UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Modernizing Electricity Market Design	**)**	**Docket No. AD21-10**

REPORT OF THE CALIFORNIA INDEPENDENT SYSTEM OPERATOR CORPORATION

The California Independent System Operator Corporation (CAISO) responds to the Commission's April 21, 2022 directive to file a report regarding its energy and ancillary service markets in light of the changing resource mix and load profiles.[1] As explained in this report, the CAISO is experiencing increased variability and uncertainty between the day-ahead and real-time markets. The CAISO plans to deploy new products and measures to address this, and other, changing system conditions. This report aims to respond to the Commission's questions and describe some of the actions the CAISO is taking to enable the operation of a reliable, cost-effective, and environmentally sustainable power system.

BACKGROUND

The CAISO maintains reliability and provides open-access to the grid comprised of transmission systems covering approximately eighty percent of the state of California

[1] *See Modernizing Wholesale Electricity Market Design*, 179 FERC ¶ 61,029 (2022) (directing each regional transmission organization and independent system operator (RTO/ISO) to submit information to the Commission related to their wholesale markets) (hereinafter "Order Directing Reports"). In addition to the Commission's directive to produce a report on the workings of the CAISO's energy and ancillary service markets, Commissioner Christie requested responses to additional topics. *See* Order Directing Reports, 179 FERC ¶ 61,029 (Christie, Comm'r, concurring at PP 5-6).

and a small portion of Nevada. Since 2019, the CAISO has been providing reliability coordinator (RC) services for much of the Western United States. The CAISO also operates the Western Energy Imbalance Market (WEIM), which provides balancing authorities across the West with a sophisticated technology platform that enables the efficient sharing of resources in real-time while reducing emissions and helping provide the lowest cost power to customers. By 2023, the WEIM will serve approximately eighty percent of the Western Electricity Coordinating Council's (WECC) total load. Since its launch in 2014, the WEIM has provided over $2.4 billion in cumulative gross economic benefits with cumulative greenhouse gas emissions reductions from avoided renewable curtailment measuring 760,000 metric tons.[2]

Along with other states across the West and nation, California is transitioning to a cleaner electric grid to mitigate the impacts of climate change and meet the need for a reliable, cost-effective and environmentally sustainable bulk electric system. California is projecting the need for up to an additional 120 gigawatts (120,000 MW) of clean power over the next two decades to meet future demand and decarbonize the grid as required by California Senate Bill 100 (SB100). In doubling its resource mix to accommodate significant projected growth in the electrification of transportation, building, and other industries, and in offsetting the retirement of conventional fuel resources, California is orchestrating significant changes to its sources of supply and electricity demand. As the fifth largest economy in the world, the sheer size and scale of

[2] The WEIM uses the CAISO's technology platform to take all of the resources that bid in the real-time market and optimize those resources to find the most cost-effective set to meet demand. The larger the footprint, the greater the diversity of resources, which improves integration of resources across a geographically broad area. More information about the WEIM is available at the following website: https://www.westerneim.com/Pages/default.aspx

California's transition presents unique challenges and leadership opportunities. States throughout the West are exploring similar changes to their sources of supply and the manner in which they consume electricity. Ongoing collaboration and expansion of our partnerships in the West is the best path towards collective regional success while continuing to meet our responsibilities to California.

Over the past decade, the CAISO has integrated over 20,000 MW of renewable energy onto the grid and has the highest concentration of battery energy storage in the world. Previously, the CAISO performed detailed analysis to understand changing grid conditions. The resulting "duck curve" illustrated the then-emerging conditions and supported market rule changes and infrastructure additions that have helped support reliable operation of the CAISO system. The CAISO expects that in the future flexible resources will address system needs. These resources will include zero-carbon resources that can, among other things, react quickly, control demand, store energy for an extended duration, and start and stop multiple times per day.

REPORT ON PLANNED REFORMS TO ENERGY AND ANCILLARY SERVICE MARKETS

I. Current System Needs

Question 1: What system needs (type and magnitude) has the RTO/ISO experienced that are attributable to changes in the resource mix and customer load profiles? How do these system needs, including types and magnitudes of net load variability and uncertainty, vary over different time horizons in the energy and ancillary services markets? For example, does a particular need exist within a real-time market interval, within an operating day, between day-ahead and real-time markets, across multiple days, and between seasons? What specific resource capabilities could address these needs (*e.g.*, dispatchable generation)?

Answer:

California leads the nation in the transition to clean, environmentally sustainable electricity generation, and the CAISO is committed to supporting energy and environmental policies while maintaining reliability through a resilient power grid system. Five years ago, the CAISO released a Discussion Paper to address technical and policy issues involved in decarbonizing and decentralizing electric service and to commit the organization to working collaboratively with policymakers, agencies, partners, and stakeholders to develop a clear and broadly supported view of the clean energy future in California and across the region.[3] Since that time, the CAISO has worked with its stakeholders and partners to evaluate whether and how to develop a strategy for reducing reliance on fossil resources for power generation, re-orienting market policy to base system operations on non-fossil based resources, enabling flexible demand, and sharing resources across the West for the benefit of all states. The operating environment is undergoing a period of rapid and fundamental transformation driven by climate change and the far-reaching policies enacted to mitigate it. The CAISO is actively engaged in addressing the evolving resource mix, an evolving market, and a growing recognition that regional coordination is necessary to enhance efficiency and reliability.

Regarding changing system needs, the CAISO increasingly relies on the diversity of clean resources. In addition, weather patterns affected by climate change have created extreme conditions beyond those anticipated by current planning standards.

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[3] *See Electricity 2030 – Trends and Tasks for the Coming Year*, Prepared by the Board of Governors and Management of the California Independent System Operator Corporation, dated Oct. 2017, http://www.caiso.com/Documents/Electricity2030-TrendsandTasksfortheComingYears.pdf

Rapid transformation to a cleaner, yet more variable and energy limited resource fleet, and the migration of load to disaggregated and more diverse load serving entities, will require the CAISO to rely on a resource portfolio that differs from the past. To do so, the CAISO is evaluating the particular system needs expected to arise within a real-time market interval, within an operating day, between day-ahead and real-time markets, across multiple days, between seasons, and in response to extreme weather events both in its footprint and throughout the WEIM. The CAISO and its partners across the West need to ensure sufficient physical resources are in place to serve load reliably and satisfy reliability requirements in all hours of the year. The development of the Western Resource Adequacy Program and California's efforts to evolve its existing Resource Adequacy (RA) program are both positive steps in this space. Together with its partners, the CAISO is actively working to develop a multiple-year roadmap that relies on its markets to provide reliable system operations in light of the changing nature of resources and load patterns throughout the West.

With changes in the resource mix and load variability, the CAISO has undertaken substantial efforts to extend participation in the day-ahead market to the WEIM entities through its Extended Day-Ahead Market (EDAM) initiative.[4] The EDAM will build upon the proven ability of the WEIM to increase regional coordination, support states' policy goals, and meet demand cost-effectively by supporting the rapidly evolving western resource adequacy landscape. The EDAM will enable efficient and effective integration of renewable resources and will be an effective tool to address the significant

[4] *See, e.g.,* Revised Straw Proposal: Extended Day-Ahead Market, dated Aug. 16, 2022, http://www.caiso.com/InitiativeDocuments/RevisedStrawProposal-ExtendedDay-AheadMarket.pdf

operational challenges presented by a rapidly changing resource mix, emerging technologies, and the impacts of climate change.

New resources and technologies continue to emerge. The CAISO has numerous initiatives underway to determine how to enhance market products, modelling, and compensate necessary operational attributes from this new fleet of resources. Emerging software technologies allow the CAISO to upgrade its ability to detect and react to grid issues faster and with finer detail. Artificial intelligence and machine learning will play an increasingly important role as the energy industry continues its trend towards more complex and distributed systems.

The CAISO envisions a future where we can leverage even greater amounts of information to support complex modeling, forecasting, and simulations that can help us respond to uncertainty and variability and efficiently integrate new resources. For example, developing tools to increase coordination with distribution utility operators will improve communication and coordination between the transmission and distribution systems as the future reliable operation of the overall grid will depend on effective coordinated planning and seamless interaction between the CAISO and distribution system operators.[5] Improving coordination with distribution system operators will require the development of communication protocols, visibility tools, and commercial interfaces between the two systems to enable reliable operation of resources at the distribution level and efficient access to the CAISO's markets.

[5] The CAISO is participating in the California Public Utility Commission's (CPUC) proceeding to assess the tasks necessary to modernize the grid for a high-distributed energy resource future. *See* Order Instituting Rulemaking to Modernize the Electric Grid for a High Distributed Energy Resources Future, R.21-06-017 (June 24, 2021).

