dated January 24, 2022: <http://www.caiso.com/InitiativeDocuments/Day-AheadMarketEnhancementsAnalysisReport-Jan24-2022.pdf>

capability and appropriately compensate resources for providing that capability. The real-time market schedules and financially settles resources for the flexible ramping product in both the upward and downward directions and co-optimizes it with energy and ancillary services, producing a marginal price for ramping capability. The flexible ramping product consists of two components:

- The first component addresses net load uncertainty that may materialize after the 15-minute market runs and reserves resource capacity with sufficient ramping capability to meet variations should they materialize. In doing this, it improves market efficiency by providing flexible resources compensation for their flexible capacity that provides ramping capability.
- The second flexible ramping product component compensates resources for being positioned by the real-time market's multi-interval optimization for ramping needs forecast in future market intervals. Real-time market energy prices alone do not compensate resources for this because the energy prices in the final binding market intervals do not reflect the multi-interval positioning of resources for forecast ramping needs in future intervals.

Under the CAISO's proposed enhancements, the CAISO will model and price the flexible ramping product at the individual resource level rather than at the balancing authority area level. Recent analysis by the CAISO showed that the real-time market procures a large proportion of flexible ramping product capacity behind constrained transmission, making energy from that capacity undeliverable if it is needed. It does this because resources behind constrained transmission tend to have lower energy locational marginal prices. Thus, they tend to have lower opportunity costs to provide flexible ramping product capacity instead of energy.

Modeling and pricing flexible ramping product locationally will help ensure it is deliverable, resulting in market prices that more accurately reflect the value of flexible capacity to the system. This effort will increase confidence in how the CAISO real-time market reflects the benefit of the diversity provided by multiple balancing authority areas

participating in the Energy Imbalance Market. This effort also will improve the real-time market's energy scarcity pricing by more appropriately reflecting the flexible ramping product's demand curve price that comes into play during tight supply conditions. The demand curve forgoes flexible ramping procurement to schedule energy as supply becomes scarce and energy prices rise. The demand curve price can be reflected in energy prices when this happens. At present, flexible ramping product prices are generally low because the CAISO does not model the flexible ramping product locationally and, consequently, the prices may not appropriately reflect tight supply in a transmission-constrained region.

Finally, the CAISO plans to improve the methodology for determining the quantity of flexible ramping product to procure by implementing a statistical regression methodology to determine the appropriate quantity. This will be an improvement over the current methodology that simply looks at past differences between the amount of ramping forecasted and the amount that actually materialized in a given hour of the day. The statistical regression methodology incorporates the current wind, solar, and load forecasts, which will make the procurement target for the flexible ramping product more accurate.

IV. The CAISO's day-ahead market enhancements will clear capacity to address net load uncertainty and real-time ramping needs

The CAISO's day-ahead market consists of an integrated forward market, which co-optimizes energy and ancillary services based on supply and demand bids, and a residual unit commitment process, which schedules supply to meet the CAISO's demand forecast. As part of an ongoing stakeholder process, the CAISO is exploring

two day ahead market enhancements: (1) adding an imbalance reserve product to the integrated forward market; and (2) enhancing the residual unit commitment process to also schedule downward capacity.³ Imbalance reserves will ensure the day-ahead market schedules sufficient real-time dispatch capability to meet net demand variation that materializes between the day-ahead and real-time markets. These reserves will also provide ramping capability to meet actual real-time energy ramping needs that can be much greater than day-ahead market hourly schedules reflect.

An imbalance reserve award will obligate a supplier to provide economic energy bids corresponding to the imbalance reserve capacity in the real-time market. Upward and downward imbalance reserves will be separate market products. Imbalance reserves awards will be capped at a resource's 15-minute ramping capability. Only resources that can be dispatched in the 15-minute market will be able to provide imbalance reserves. If not scheduled for energy, a resource with an imbalance reserve award will have to be able to start in fifteen minutes.

The market optimization will consider transmission constraints to ensure imbalance reserves are deliverable. Modeling these transmission constraints will consider the resultant energy flows if the imbalance reserves are deployed, helping to ensure energy from the imbalance reserves will be deliverable in real-time. Consequently, the imbalance reserves will have a locational marginal price that reflects each resource's locational value in providing reserves.

Finally, in addition to adding imbalance reserves to the integrated forward

³ More information about this stakeholder initiative is available on the following website: <https://stakeholdercenter.caiso.com/StakeholderInitiatives/Day-ahead-market-enhancements>.

market, the CAISO is seeking to enhance the residual unit commitment process to provide downward dispatch capability. The CAISO needs this ability if its net load forecast is less than the net load scheduled in the integrated forward market.

Downward dispatch capability in real-time has become increasingly important because of increased net load variability and uncertainty.

The CAISO's day-ahead market enhancements will secure needed capabilities more efficiently than existing processes. Today, the CAISO routinely uses out-of-market actions in the day-ahead timeframe to secure these capabilities. These actions predominantly consist of increasing the load forecasts used by the residual unit commitment process. The CAISO increases the load forecast used in the residual unit commitment process as a measure to commit additional supply that can help cover the uncertainty between day-ahead and real-time markets and ensure sufficient ramping in real-time.