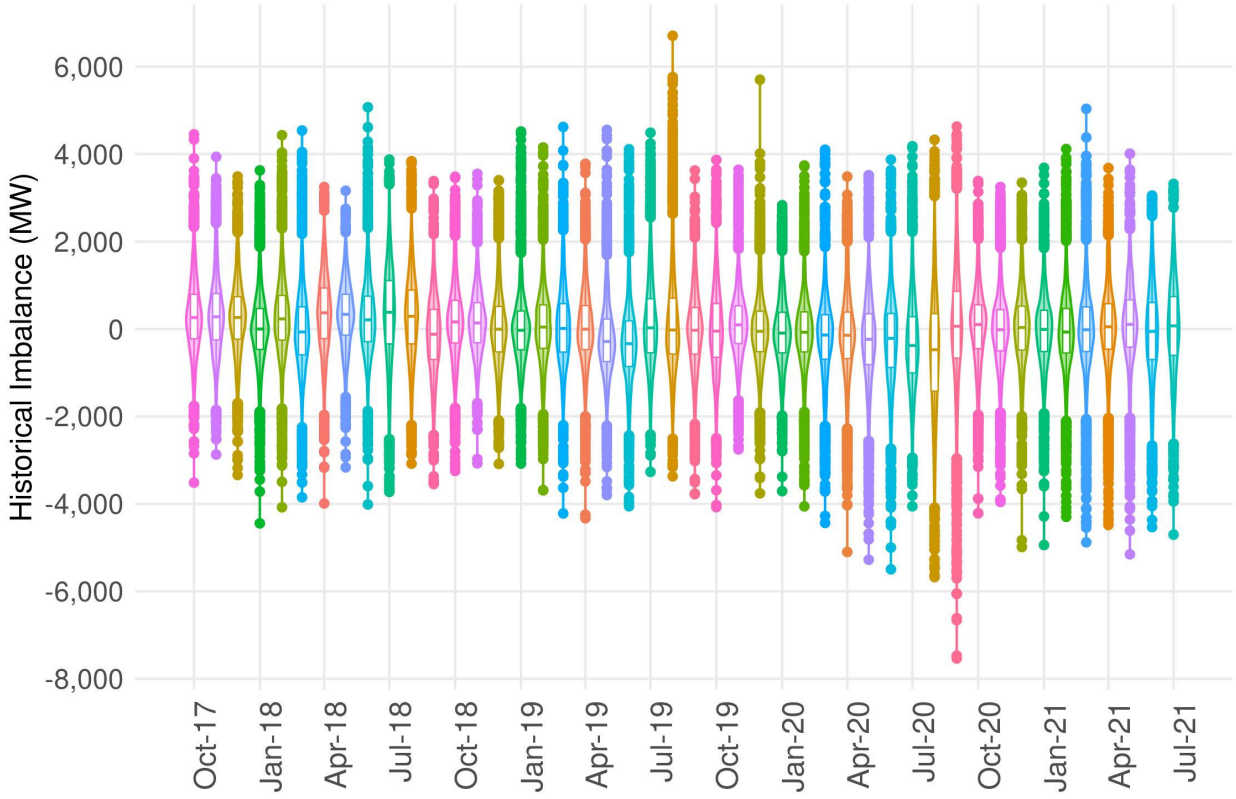
In recent years, the CAISO has observed increased net load uncertainty and variability between day-ahead and real-time, and it has recently begun work to identify ways to address this uncertainty. Without mitigation, this uncertainty and variability requires large amounts of energy ramping capability, and real-time energy ramping needs may exceed that accounted for in hourly day-ahead market schedules.

These 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 generates hourly schedules for resources, whereas the real-time market generates 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 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 timeframe is uncertain. The actual real-time net load can be significantly higher or lower than the forecasted value. Increased amounts of variable energy resources, behind-the-meter solar, extreme weather, and other variables 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 ramping capability to meet uncertainty that may realize in the real-time market. For example, if load in real-time is significantly higher than the day-ahead forecast there is a risk that there will be insufficient capacity available in real-time to

make up the difference. In addition, supply conditions can change because of weather, equipment failure, fuel supply disruption, and battery energy storage resources' state of charge.

Figure 1 shows the monthly trend of historical day-ahead imbalances between October 2017 and July 2021. These imbalances can exceed 6,000 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 Imbalance



The CAISO has published materials regarding imbalances and uncertainty between the day-ahead and real-time market.[6] In addition, the CAISO has provided this information in the context of other stakeholder initiatives, including its efforts to deploy flexible ramping enhancements.[7] The CAISO expects net load uncertainty and variability between day-ahead and real-time to continue to increase based on planned resource additions that have availability limitations and increasingly variable load patterns.

II. Expected Changing System Needs

Question 2: Referring to the system needs identified in answering question 1, how does the RTO/ISO expect those system needs to change over the next five years? Over the next 10 years? What does the RTO/ISO expect the magnitude of those system needs to be in five years? In 10 years?

Answer:

Through collaborative, innovative, and efficient market design and grid planning, the CAISO is playing a crucial role in helping California achieve its goal of a carbon-free power system by 2045. Successfully managing this unprecedented transition requires us to look very carefully at both the short and the long term — short-term because we must maintain reliability during the transition to a carbon-free grid, and long-term

[6] *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

[7] More information about the CAISO's flexible ramping product refinements is available on the CAISO's website: https://stakeholdercenter.caiso.com/StakeholderInitiatives/Flexible-ramping-product-refinements. This matter is pending in Commission Docket ER22-2661.

because we must make sound decisions now to help us reach that destination in the most reliable and cost-effective way.

Regarding the long-term, the CAISO published its first 20-Year Transmission Outlook in February 2022 that took an extended view on infrastructure needs and proposed baseline architecture.[8] The objective of the 20-Year Outlook is to provide a long-term conceptual plan of the transmission grid in twenty years that meets the resource and electric load needs and aligns with state agency input on integrated load forecasting and resource planning. With input from the CPUC and the California Energy Commission (CEC), the CAISO's 20-Year Outlook presents a comprehensive infrastructure plan for achieving the state's 2045 objectives when considering the state's SB100 "Starting Point" scenario for generation resource development as well as the state's high electrification load projection. The 20-Year Outlook provides a baseline to establish expectations for longer-term planning, recognizing that future resource planning and procurement decisions will likely differ from the assumptions used to establish this baseline.

Regarding the short term, our new 5-Year Strategic Plan focuses on what the organization must do over the next five years to strengthen reliability today while keeping California on the path to the clean, reliable grid of the future.[9] As the 5-Year Plan explains, the CAISO serves a diverse set of customers and stakeholders throughout California and the broader West. To meet the needs of this large, diverse

[8] More information about the CAISO's 20-Year Transmission Outlook is available on the CAISO's website: https://stakeholdercenter.caiso.com/RecurringStakeholderProcesses/20-Year-transmission-outlook.

[9] The CAISO's 5-Year Strategic Plan is posted on its website: http://www.caiso.com/Documents/2022-2026-Strategic-Plan.pdf

group most effectively, we intend to (a) continue to strengthen our engagement with stakeholders and build trust with many more interested parties and constituents to fulfill our mission, (b) provide highly accurate, easily accessible, clear information to ensure customer preparedness and deepen understanding about the reliability needs of the grid, (c) ensure rigorous information-driven decisions, and (d) maintain customer confidence through continued disciplined cost management and strategic investments.

Numerous variables will inform uncertainty and variability on the CAISO system over the short and long-term horizons. Among others, these variables include resource additions (both utility-scale and behind-the-meter) and the planned retirement of resources. Efforts to electrify heating and transportation and the growth of flexible demand resources will also inform these planning efforts. Finally, the potential to balance supply and load profiles across a wide area of balancing authorities in the Western Interconnection will contribute to any assessment of system needs.

The CAISO undertakes assessments of future system needs in coordination with its stakeholders, including state agencies and local regulatory authorities. In part, these efforts occur in connection with the CAISO's transmission planning process, as well as in the CEC's Integrated Energy Policy Report (IEPR) proceedings[10] and the CPUC's Integrated Resource Planning (IRP) proceedings.[11] In the current transmission planning process, the CAISO is undertaking various analyses over different time horizons to

[10] More information about the CEC's IEPR proceedings is available on the following website: https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report

[11] More information about the CPUC's Integrated Resource planning proceeding is available on the following website: https://www.cpuc.ca.gov/irp/

assess system needs between 2024 and 2032.[12] As part of these efforts, the CAISO will assess the impacts of high electrification scenarios, emission reduction targets, reduced reliance on Aliso Canyon natural gas storage facility, and the deliverability and corresponding transmission needs related to long-lead time resources, such as out-of-state wind and geothermal resources beyond the CAISO's balancing area authority.[13]

The CEC's IEPR proceedings address the development of numerous planning and modeling assumptions, including, among others, electricity demand forecasts. The CAISO participates in these proceedings to understand the state's policy development for meeting California's emission reduction objectives under SB100.[14] The CEC's demand forecast is an input assumption into the base case used in the CAISO's transmission planning process.

The CPUC's IRP proceedings serve to consider electric procurement policies and programs and establish procurement targets for CPUC-jurisdictional load serving entities. The CAISO participates in these proceedings to inform modeling efforts and the development of portfolios designed to meet California's needs. These resource portfolios also serve as an input into the CAISO's transmission planning process. In connection with the CPUC's proceedings, the CAISO has performed production cost

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[12] CAISO Final Study Plan for 2022-2023 Transmission Planning Process: http://www.caiso.com/InitiativeDocuments/FinalStudyPlan-2022-2023TransmissionPlanningProcess.pdf

[13] CAISO Presentation dated July 6, 2022: http://www.caiso.com/InitiativeDocuments/CAISOPresentation-2022-2023TransmissionPlanningProcess-Jul62022.pdf

[14] SB100 requires a zero-carbon resources supply 100 percent of electric retail sales to end-use customers by 2045. More information about California's implementation of Senate Bill 100 is available on the CEC's website: https://www.energy.ca.gov/sb100#:~:text=Senate%20Bill%20(SB)%20100%20established,end%2Duse%20customers%20by%202045.

modeling to help identify system needs. In 2020, the CAISO prepared and submitted modeling results of a resource portfolio selected by the CPUC into the CPUC IRP's proceeding.[15] In that proceeding, the CPUC ultimately adopted a decision directing procurement of at least 11,500 MW to meet mid-term reliability needs arising between 2023 and 2026, with the procurement consisting largely of renewable and storage resources. Since these procurement authorizations, the deployment of new capacity and the effective performance of existing resources has aided the CAISO in balancing supply and demand during extreme events. The addition of lithium-ion storage capacity has been an extremely positive development. As of October 1, 2022, the CAISO had approximately 4,300 MW of storage capacity available for dispatch.[16] We anticipate storage capacity will increase over the next several years, as the CPUC's plans contemplate the addition of approximately 10,000 MW of total storage capacity by 2024.

The CAISO continues to work with the CPUC and its jurisdictional load serving entities in the context of the IRP proceedings to assess how planned resource portfolios can meet system needs and identify any gaps or deficiencies those portfolios may not address.[17] These efforts will inform the magnitude of uncertainty and variability the CAISO expects on its system over the next five and ten years.

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[15] Comments of the CAISO dated October 23, 2020 in CPUC Rulemaking 20-05-003: http://docs.cpuc.ca.gov/SearchRes.aspx?DocFormat=ALL&DocID=349245428. The CAISO's reliability assessment of a CPUC-selected resource plan is attached to those comments: https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M349/K264/349264665.PDF

[16] *See* CAISO Key Statistics http://www.caiso.com/Documents/Key-Statistics-Sep-2022.pdf

[17] Recently the CAISO submitted comments in the CPUC's IRP proceeding recommending the CPUC create a list of planned resources assumed in any IRP resource authorization and track each resource's progress. Based on this list, the CAISO urged the CPUC to authorize additional procurement commensurate with the delayed resources' effective capacity. The CAISO also recommended that in response to any unexpected retirements, the CPUC should immediately authorize additional procurement commensurate with the retired or retiring resources' effective capacity.

Question 2.1: In answering, please provide a high-level overview of the methods used to develop the system needs forecast over the next five years and over the next 10 years. Please provide a high-level discussion of any industry trends that are particularly important to the RTO's/ISO's forecast, such as electric vehicle adoption, behind-the-meter distributed energy resource deployment, increased demand response participation and price-responsive load, growth in transmission infrastructure, and other trends. In evaluating the impact of such industry trends, how does input from efforts by states, local agencies, and utility programs inform that analysis?

Answer:

The CAISO's modeling work depends on a number of supply assumptions including new resource additions, resource characteristics, fuel costs, availability limits and import availability. This work also depends on important inputs regarding demand profiles and expected growth. As referenced in response to question 2, several industry trends will serve as inputs into the CAISO's modeling and inform what uncertainty or variability might develop on the system. The CAISO closely coordinates with the CEC, the CPUC, and its stakeholders and partners to develop the inputs for its modeling work.

The CAISO's October 23, 2020 reliability assessment submitted in the context of the CPUC's IRP proceeding reflects some these industry trends in connection with system needs to balance energy requirements across a typical summer day in 2026. The CAISO's assessment of the IRP portfolio scenario focused on assessing reliability needs arising from the CPUC's portfolio. Specifically, the CAISO conducted the assessment to understand if the IRP portfolio provides sufficient resources to replace the retiring Diablo Canyon Power Plant, and for 2030, to test if the portfolio can meet both a 0.1 day loss of load expectation (LOLE) and the CPUC's 38 MMT CO_2 emission target. The assessment also reflects the impacts of high concentration of solar and

storage in the studied resource portfolio and the benefits of diversifying the planned fleet.

The CAISO's assessment does not estimate what level of uncertainty and variability may exist between the day-ahead market results and real-time in the 2026 timeframe. Historically, the CAISO balancing authority area consisted of a predictable generation fleet and a predictable load, as was the case for most system operators in the West. System operators now manage a resource fleet and a load curve that introduces uncertainty and variability into the time span between the day-ahead and real-time market. Uncertainty and variability will increase as the resource fleet evolves to include more weather dependent resources such as wind and solar and increased deployment of battery energy storage. This will be exacerbated as demand becomes more difficult to forecast due to changes in electrification initiatives, behind-the-meter resource installations, and changing weather patterns. The CAISO discusses the market changes and developments underway to manage this growing uncertainty throughout this report.

Question 2.2: What time horizons, such as times of day (e.g., minutes, hours), days, or seasons, are expected to present the biggest challenges with respect to net load variability and uncertainty? Why?

Answer:

The CAISO anticipates that net load variability and uncertainty will present increasing challenges throughout the operating year and hours of the operating day. Net load variability and uncertainty can affect the system throughout the operating day, but it poses the most significant risks when the system ramps up and ramps down from peak load conditions. Changes between the day-ahead and real-time market are

inevitable, and the real-time market will continue to manage the imbalances that occur within the hour. Large imbalances attributable to the net load uncertainty between the day-ahead and real-time market and the large amount of variability in real-time, however, present challenging operating conditions.

Net load uncertainty and variability also present seasonal challenges during winter and spring conditions with reduced electric demand and changing weather patterns. In addition, annual maintenance of resources can present challenges if the supply fleet does not include surplus resources to meet increased energy needs that can occur during what used to be considered "shoulder months." As weather patterns change, so too will climate uncertainty and variability. For example, extreme heat events have typically occurred in August or September, and they created reliability impacts during peak and net peak demand hours. In recent years, the CAISO has also experienced extreme heat events in May, and other extreme weather conditions have emerged, including drought and wildfires that can affect system operations.

Question 3: What new system needs not already described, if any, does the RTO/ISO expect to emerge over the next five years? Over the next 10 years? What are the drivers of those new system needs? Are those new system needs quantifiable, and if so, please provide information on how you have quantified those needs.

Answer:

In addition to the system needs discussed above, the CAISO anticipates the trends discussed above will also inform net load variability and uncertainty across the Western Interconnection in the next five-to-ten years as utilities operating in these states face similar challenges arising from resource transition, electrification trends, and extreme weather. The importance of regional collaboration will necessarily increase to

meet system needs across a wide area and support reliable grid operations in the region. Other trends such as the development of long duration storage technologies will help address the reliability challenges that arise from increased net load variability and uncertainty, but increasing reliance on new technologies may unearth different challenges.

Apart from net load variability and uncertainty, the CAISO assesses additional systems needs through its transmission planning process, which considers the resource transition and capabilities of new resources interconnecting to the system. For example, the CAISO has assessed its needs for primary frequency response capability in connection with the transition to asynchronous resources.[18]

III. Reforms to RTO/ISO Markets and Operations to Manage Expected Changing System Needs

Question 4: Discussions at the technical conferences and in comments noted failures of E&AS market designs to incent resources to offer and perform in a manner that meets system needs that are present now or expected to emerge in the near-term. However, we note that much of the discussion indicated that system needs will continue to change significantly beyond the near-term, which could increase the adverse impacts of current flaws in E&AS market designs. Such increases in adverse impacts, such as insufficient operational flexibility in real-time, could threaten reliability and could also increase out-of-market actions and associated impairments to price formation.

Referring to the changing system needs discussed in questions 2 and 3, to what extent are current RTO/ISO E&AS market products and compensation schemes not designed to procure the resource capabilities needed to meet these expected changing system needs? To what extent are such prices and products unable to adequately compensate the resources possessing the capabilities necessary to meet these expected changing system needs? To what extent does the risk of disorderly retirements of resources with capabilities that are needed to address such needs (e.g., fast ramping dispatchable resources) increase if E&AS markets are not reformed? Why?

[18] *See* Section 6.3 CAISO 2021-2022 Transmission Plan at 346-353: http://www.caiso.com/Documents/ISOBoardApproved-2021-2022TransmissionPlan.pdf

Answer:

The CAISO's energy and ancillary service markets are technology neutral and designed to procure services made available by resources technically-capable of providing the service. In the day-ahead market, the CAISO optimizes energy and ancillary services awards and schedules based on 24 hours of the next operating day. The real-time market consists of the fifteen-minute market and 5-minute real-time dispatch. Enhancements to both the day-ahead and real-time market processes will help the CAISO procure resource capabilities to meet changing system needs.

As described in the response to question 1, increased net load uncertainty and variability require 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 arising out of the day-ahead market, in 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 that schedules additional capacity to meet the load forecast that did not clear in the CAISO's integrated forward market for energy and ancillary services. The CAISO has relied on out-of-market actions because there is no day-ahead market product to reserve and value resource energy ramping capability to respond to net load uncertainty. In addition, day-ahead market energy schedules are hourly and thus may not provide sufficient ramp capability to cover steep energy ramps that can occur between five-minute real-time market intervals (even if the day-ahead net load forecast is accurate). To address these issues the CAISO is developing a day-ahead market product, termed "imbalance reserves," to address these issues as part of

its day-ahead market enhancements initiative.[19] Developing a market product to address these system needs will reduce reliance on out-of-market actions.

The CAISO's real-time market includes a flexible ramping product to manage the supply fleet's energy ramping capability and compensate resources for providing that capability. Resources technically capable of providing these needed services can participate on a technology-neutral basis. 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. This issue does not exist in the day-ahead market because the day-ahead market optimizes all hours of the day simultaneously.

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 uncertainty should it materialize. This improves market efficiency by compensating flexible resources for their flexible capacity that provides ramping capability. The second component compensates resources when the real-time market positions them in the current interval to meet ramping needs in future market intervals as part of the CAISO's multi-interval optimization. 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 forecasted ramping needs in future intervals.

[19] More information about the CAISO's Day-Ahead Market Enhancements initiative is available on the following website: https://stakeholdercenter.caiso.com/StakeholderInitiatives/Day-ahead-market-enhancements

Recent analysis by the CAISO revealed that improvements to the flexible ramping product were needed to make it more effective in reserving unloaded ramping capability and providing meaningful price signals for that resource capacity. This analysis showed that the real-time market procures a large proportion of the flexible ramping product capacity behind constrained transmission, making energy from that capacity undeliverable. The optimization does this because resources behind constrained transmission tend to have lower energy locational marginal prices. Thus, the real-time market selects such resources because they often have lower opportunity costs to provide flexible ramping capacity instead of energy. However, because the transmission constraints emerge in real-time, the ramping capability is actually not available, artificially depressing flexible ramping product prices and their impact on energy prices. The CAISO recently filed tariff revisions to enhance its modeling of the flexible ramping product at the individual resource level rather than at the balancing authority area level.[20] The CAISO's proposed enhancements will help ensure resources selected to provide the flexible ramping product are deliverable, which in turn will produce market prices that more accurately reflect the value of flexible capacity to the system. 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 in energy prices that comes into play during tight supply conditions.[21]

[20] CAISO Tariff Amendment to Refine Flexible Ramping Product dated August 15, 2022 in Commission Docket ER22-2661. The CAISO provides more information about these refinements in response to question 6.1, *infra*.

[21] The demand curve forgoes flexible ramping procurement to schedule energy as supply becomes scarce and energy prices rise. Energy prices can reflect the flexible ramping product demand curve price when this happens.