In contrast to relying on the residual unit commitment process to secure capabilities needed in real-time, co-optimizing imbalance reserves in the integrated forward market will more efficiently reserve capacity than out-of-market actions. The market optimization will allocate resources' ramping capability between energy schedules and capacity reserved to address real-time imbalances. It will also more efficiently commit resources based on modeled needs. By allowing resources to bid their available capacity based on their costs of making the capacity available in real-

time, the market optimization can make a better assessment of which available capacity it should clear considering both economics and location.⁴

The CAISO never intended or designed the residual unit commitment process to provide ramping capability or additional capacity for net load uncertainty. It is designed to procure hourly supply to meet the difference between cleared energy scheduled in the integrated forward market and the CAISO's load forecast. Differences between cleared energy schedules and CAISO's load forecast are largely driven by differences in the day-ahead schedules of load and variable energy resources compared to their respective forecasts, and by the net position of convergence bidders.

Co-optimizing imbalance reserves in the integrated forward market will more efficiently reserve capacity than out-of-market actions. It will better allocate resources' ramping capability between energy schedules and capacity reserved to address real-time imbalances. The CAISO does not co-optimize capacity procured through the residual unit commitment process with energy schedules. In addition, because it does not model energy ramping needs, the residual unit commitment process may not necessarily commit additional resources that would provide additional ramping, or it may commit slow-ramping resources that may not meet real-time energy ramping needs.

⁴ The CAISO Market Surveillance Committee has argued that recovering costs through bi-lateral contract payments rather than through market prices creates some market inefficiencies. See Market Surveillance Committee. RUC Pricing Design: Cost Shifting and Market Efficiency Considerations. August 27, 2021. http://www.caiso.com/Documents/RUC Pricing Design Cost Shifting and Market Efficiency Presentation-Aug27_2021.pdf.

See *also* Market Surveillance Committee. Day-Ahead Market Enhancements Discussion (pages 3-8). July 30, 2020. http://www.caiso.com/Documents/Day-Ahead Market Enhancements Discussion Presentation-Jul30_2020.pdf.

Resources incur costs to be available in real-time such natural gas procurement and scheduling, costs associated with setting-up a hydro system, and costs associated with making demand response available. These costs also include transmission and opportunity costs for imports. An advantage of imbalance reserves is that resource bids for imbalance reserve represent these costs, allowing the market to reach an efficient solution by clearing reserves from the resources that have the lowest cost of providing them. This is more efficient than the CAISO's existing structure in which resource adequacy resources have to be available each day and the residual unit commitment process awards them schedules without regard to their real-time availability costs.

Market prices arising from imbalance reserves will also make transparent the value of flexible capacity and result in more efficient allocation of the costs of flexible resources that the CAISO needs to meet energy ramping needs. Finally, imbalance reserves will encourage more 15-minute import schedules rather than inflexible hourly block import schedules because imbalance reserve awards will compensate importers for hourly transmission costs they may be unable to recover if they are not dispatched for an entire hour.

V. The CAISO's planned day-ahead market enhancements are important components of the design of an Extended Day Ahead Market

The CAISO's day ahead market enhancements will be an important component of extending the day-ahead market to Energy Imbalance Market participants. The enhancements will allow the CAISO to optimize scheduling of reserve capacity across a larger footprint to meet net load uncertainty and real-time ramping needs, which will also

contribute to the reliability and dependability of energy transfers in an extended day-ahead market. They will optimize energy transfers among participating balancing authority areas by allowing the integrated forward market to consider needed imbalance reserves.

VI. The Commission should not direct a uniform market design to address operational flexibility needs

The CAISO recommends the Commission allow the CAISO to pursue the market enhancements that it is designing with its stakeholders to meet its specific operating conditions. A one-size fits all approach to address operational flexibility needs makes no sense given the different operational challenges facing each regional transmission operator (RTO) and independent system operator (ISO) and the existing differences in overall market design among the RTOs and ISOs. For example, the CAISO must ensure it has sufficient amounts of energy ramping capability in real-time, rather than an overall amount of capacity that other reserve products would procure. Day-ahead imbalance reserves and a real-time flexible ramping product specifically model this ramping capability need. Shortages of ramping capability may not represent an overall capacity shortfall and therefore may make it more appropriate to price this ramping capability during tight supply conditions differently than the operating reserve demand curves utilized by other RTOs/ISOs. The Commission should permit each RTO/ISO to explore market design enhancements to meet their specific operational flexibility needs through their individual stakeholder engagement processes.

VII. Conclusion

The CAISO is working with stakeholders to implement and design enhancements to its real-time flexible ramping product and the day-ahead market. These enhancements will assist the CAISO address net load uncertainty, support more reliable and efficient market outcomes, and provide a foundation for extending that day-ahead market to other entities in the Western Interconnection. The Commission should allow these market design efforts to proceed and not direct a one-size fits all approach to meet operational flexibility needs across RTO/ISO markets.

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Dated: February 4, 2022

CERTIFICATE OF SERVICE

I certify that I have served the foregoing document upon the parties listed on the official service list in the captioned proceedings, in accordance with the requirements of Rule 2010 of the Commission's Rules of Practice and Procedure (18 C.F.R. § 385.2010).

Dated at Folsom, California this 4th day of February, 2022.

/s/ Jacqueline Meredith

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