The CAISO is also undertaking efforts to ensure the markets allow the storage fleet to provide all products for which they are technically-capable of delivering. Most of the currently-installed battery energy storage systems can discharge at maximum output levels for only four hours. Typically, optimal times to charge storage resources are in the middle of the day when solar is abundant (and the prices are lowest) with optimal discharge times during the evening peak (where prices are the highest). When the real-time market generates dispatch instructions in the middle of the day, it has no insight into and does not consider what system prices and conditions will materialize in the evening. The real-time market primarily makes dispatch decisions for storage resources based on bids and locational marginal prices that materialize in the market, while considering the operational characteristics of the resource. The CAISO is working with stakeholders to explore new approaches to modeling energy storage and associated assumptions and inputs.[22]

As technology continues to evolve and more storage capacity is added to the system, including both short and long-duration, the CAISO is working with stakeholders to ensure market rules and protocols are in place to effectively leverage the technical capabilities of the storage fleet. For example, at the end of last year, the CAISO implemented a default energy bid for storage resources to protect against the potential exercise of market power. Additionally, the CAISO continues to develop tools to allow hybrid resources to express their operating parameters to the CAISO, and the CAISO plans to have these available and reflected in the market by the end of 2022. The

[22] More information about the CAISO's Energy Storage Enhancements initiative is available on the following website: https://stakeholdercenter.caiso.com/StakeholderInitiatives/Energy-storage-enhancements

CAISO is currently developing policy to help manage storage resources and market participation features to help qualifying resources capture federal investment tax credits. The CAISO is also working on policy to develop a new market model for storage participation, which will better allow storage projects to express their costs.

In the overall context of price formation, the CAISO acknowledges the need to assess whether its market is creating accurate prices. The CAISO is exploring numerous questions on this matter. One is whether prices produced by the CAISO markets provide sufficient incentives by adequately accounting for scarcity conditions. Potential changes being evaluated range from changing the administrative prices the CAISO markets set when there is a supply shortfall to solving longer-term changes involving the interaction of ancillary services pricing with energy prices.

Another question is whether the CAISO markets should incorporate fast-start pricing. Some stakeholders, particularly those that import power into the CAISO system, maintain that energy locational marginal prices should incorporate commitment costs of fast-start resources. They argue that besides providing more accurate price formation to reflect all marginal costs, fast-start pricing is important to price imports appropriately. Currently fast-start resources receive only the energy price and do not receive separate make-whole payments for commitment costs. The CAISO has started an initiative to explore these market design questions, which are critical to assess how the CAISO's market products may need to change to meet system needs.[23]

[23] More information about the CAISO's Price Formation Enhancements initiative is available on the following website: https://stakeholdercenter.caiso.com/StakeholderInitiatives/Price-formation-enhancements

Regarding the risk of disorderly retirements, the CAISO's experience is that state energy policies and capacity procurement decisions to implement those policies drive resource retirements on its system more so than market prices for energy and ancillary services. However, accurately defining and pricing the capabilities the CAISO system needs through energy and ancillary serves markets remains a critical input to informing capacity retirement decisions.

Question 5: Much of the discussion at the technical conferences and in comments about planned reforms concerned near-term reforms that the RTO/ISO is currently developing with stakeholders or has recently implemented to manage system needs emerging in the near-term. However, much of the discussion signaled that system needs will continue to change significantly over time beyond the near-term. The following questions seek to understand how the RTO/ISOs are considering and working to identify and address longer-term future needs through E&AS market reforms.

Referring to the changing system needs discussed in questions 1, 2, and 3, what planned E&AS market reforms is the RTO/ISO contemplating or other stakeholder processes, if any, is the RTO/ISO conducting related to meeting those expected changing system needs? How will those specific reforms or stakeholder processes help the RTO/ISO meet those expected changing system needs?

Answer:

Each year, the CAISO publishes a market policy roadmap. The annual roadmap process is intended as a comprehensive planning process for enhancing our markets. The roadmap is developed through a stakeholder process to prioritize the policy initiatives the CAISO will undertake over the next three years. The CAISO published the Final Policy Initiatives Roadmap for 2022-2024 on March 10, 2022.[24] The primary drivers of the 2022 Roadmap include increased resource and load variability, increasing

[24] The roadmap is available on the following website: http://www.caiso.com/InitiativeDocuments/FinalPolicyInitiativesRoadmap2022-2024.pdf

volumes of battery energy storage resources, and economic and reliability benefits of greater integration of Western markets.[25] These drivers inform our efforts to enhance our energy and ancillary services markets, as well as extend the day-ahead market to WEIM entities across the Western Interconnection.

The CAISO will soon undertake discussions with stakeholders on updating its market policy roadmap.[26] This process, and the CAISO's strategic plan and regulatory requirements, will inform the enhancements the CAISO will explore to its energy and ancillary services markets over the next three years. As discussed above, we expect this work will include the following initiatives particularly relevant to the Commission's inquiry:

- **Day-Ahead Market Enhancements**: The CAISO and its stakeholders are exploring developing an additional day-ahead market reserve product, termed imbalance reserves. As described in response to question 6.1, *infra*, this will allow the CAISO to procure resource ramping capability optimized and priced in the day-ahead market rather than relying on out-of-market actions.

- **Extending the Day-Ahead Market:** The CAISO and its stakeholders are developing a proposal to extend the day-ahead market platform to WEIM entities. This effort will provide for more efficient unit commitment and dispatch across WEIM footprint the day ahead timeframe, thereby increasing economic outcomes for participants, supporting the integration of clean resources and enhancing reliability across a wide area. This will promote more efficient, reliable, and cost-effective operations across the West and enable entities to obtain the benefits of day-ahead market participation without requiring participation in a full-fledged regional transmission organization. .

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[25] A copy of the CAISO's briefing document on its market policy initiatives roadmap 2022 – 2024 presented to the CAISO Board of governors is available on the following website: http://www.caiso.com/Documents/Briefing-Annual-Roadmap-Three-Year-Plan-Joint-Presentation-Feb-9-2022.pdf

[26] More information about this process is available on the following website: https://stakeholdercenter.caiso.com/RecurringStakeholderProcesses/Annual-policy-initiatives-roadmap-process-2023

- **Energy Storage Enhancements:** The CAISO and its stakeholders are developing enhancements to how the CAISO optimizes, dispatches, and settles energy storage and similarly situated resources. We are exploring market reforms to help resources accurately represent their marginal costs in the day-ahead market; ensure energy storage resources' operating attributes are modeled more accurately in the day-ahead market; and modify exceptional dispatch tools so the CAISO has better visibility and control over these resources during challenging conditions.

- **Price Formation Enhancements:** The CAISO and its stakeholders are exploring various real-time market reforms to better align market prices with system needs. These enhancements include scarcity prices that are important to attract supply and incentivize availability and provide price signals to reduce demand. The CAISO and its stakeholders will also consider adopting fast-start pricing rules and interactions between the real-time market's multi-interval optimization and its dispatch of storage resources.

- **Resource Adequacy Reforms:** The CAISO will soon launch a stakeholder initiative to consider the reforms necessary to meet the needs of the transforming grid during all hours of the year, including the system's capacity, energy and flexibility needs.

The CAISO's current planning for market reforms does not extend to a five or ten-year horizon, but we expect the work underway to address the changing nature of the system and our current policy roadmap will serve as a foundation for future reforms. The draft 2023 policy initiative catalog provides a full description of the current, potential, planned, and ongoing policy initiatives to develop enhancements to the CAISO markets.[27] The CAISO updates the policy initiative catalog twice per year, with stakeholders submissions collected and considered for each catalogue update. As documented in the catalog, numerous initiatives are underway with our stakeholders and partners to address changing system needs and potential market reforms; each

[27] The draft 2023 catalog was published in August 2022 and can be accessed at the following link: http://www.caiso.com/InitiativeDocuments/Draft2023PolicyInitiativesCatalog.pdf

initiative includes consideration of how the particular reform will assist the CAISO in meeting the expected changing system needs.[28]

Question 6: Several commenters questioned the incentives created by current E&AS market designs and planned E&AS market reforms. Commenters raised many market design considerations as important for ensuring that E&AS markets incentivize resources to offer and perform in ways that support system needs. For example, some commenters argue that some E&AS market designs pay resources who make no contribution to satisfying system needs or encourage behavior that creates challenging conditions for operators. Commenters also discussed whether current compensation schemes for ancillary services products, such as using opportunity costs, will continue to be appropriate as the resource mix evolves over time. Over the next five years, and over the next 10 years, how well will existing RTO/ISO market designs together with planned reforms adequately incentivize resource behaviors that will enable the RTO/ISO to meet its changing system needs?

Answer:

The annual market policy roadmap considers how the CAISO's energy and ancillary services markets meet the needs of the CAISO system and WEIM participants. In the near term, as discussed above, the planned day-ahead market enhancements will create an imbalance reserve product that models and prices ramping capability in both the upward and downward directions. This will help address the intra-hour ramping needs that can arise between the day-ahead and real-time market. Enhancements to model storage resources more effectively and improvements in price formation will better integrate new technologies and incentivize resources to perform in a manner that enables the CAISO to meet its changing system needs.

The evolution of demand side resources, including electrification of buildings and transportation, will also impact the CAISO system over the next five to ten years and will inform the need for greater coordination at the transmission and distribution interface. The CAISO believes its current market design and planned reforms can effectively

[28] *See id.*at Sections 5 and 6.

integrate demand side resources into transmission system operations when it makes economic sense to do so. In addition, the CAISO will offer WEIM participants the opportunity to participate in the day-ahead market by using the CAISO's security constrained unit commitment and economic dispatch to balance supply and demand across a wide area.

Question 6.1: Discussions at the technical conferences and in comments emphasized the importance of having E&AS products match the time horizon and direction of system needs and uncertainties through shorter-term products (e.g., fast frequency response products and 10- or 15-minute ramp product), and longer-term products (e.g., multi-hour ramp products). However, commenters also noted that RTO/ISO system needs vary, and no "one-size-fits-all" E&AS reform currently exists to meet the unique needs of each RTO/ISO. We are requesting additional details on how the RTOs/ISOs plan to tailor their E&AS market reforms to their unique needs and why the reforms they are considering are appropriate to meet their expected system needs.

How will existing E&AS market designs together with planned E&AS market reforms create appropriate incentives for existing resources to respond to system needs on operational time horizons (e.g., instantaneously, within five minutes, within 10 or 15 minutes, within one to four hours, etc.), and in the appropriate direction (up versus down)?

Answer:

To accommodate future system needs, the CAISO will require a fleet of flexible resources that can quickly and flexibly respond to greater levels of supply and demand uncertainty. Energy market prices in the West are largely driven by net loads, meaning the total load less wind and solar production. As discussed in response to Question 4, the CAISO designed the flexible ramping product to provide the appropriate incentive for existing resources to respond to real-time system needs in the appropriate direction. The CAISO procures the flexible ramping product in the 15-minute and 5-minute markets. Over the course of the past year, the CAISO has completed a series of refinements to increase the product's effectiveness. These changes can be generally

classified as (1) procuring the flexible ramping product on a nodal basis, ensuring deliverability and 2) developing a new methodology to calculate uncertainty.

Under the CAISO's proposed refinements, the CAISO will model and price the flexible ramping product at the individual resource level rather than at the balancing authority area level. This modeling effort will recognize transmission constraints that currently may make flexible ramping capacity undeliverable and create inaccurate pricing. Modeling and pricing flexible ramping product at specific locations 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 WEIM and will improve the real-time market's energy scarcity pricing by more appropriately reflecting the flexible ramping product's demand curve price during tight supply conditions.

The CAISO also 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. Stakeholders have also recommended the CAISO explore a longer-term ramping product in the real-time market. Such a product could support optimizing the state of charge of energy storage over a longer time horizon than the current real-time

market multi-interval optimization and could also reduce the need for out of market load forecast adjustments to secure additional supply.

The CAISO's flexible ramping product initiative demonstrates how the CAISO's existing market designs, together with its planned market reforms, create appropriate incentives for resources to respond to system needs on operational time horizons and in appropriate directions. In addition, as part of the ongoing Day-Ahead Market Enhancements stakeholder process, the CAISO is exploring additional enhancements, including: (1) adding an imbalance reserve product to the integrated forward market and (2) enhancing the RUC process to schedule downward capacity. 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 and awards will be capped at a resource's 15-minute ramping capability. Only resources that can respond to dispatches in the 15-minute market will be able to provide imbalance reserves. 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.[29].

Question 6.2: Parties presented different views on whether the widespread use of opportunity cost-based ancillary service pricing will continue to sufficiently incent and compensate resources for meeting system needs as the resource mix and system needs evolve in the future. Given the critical role RTO/ISO resources play in meeting system needs, more information on how E&AS markets will provide adequate compensation for these costs is needed.

How will existing E&AS market designs together with planned E&AS market reforms create sufficient fixed cost recovery under existing pricing methods (i.e., opportunity costs, shortage pricing, etc.) for resources to make needed investments, remain in service, and continue to offer the capabilities necessary to meet changing system needs?

Answer:

Within the CAISO markets, scheduling coordinators for resources can submit energy and ancillary services bids to recover costs. The CAISO day-ahead market procures ancillary services and produces ancillary services schedules to meet the forecasted requirement. The CAISO real-time market does not re-optimize these schedules and it only procures incremental ancillary services quantities, if needed. Ancillary services awards reflect a resource's energy opportunity cost based on its energy bid and its ancillary service bid price. Ancillary service bid cost represents a resource's incremental cost to provide ancillary services in real-time, such as fuel availability and operating costs incremental to those accounted for in its energy bid. Thus, the resultant marginal ancillary services prices produced by the markets

29 *See also* Comments of the CAISO in AD21-10 dated February 4, 2022 at 7-11.

incorporate the opportunity costs and the ancillary service bid costs of the marginal resource.

Fixed cost recovery, which allows resources to make needed investments, remain in service, and continue to offer the capabilities necessary to meet changing system needs, is largely dependent on capacity prices. As California transitions to a resource adequacy fleet primarily composed of non-thermal units, the CAISO expects that many clean resources will continue to rely on capacity contracts payments through the resource adequacy programs administered by local regulatory authorities. The CAISO market clearing process will, however, establish prices based on economic bids for the various capabilities, including energy, ancillary services, and imbalance reserves. The revenue earned through these markets should continue to produce efficient market outcomes, which, in turn, should support and enhance confidence in the integrity of the CAISO's markets and platforms. In addition to market clearing prices, the CAISO uses various administrative prices to reflect tight supply and scarcity conditions that may contribute to fixed cost recovery.[30] Outside of the CAISO's energy and ancillary services market, participating resources can also recover fixed costs through resource adequacy contracts. Market revenues supplement capacity payments made under these resource adequacy programs administered by local regulatory authorities.

[30] *See, e.g.,* CAISO tariff section 27.4.3 that describes the use of penalty prices in the pricing run of the CAISO's optimization when the CAISO relaxes a transmission constraint or a power balance constraint to solve the market optimization. *See also, e.g.,* CAISO tariff section 11.21.3 - *Make Whole Payments for HASP Block Intertie Schedules*; and CAISO tariff section 34.10 - Dispatch of Energy from Ancillary Services.

Question 6.2.1: How will existing E&AS market designs together with planned E&AS market reforms create an efficient long-run price signal for investment in new resources with the capabilities necessary to meet changing system needs?

Answer:

Accurate market prices are essential to achieving reliable operations, an economically efficient energy dispatch, and open and non-discriminatory access to the transmission system. Accurate prices also provide signals to the investors funding current and future system resources. The CAISO's existing market designs, together with planned reforms, are rooted in the goal of establishing real-time pricing that corresponds closely to physical system conditions and appropriately reflects the scarcity of the product. Recent energy shortages and the associated prices in the real-time market have emphasized the need for the CAISO to review and enhance its scarcity pricing provisions.

Under the current market structure, the CAISO uses administrative values to set prices during scarcity conditions in the day-ahead and real-time markets. The CAISO currently implements energy price caps at either $1,000/MWh or $2,000/MWh, depending on whether the soft or hard offer cap binds. In the ancillary service markets, scarcity prices are administratively set as the scarcity reserve demand curve with additive penalty factors used to reflect the degree of shortage. Ancillary services scarcity prices, however, do not always occur in tight conditions. Recognizing that a failure to reflect scarcity pricing adequately in the energy and ancillary services markets could distort the long-run price signal for investment in new resources, the CAISO has started an initiative on price formation. In this process we intend to address any potential market inefficiencies that would otherwise distort the long-run price signal.

Question 6.3: Panelists agreed on the importance of establishing demand curves for ancillary service products carefully and rigorously but disagreed on the best approach, particularly with regard to using VOLL in such demand curves. While some panelists argued that VOLL should be the basis for all demand curves, others highlighted shortcomings of VOLL and suggested alternative approaches. Given the importance of defining demand curves for ancillary service products, further clarification of how such curves will be defined in future E&AS market reforms is needed.

Regarding E&AS products for which the RTO/ISO is contemplating reforms, to what extent will the reforms ensure that the E&AS products have well-defined demand curves that are rigorously designed to reflect system needs and transparently specify the quantity demanded by the market?

Answer:

The CAISO agrees that well-defined demand curves are essential to ensuring accurate market results. Further work is underway to explore how to enhance the demand curves used by the CAISO, and the CAISO expects such refinement to continue as the above-described net load variability is mitigated through the deployment of the near-term market products discussed *supra*. Specifically, the price formation enhancement initiative is underway, and such considerations are part and parcel of the initiative.

Question 6.4: Many commenters raised concerns regarding the risk that E&AS market reforms will pay the incorrect resources, for example, paying all resources instead of resources that actually contribute to resolving system needs. Given the importance of ensuring appropriate incentives and compensation to resources that contribute to satisfying system needs, further clarification of how future E&AS market reforms will ensure appropriate compensation (e.g., that only resources that help operators meet system needs are paid) is needed.

Regarding E&AS products for which the RTO/ISO is contemplating reforms, to what extent will the reforms ensure that the E&AS products direct compensation to resources that contribute to satisfying the particular system need(s) the product is designed to address and not to resources that do not make such contributions?

Answer:

The CAISO is designing its market enhancements so resources providing the necessary services receive appropriate compensation. As explained above, the CAISO created the flexible ramping product so resources delivering ramping capability receive compensation when the CAISO relies upon such resources to address the uncertainty caused by load and variable energy resources that materializes in the real-time market. Under the CAISO's proposed refinements, resources will receive compensation for their scheduled energy ramping and their reserved flexible ramping capability at the system's marginal cost for this ramping, as adjusted for deliverability.

The CAISO employed a nodal approach when developing the flexible ramping product which ensures direct compensation is provided to resources that contribute to satisfying the particular system need(s) the product is designed to address and not to resources that do not make such contributions. Future reforms such as the day-ahead market imbalance reserves will follow a similar approach.

Question 6.5: Discussions at the technical conferences and in comments raised the possibility that there is some discrimination in current E&AS markets and stressed that any future reforms should not introduce further discrimination. Given the importance of avoiding undue discrimination in E&AS markets reforms and the disagreement about the degree of undue discrimination in E&AS markets, further clarification on how RTOs/ISOs will avoid or eliminate undue discrimination in future E&AS market reforms is needed.

Regarding E&AS products for which the RTO/ISO is contemplating reforms, including reforms to resource eligibility rules, to what extent will the reforms ensure that the E&AS products permit all resources technically capable of providing a product or service to offer to do so?

Answer:

The CAISO considers reforms to its energy and ancillary service markets through a public stakeholder process. A principle is to design market rules to ensure all resources technically capable of providing a product or service may do so. The process of assessing market rules occurs through an "issue paper," a series of iterative straw proposals, stakeholder meetings, and working groups. Any person has an opportunity to engage and submit comments to the CAISO at different points throughout the stakeholder process, and CAISO welcomes such input. This process ensures all participants have a voice and can help shape final market policy outcomes, including ensuring that rules do not foreclose resources from providing services that they technically can provide.

The CAISO also agrees with the Commission that effort must be undertaken to follow through on commitments to prevent undue discrimination. The 5-Year Strategic Plan documents the CAISO's commitment to providing a transparent view of our decisions, actions, and activities to enable, support and contribute to a reliable, cost-effective and environmentally sustainable electric sector. Through collaboration with a broad spectrum of stakeholders, the CAISO aims to avoid and eliminate undue discrimination in future energy and ancillary service market reforms and instead further a process that identifies and implements mutually beneficial solutions. Using our considerable convening power and independence, we aim to work inclusively through difficult and complex issues and increase our responsiveness to stakeholders.

Question 7: Discussions at the technical conferences and in comments identified challenges to existing RTO/ISO operational practices and corresponding solutions, such as improvements in forecasts and tools to assist operators that RTOs/ISOs are developing or plan to develop. While discussions centered on changing operational practices such as these in the near-term, other discussions indicated that system needs and the associated operational challenges will continue to change significantly beyond the near-term. As such, more clarification about how RTOs/ISOs intend to improve operational practices beyond the near-term is needed.

Referring to the changing system needs discussed in questions 2 and 3, how does the RTO/ISO expect to alter its operational practices, if at all, in order to successfully manage changing system needs over the next five years and over the next 10 years?

Answer:

The CAISO is assessing how operational practices will need to change over the near-term, the next five years, the next 10 years, and the next 20 years. The electricity landscape in the West is a complex interaction of many systems and entities, and it is essential that we provide transparent, accessible information so the solutions we develop together through our collaborative stakeholder processes will be effective in ensuring reliable and efficient delivery of electricity throughout the West. Throughout this process, the CAISO is devoted to ensuring rigorous information-driven decision making.[31]

[31] Recently the CAISO introduced new data transparency measures. More information about these measures is available on the following website: http://www.caiso.com/Documents/Data-Transparency-Improvements-2022-Readiness-Note.pdf

See also , Energy Matter Blog by Keoni Almeida, CAISO Senior Manager, Stakeholder Affairs http://www.caiso.com/about/Pages/Blog/Posts/The-California-ISO-implements-suite-of-transparency-enhancements.aspx

Question 7.1: How does the RTO/ISO expect to meet challenges related to forecasting customer loads and variable energy resource outputs?

Answer:

There are significant challenges inherent in forecasting customer loads together with variable energy resource outputs, particularly as distributed-energy resource installations expand. The CAISO system and markets are evolving towards a non-deterministic environment. Numerous variables, including cloud cover, wind speed, and temperature, introduce uncertain components into multiple variables in the system including the load forecast, generation forecasts, and ancillary services requirements. The CAISO expects energy storage to be a foundational resource in future grid operations, but the rapid growth in storage technologies has revealed the need for new forecasting techniques to account for the role of such resources accurately, especially when co-located or combined with renewable resources such as wind and solar.

To meet these challenges, a multidisciplinary forecasting team is essential. The CAISO's current forecasting team includes statisticians, mathematicians, economists, data scientists, electrical engineers, and meteorologists, each of whom has a unique and specialized background. Over the near-term, the CAISO is engaged in working with its stakeholders, partners, and numerous institutions to determine how to refine its demand forecasting tools given the evolution towards a non-deterministic environment. In the prior years, demand forecasting's key variable was temperature. Demand forecasting has changed as customers have adopted behind-the-meter generation

technologies, such as rooftop solar and electric vehicles.[32] Improvements in the collection and automation of data regarding behind-the-meter resources and obtaining further visibility on the characteristics of these resources (*e.g.,* generating rooftop solar and charging behavior of electric vehicle fleets), together with enhanced weather and climate tools, will be key to maintaining confidence in demand forecasts that will undoubtedly increase in complexity.

The CAISO will engage in several strategies to address forecasting needs. These will include efforts to understand and document climate-related needs and develop a climate data repository to assist with guidance in planning and real time operations. We will also work to enhance real time data availability as it relates to assisting in improving solar forecasting. With the growing solar fleet, having more real time data to tune weather models and then solar MW forecasts will be critical. Additionally, greater data visibility for non-market participating DERs will be essential to utilizing and developing the demand forecasting tools. We will also explore enhancements to incorporate use of probabilistic net load forecasts into operations to improve renewable forecasts in the hour ahead timeframe to help with real-time optimization. Implementing real-time "telemetry" of renewable resource potential, like the CAISO's high sustainable limit, will improve renewable forecasting when dispatch or operating instructions curtail resources' output. Finally, incorporating extreme heat impacts and smoke impacts into forecasting variable supply and demand will assist with managing the system during extreme heat events.

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[32] *See* Presentation by Amber Motley, CAISO Sr. Manager, Short Term Forecasting, to NARUC/NASEO/NASUCA dated June 22, 2021: https://pubs.naruc.org/pub/0F3542E0-1866-DAAC-99FB-3E8AB1C5EF36

Question 7.2: What model improvements, new operational tools, refinements to existing operational practices, or market software enhancements, if any, does the RTO/ISO expect to develop and/or deploy?

Answer:

The CAISO is exploring model improvements, operational tools, refinements to existing practices, and market software enhancements that support our planned market design enhancements and efforts to extend the day-ahead market to WEIM participants. The CAISO is also engaged in understanding and documenting climate-related needs and developing a climate-related data repository to assist in planning and operations. Gaining access to real-time data for resources across the system, including behind-the-meter resources, will improve forecasting and allow the operators to plan, prepare for, and respond to the system's rapidly-changing needs. As climate-related data is integrated with the real-time operational data, the CAISO anticipates new forecasting tools will be developed to supplement the tools used today.

Deploying effective operational tools to monitor and assess how different technologies perform on the CAISO system is a high priority. The CAISO will need to forecast resource availability and capability accurately and then measure resources' performance. Any unavailability or performance that deviates from the forecast adds to the uncertainty and variability inherently on the system and can create significant impact BA functions such as managing area control error. The CAISO has been in a reactionary position in the wake of significant growth in inverter-based resources. We must anticipate the next chapter of this resource transition and implement measures proactively. Large-scale deployment of energy storage resources and the retirement of conventional resources will require us to evolve tools that can predict future behavior

and help us meet our responsibilities to complete operational planning assessments and post-contingency analyses. This will require innovation in terms of validating models, control room visibility, and automation.

Question 8: Some discussions in the comments and technical conferences noted that while many RTOs/ISOs are creating new E&AS products to incentivize flexibility, existing E&AS market designs might be incentivizing inflexibility. Some discussions specifically referred to uplift payment policies and operational parameters such as economic minimums as creating incentives for inflexibility. Given the importance of E&AS markets incentivizing resource capabilities and performance that help to meet system needs, more information about how future reforms will address possible incentives for inflexibility is needed.

Beyond the reforms discussed in answering questions 4-7, what other reforms to current RTO/ISO E&AS market rules may be required in the future given the RTO's/ISO's expected changing system needs and shortcomings of current E&AS market designs? Why? For example, are changes to resource eligibility rules for ancillary services or uplift policies expected to be necessary?

Answer:

The CAISO will continue to assess the need for additional reforms to its energy and ancillary services markets as system needs continue to evolve. This effort occurs in the context of the CAISO's annual roadmap process, discussed above, which captures the policy initiatives the CAISO will undertake in the following year. Developing the annual roadmap includes updating the CAISO's policy initiatives catalog, which is a comprehensive directory of current, planned and potential policy initiatives that require a stakeholder process. The CAISO accepts submissions into this process year-round.[33]

[33] More information about the CAISO's current annual roadmap process, including a submission form, is available at the following website: https://stakeholdercenter.caiso.com/RecurringStakeholderProcesses/Annual-policy-initiatives-roadmap-process-2023

IV. Other Potential Reforms

Question 9: Despite the focus of the E&AS technical conferences on E&AS markets, several panelists and commenters expressed support for the continued use and importance of capacity markets and potentially new resource adequacy constructs to satisfy future system needs. Given the focus of the record thus far on potential E&AS market reforms to satisfy operational flexibility needs and other system needs, the Commission would like to give RTOs/ISOs and other commenters the opportunity to comment on other possible reforms beyond E&AS market reforms that should be considered to meet changing system needs.

For RTOs/ISOs that administer a capacity market, what capacity market reforms, if any, is the RTO/ISO considering to meet expected system needs in the future? For RTOs/ISOs that do not administer a capacity market but rely on a different resource adequacy construct, what reforms, if any, is the RTO/ISO considering to that construct to meet changing system needs?

Answer:

In California, resource adequacy responsibilities are distributed between state agencies such as the CPUC, other local regulatory authorities, and the CAISO. In addition to our core responsibilities around transmission planning, the CAISO has several important tariff responsibilities regarding the evaluation of resource adequacy showings, establishing baselines for demand response resource performance, and setting local, system, and flexible resource adequacy requirements. Clarifying our analytical approach and regulatory strategy on each of these elements, aligning them as much as possible with state policies, and engaging effectively in other state processes that impact overall reliability in California will be a central focus of the CAISO over the next few years.

The CAISO has started this effort and is working with stakeholders and local regulatory authorities to explore potential reforms to California's RA program. At present, the CPUC is hosting a series of workshops to explore how to develop details of a 24-hour "slice of day" RA framework that accounts for energy needs of the RA month

plus a planning reserve margin rather than solely planning for annual peak load capacity needs.[34] In light of the changing resource mix (in particular the sharp increase in battery storage production), the CAISO supports the CPUC developing RA reforms to address these issues.

The CAISO believes resource adequacy reforms must meet the following objectives:

- Ensure resource adequacy resources can meet a planning reserve margin based on a well-vetted reliability-based assessment (*e.g.*, a fleet that can meet a 0.1 loss of load expectation). This includes meeting reliability needs across critical operational periods, under multiple day high-load conditions, and other climate change-driven risks/events.

- Ensure load serving entities show and offer to the CAISO sufficient resources with the right capabilities under a 24x7 must-offer obligation.

- Secure sufficient flexibility to adapt to the rapidly evolving demand and resource mix.

- Count resource adequacy capacity in a manner that accurately reflects a resources availability and contribution to reliability, including consideration of outage rates, use limitations, and availability limitations.

- Secure sufficient capability to meet both energy and capacity needs, including resources to meet storage charging demand.

- Ensure load serving entities contract for sufficient capacity and capability to meet resource adequacy requirements without unnecessary reliance on CAISO backstop procurement.

- Coordinate and integrate with CAISO's resource adequacy construct, recognizing and respecting that the CAISO must administer efficient, implementable, and operable resource adequacy programs for all local regulatory authorities within the CAISO balancing area.

- Ensure buyers and sellers can efficiently and economically contract for resource adequacy supply with commercially viable options to ensure rational compliance with the planning targets.

[34] *See generally,* CPUC Rulemaking 21-10-002

- Consider important linkages and dependencies of efficiently and effectively operating a resource adequacy program within a greater regional Western resource adequacy framework.

The CAISO recognizes that modifications to CAISO resource adequacy rules are needed, and we have committed to coordinate with the CPUC and CEC to harmonize programs to the extent possible to ensure California has both a reliable and efficient resource adequacy program. While working to achieve a reliable and efficient resource adequacy design, we will seek modifications that appropriately balance effectiveness, simplicity, and flexibility.

Given both the supply insufficiencies experienced in the past couple years and the changing resource mix, it is critical that we engage in consistent and realistic foundational modeling and develop a planning reserve margin that provides the CAISO with sufficient energy to run the grid reliably both in the near term and longer term.

As the CAISO works with state agencies and local regulatory authorities to further diversify our resource mix, the CAISO recognizes it must also ensure the necessary transmission infrastructure exists to efficiently deliver power reliably and cost-effectively. As such, the CAISO will seek to strengthen resource adequacy through its long-term transmission planning and effective regional coordination.

Question 9.1: What new capacity accreditation methods, if any, is the RTO/ISO considering for its resource adequacy processes? How will such new capacity accreditation methods help the RTO/ISO satisfy expected changing system needs?

Answer:

Working with local regulatory authorities such as the CPUC, the CAISO is assessing enhancements to capacity counting methodologies given the evolving needs of the grid. Capacity counting and accreditation can be accomplished through different

techniques, all of which have advantages and disadvantages, including assessing resources based on their effective load carrying capability, employing exceedance-based resource counting methods, or applying an unforced capacity methodology to accredit resource adequacy capacity based on a resources' contribution to reliability needs. Recently, the CPUC issued a decision adopting regional effective load carrying capability values for wind resources and changing the demand response qualifying capacity methodology for the 2023 and 2024 RA years.[35] Additional rule changes will likely follow any revisions to RA requirements under consideration by the CPUC.

Question 9.2: What new products that value flexible attributes, if any, should be introduced in resource adequacy constructs, including capacity markets? Would such a change support adequate price signals for the investment and/or retention of resources with the capabilities needed to address emerging needs?

Answer:

In addition to the matters discussed above, the CAISO's tariff includes separate flexible resource adequacy requirements.[36] The CAISO establishes these requirements through an annual study to determine the flexible capacity need of the CAISO Balancing Authority Area for each month of the next calendar year. This study estimates the maximum three-hour ramp during each calendar month and flexible resource adequacy capacity must have the capability to ramp up and sustain output for a three-hour period.

[35] CPUC Decision 22-08-039, *Decision Addressing Regional Wind Effective Load Carrying Capability Values and Demand Response Qualifying Capacity Methodology*, issued August 29, 2022: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M496/K666/496666765.PDF

[36] CAISO tariff section 40.10: http://www.caiso.com/Documents/Section40-ResourceAdequacyDemonstration-for-SchedulingCoordinatorsintheCaliforniaISOBalancingAuthorityArea-Jun1-2022.pdf

The CAISO allocates the flexible capacity need among local regulatory authorities who then direct procurement by their load-serving entities to ensure sufficient flexible resource adequacy. The CPUC's latest report on bilateral prices for flexible resource adequacy capacity indicate the 2020 weighted average price for flexible capacity is $4.65/kW-month compared to $4.81/kW-month for non-flexible system capacity.[37] This price comparison suggests there is no premium placed on flexible capacity, given the current product definitions. In light of the work underway to develop day-ahead imbalance resource products in both the up and down direction, the CAISO plans to consider how to evolve flexible resource adequacy requirements in a subsequent stakeholder intuitive involving enactments to resource adequacy rules.

Question 10:

While this proceeding focused on RTO/ISO markets, several panelists and commenters noted challenges to meeting RTO/ISO system needs that arise from sources beyond the RTO/ISO markets themselves. Panelists and commenters noted potential reforms necessary to address challenges related to coordination between adjacent balancing authorities, coordination between transmission and distribution operations, and inflexibility in the fuel supply of certain resources. Given the lack of record thus far on these challenges and potential reforms, more information is needed to ensure RTOs/ISOs can continue to meet system needs as they evolve in the future and identify and address any obstacles to that objective.

What reforms beyond those to the RTO's/ISO's tariff(s) does the RTO/ISO believe might be needed to address expected changing system needs?

Answer:

Beyond RTO/ISO tariff rules to address greater coordination in resource commitment and dispatch to support transmission operations, significant opportunities

[37] CPUC 2020 RA Report dated April 2022 at 30: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/resource-adequacy-homepage/2020_ra_report-revised.pdf

exist to coordinate resource adequacy programs and resource planning decisions across the western region. Coordinating resource adequacy programs could provide a wider area view of resource sufficiency in the year-ahead, season-ahead, and month-ahead timeframes. The importance of this effort will increase as greater volumes of availability limited resources interconnect to the electric system and the volume of imports on which balancing authority areas have traditionally relied tightens.

The CAISO's experience has shown that with a changing resource mix and the impacts of climate change and extreme weather, we cannot assume historic patterns of resource and load diversity will continue. States and balancing authorities will need to refresh this assumption and assess how best to coordinate within a new paradigm. Leveraging a diverse resource mix across the Western Interconnection also offers opportunities for states to achieve clean energy goals more economically. If states more effectively coordinated resource procurement decisions, the region could integrate greater volumes of renewable resources at lower cost. This coordination could also provide opportunities for sharing of transmission infrastructure costs that benefit utilities and their customers throughout the region.

Question 10.1: What reforms to reliability requirements, such as reforms to NERC standards, might be necessary?

Answer:

It is crucial to ensure resources can operate or "ride through" transient grid events. In addition, NERC and the industry must ensure generator interconnection models are sufficiently robust and accurate. This will require coordination among developers, Planning Authorities, NERC and Regional Entities. The Commission can

support these efforts by fostering industry dialog regarding the development and validation of non-proprietary models and, where appropriate, enhancing reliability standards and compliance, monitoring, and enforcement programs. In addition, the Commission and NERC should consider facilitating additional discussions regarding the need to revisit control performance standards that apply to balancing authority functions.

Question 10.2: What reforms to policies for coordinating operations with adjacent balancing authority areas in both RTO/ISO and non-RTO/ISO regions might be necessary?

Answer:

Coordination across seams remains critical to support economic dispatch, enhance reliability, and minimize the impact of extreme weather events across the West. Increased transparency between balancing areas to provide insight into resources' availability, assumptions on imports/exports (and sources of the energy), and operational redispatch options will help balancing authorities better coordinate and prepare for these extreme weather events. In addition to bilateral coordination, the CAISO and neighboring balancing authorities have reduced seams issues through fostering participation in the WEIM. The CAISO is now working with stakeholders to explore whether it can leverage this platform to better address extreme weather events and extend a day-ahead market platform to WEIM entities. These efforts may lead to additional redispatch opportunities across RTO/ISO and non-RTO/ISO seams.

In the Western Interconnection, the majority of forward procurement occurs through integrated resource planning processes. The CAISO believes increased

coordination across the western region by utilities and state authorities in their resource procurement decisions will enhance each balancing authority area's ability to integrate a diverse set of technologies and a resource mix that leverages geographic diversity. In the context of energy and ancillary services products, centralized procurement and dispatch of these products will advance efficient integration of larger numbers of inverter-based resources in a more reliable manner and with more economic unit commitment. Accordingly, the Commission should support innovative approaches to wide area coordination of electric system operations.

Question 10.3: What actions should the Commission consider taking to encourage coordination between the electricity transmission and distribution system operators in order to address challenges arising from limited visibility into distribution-connected resources?

Answer:

Distributed energy resources provide a valuable contribution to reliability and resilience. The CAISO has developed and will continue to refine pathways for wholesale market participation by distributed energy resources and incorporates forecasted development of distributed energy resources into its transmission planning process by relying on electric demand forecast prepared by the CEC.

In addition to participating in wholesale supply markets, distributed energy resources will include new sources of flexible demand, including electric vehicle charging and smart buildings. We anticipate that these resources can provide value to the electric system by helping shift and shape the load curve to relieve stress on the electricity grid. The Commission should continue to facilitate industry dialog regarding the coordination between the transmission and distribution interface. This effort includes identifying practices and technologies to integrate distribution–connected

resources into organized electricity markets, when it makes sense to do so, as well as information sharing practices and tools between distribution system operators and transmission operators to enhance load forecasting for planning and operational purposes.

Question 10.4: What reforms to other services within the Commission's jurisdiction, such as natural gas transportation services, should the Commission consider in order to improve operational flexibility in the fuel supply?

Answer:

Regarding natural gas transportation services, the Commission should consider whether to encourage hourly nominations on gas transmission lines, especially on lines that have operating constraints. In addition, the CAISO supports efforts to enhance weatherization at wellheads and ensure reliable and back-up power exists at natural gas compression stations and at wellhead injection locations. The Commission could also could explore steps to support flowing hydrogen across pipelines as well as providing additional support for paralleling lines, thereby enhancing resilience and increasing line packing flexibility.

Question 11.
While the questions in this order have asked about a five-year and 10-year time horizon, what activities, if any, is the RTO/ISO undertaking to consider changing system needs that could materialize beyond the 10-year time horizon?

Answer:

Earlier this year, the CAISO published its 20-Year Transmission Outlook. The objective of the 20-Year Transmission Outlook is to provide a long-term conceptual plan of the transmission grid in 20 years, meeting the resource and electric load needs in alignment with state agency input on integrated load forecasting and resource planning.

The CAISO performed this assessment in collaboration with the CEC and the CPUC with the goal of exploring the longer-term grid requirements and options for meeting California's greenhouse gas reduction and renewable energy objectives reliably and cost-effectively. The assessment also seeks to inform resource planning processes conducted by the CPUC and CEC and to provide a longer-term context and framing of pertinent issues in the CAISO's ongoing annual 10-Year Transmission Plan. Among other findings, the CAISO's 20-Year Outlook provides a high-level summary of the transmission development required for upgrades to the existing CAISO footprint to accommodate offshore wind integration and out-of-state wind integration.[38]

Question 12:

If RTO/ISO market design changes beyond the RTO/ISO's planned E&AS market reforms discussed in answering questions 4-7 are necessary to manage expected changes in system needs, how can the Commission best assist RTOs/ISOs and their stakeholders in reforming their markets in the future?

Answer:

The Commission can best assist RTOs/ISO by allowing those processes to occur and, where applicable, help to identify a common issue or issues emerging in one market that may also emerge in other markets. The evolution of organized electricity markets as we decarbonize the electricity system is inevitable. This work will require significant interaction between the Commission and state regulators. Providing analytical support based on operational data, encouraging wide area balancing, and identifying new paradigms to support the integration of non-emitting resources and

[38] A copy of the CAISO's 2022 20-Year Outlook is available on the CAISO website: http://www.caiso.com/InitiativeDocuments/20-YearTransmissionOutlook-May2022.pdf

storage technologies into RTO/ISO operations are important steps the Commission can take to assist RTOs/ISOs.

The Commission should allow the CAISO and other RTOs/ISOs to pursue the market enhancements they are designing with stakeholders to meet their specific operating conditions. A single approach to address operational flexibility needs makes no sense given the different operational challenges facing each RTO/ISO and the existing differences in overall market designs. For example, a pressing need for the CAISO market is to secure sufficient amounts of energy ramping capability in real-time, rather than an overall amount of capacity that other reserve products would procure. The CAISO's proposed 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 be more appropriate to price this ramping capability during tight supply conditions differently than the operating reserve demand curves utilized by other RTOs/ISOs.

V. Additional Questions

The CAISO offers short answers to the following questions identified by Commissioner Christie in his separate statement.

Question: Are the RTO/ISO markets compensating dispatchable resources appropriately in all markets? Are pricing policies causing premature retirements of dispatchable resources that may threaten reliability (as the MISO Midwest results may indicate)?

Answer:

The CAISO's current multi-interval optimization with the planned enhancements to its flexible ramping product and day-ahead market imbalance reserves seek to

compensate dispatchable resources for their ramping capability. The CAISO believes these planned enhancements will also reduce out of market actions taken to ensure there is sufficient supply to balance demand, thereby creating more accurate pricing to meet net load uncertainty and variability. The CAISO does not believe pricing policies in its markets are causing early or disorderly retirements of resources. If these retirements occur, it is more likely the result of capacity procurement policies and decisions and other state energy and environmental policies.

Question: Are intermittent and hybrid resources compensated appropriately to ensure reliability?

Answer:

Yes, the CAISO compensates these resources similar to other resources. They are settled using locational marginal prices that value their contribution to congestion management and ability to serve expected energy and reserve requirements on the CAISO's system. The CAISO's work to model the state of charge of battery energy storage more effectively will also allow the CAISO to enhance its modeling of hybrid resources to help ensure reliable operations and appropriate compensation.

Question: Is it appropriate to continue to use LMP in energy and capacity markets? Does the continued use of LMP threaten reliability as the generation mix changes? Does the use of LMP ensure that consumers get the benefit of low clearing prices? Is there a better pricing model than LMP in RTO/ISO markets to achieve reliability and fairness to consumers?

Answer:

The CAISO uses locational marginal pricing to manage congestion on its transmission system and across the WEIM footprint. This mechanism allows the

CAISO to clear economic bids and self-schedules through its security constrained unit commitment and security constrained economic dispatch. The CAISO believes it is appropriate to continue using locational marginal pricing in its energy markets because it provides a signal about where congestion on the system might require infrastructure additions. Locational marginal pricing also provides economic signals to offer supply or reduce consumption during periods of scarcity and to curtail supply or increase consumption (*e.g.,* charge battery energy storage systems or electric vehicles) during periods of over-supply. The CAISO appreciates there may be other pricing mechanisms to manage congestion, compensate resources, and incentivize behavior. If the Commission wishes to explore alternative pricing mechanisms to locational marginal pricing in ISO and RTO regions, the CAISO recommends it convene a technical workshop to frame any problem statement and identify potential alternatives for industry wide discussion.

Question: Are capacity markets appropriate to use for resource adequacy? If not, is there a better alternative to capacity markets? Should capacity markets be purely residual or mandatory?

Answer:

Given the significant differences between each region and the principle that there can be more than one just and reasonable approach to capacity procurement, the Commission has rightly determined there is no one-size-fits-all construct to ensure resource adequacy.[39] Centralized capacity markets are one construct to facilitate resource adequacy. Within the CAISO balancing authority area, a bilateral capacity

[39] *CXA La Paloma, LLC v. Cal. Indep. Sys. Operator Corp.,* 165 FERC ¶ 61,148 at P 76 (2018), *reh'g denied*, *CXA La Paloma, LLC v. Cal. Indep. Sys. Operator Corp*., 169 FERC ¶ 61,045 (2019).

market exists to support resource adequacy. The CAISO and local regulatory authorities share responsibility to ensure resource adequacy. Local regulatory authorities establish planning reserve margins, determine the qualifying capacity values for resources providing resource adequacy capacity, and develop demand forecasts to determine load serving entities' resource adequacy requirements.[40] The CAISO operationalizes this program and undertakes backstop procurement in the event of a deficiency or a significant event. The Commission accepted this division of responsibility between the CAISO and local regulatory authorities because the framework respects the jurisdictional boundaries of the Federal Power Act and recognizes the historical role of local regulatory authorities.[41] Rather than selecting one construct for resource adequacy, it is more important that existing resource adequacy constructs evolve to address changing grid needs.

Question: How will compliance with Order No. 2222 mandating the participation and compensation of aggregated distributed energy resources (DERs) in RTO/ISO markets affect the answers to questions 1-4 above?

Answer:

Implementation of Order No. 2222 provides a pathway for distributed energy resources to participate in RTO/ISO markets through an aggregation arrangement. The

[40] Under California law, the CPUC, in consultation with the CAISO, is required to establish RA requirements for all load-serving entities. California Public Utilities Code § 380. California law directs that each load serving entity maintain physical generating capacity adequate to meet its load requirements, including, but not limited to, peak demand and planning and operating reserves. The generating capacity shall be deliverable to locations and at times as may be necessary to provide reliable electric service. California Public Utilities Code §380(c).

[41] *CXA La Paloma, LLC v. Cal. Indep. Sys. Operator Corp.,* 165 FERC ¶ 61,148 at PP 69-70 (2018) *citing Cal. Indep. Sys. Operator Corp.,* 116 FERC ¶ 61,274, at PP 1117 -1118 (2006); *reh'g denied CXA La Paloma, LLC v. Cal. Indep. Sys. Operator Corp*., 169 FERC ¶ 61,045 (2019).

CAISO supports this option and has had a participation model for distributed energy resource aggregation in effect since 2016, which has spurred considerable dialog around the coordination between transmission and distribution systems. Distributed energy resources can also realize value by providing distribution services, *i.e.,* deferring distribution upgrades, or by managing retail rates a utility customer may otherwise pay. Distributed energy resources also enhance reliability and resilience of the overall system. Although distributed energy resources within the CAISO's balancing authority area have elected to use other pathways for wholesale market participation, Order No. 2222 implementation may give rise to new applications that can effectively aggregate distributed energy resources for market participation purposes. Work on this issue is actively underway.

Trends in building electrification, EV aggregations and virtual power plants present questions about how best to integrate these resources. The majority of these resources will interconnect on the distribution system, often behind the customer meter. The size of newly electrified resources may also make current requirements for providing wholesale market-based services too costly and complex, thereby inhibiting markets from fully obtaining services from these resources. The CAISO supports enabling distributed energy resources to provide essential grid services, like conventional supply does today, but the CAISO also sees an emerging path and growing opportunity for these resources to play a greater role in supporting grid reliability by taking beneficial load modifying actions through grid informed time-variant and dynamic retail rate options. The Commission, in coordination with state regulators, should help facilitate a clear and unified vision for how transmission and distribution

operators integrate these resources. Likewise, the need to develop compensation rules, mechanisms, and practices that reward "avoided costs," such as avoided resource adequacy capacity, due to beneficial load modifying actions is another important issue that requires further development and discussion. Opening a viable "load modifying" path provides developers the choice to elect a supply-side or load-modifying option for their projects, with each path providing just compensation for the services rendered or costs avoided, and each path having somewhat different benefits and burdens. In this way, distributed energy resources can contribute to the highly electrified, zero-carbon grid of the future either inside or outside wholesale electricity market participation, providing system benefits either way.

Conclusion

The transitions occurring on the electricity system to both supply and demand and the rate of change of those transitions require RTOs/ISOs to modernize their energy and ancillary services market designs. These changes are affecting net load uncertainty and variability albeit at a different pace across the country. The Commission should allow RTOs and ISOs to address system needs with market design changes developed through their stakeholder initiative processes, so organized markets can evolve to meet the needs of their respective systems. These efforts will yield

learning opportunities about how best to balance supply and demand in an efficient and reliable manner as the electricity system changes over the next decade.

Respectfully submitted,

By: */s/ Andrew Ulmer*
Roger E. Collanton
General Counsel
Anthony Ivancovich
Deputy General Counsel
Andrew Ulmer
Assistant General Counsel
Heather Curlee
Senior Counsel
California Independent System
Operator Corporation
250 Outcropping Way
Folsom, CA 95630
aulmer@caiso.com

Counsel for the California Independent
System Operator Corporation

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 18th day of October, 2022.

/s/ Martha Sedgley
Martha Sedgley