California ISO

Western Energy Imbalance Market
Resource Sufficiency Evaluation
Metrics Report covering November 2022

December 21, 2022

Prepared by: Department of Market Monitoring

California Independent System Operator

1 Report overview

As part of the Western Energy Imbalance Market (WEIM) resource sufficiency evaluation enhancements stakeholder initiative, DMM is providing additional information and analysis about resource sufficiency evaluation performance, accuracy, and impacts in regular monthly reports.[1] This report provides metrics and analysis covering November 2022 and is organized as follows:

- Section 2 provides an overview of resource sufficiency evaluation performance during the September heatwave.
- Section 3 provides an overview of the flexible ramp sufficiency and bid-range capacity tests.
- Section 4 summarizes the frequency and size of resource sufficiency evaluation failures.
- Section 5 summarizes WEIM import limits and transfers following a resource sufficiency evaluation failure.
- Section 6 summarizes imbalance conformance adjustments and provides some context with how it interacts with the resource sufficiency evaluation.
- Section 7 summarizes input differences between the resource sufficiency evaluation and latest 15-minute market run.

DMM continues to welcome feedback on existing or additional metrics and analysis that WEIM entities and other stakeholders would find most helpful. Comments and questions may be submitted to DMM via email at DMM@caiso.com.

[1] California ISO, *EIM Resource Sufficiency Evaluation Enhancements Straw Proposal*, August 16, 2021. http://www.caiso.com/InitiativeDocuments/StrawProposal-ResourceSufficiencyEvaluationEnhancements.pdf

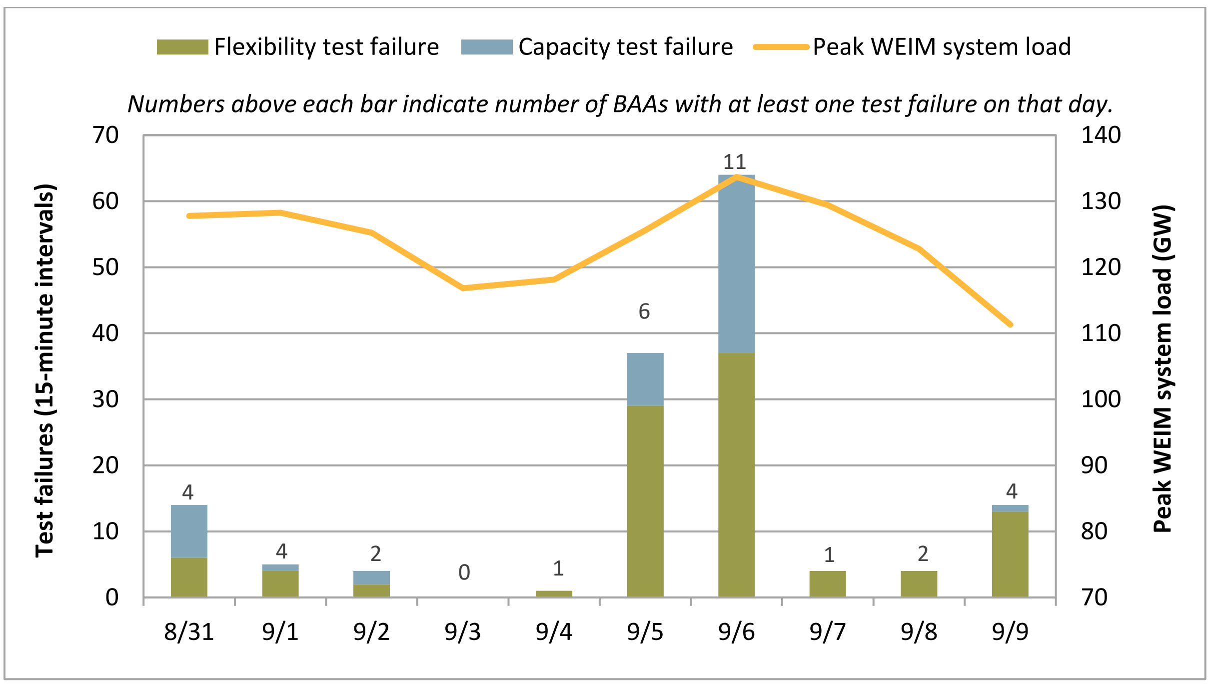
2 Resource sufficiency evaluation performance during the September heat wave

Between August 31 through September 9, the combined CAISO and WEIM system experienced a prolonged heat event. This period was marked by record setting extremely high temperature weather conditions across most of the western United States. This section describes resource sufficiency evaluation performance during this critical period.

Resource sufficiency evaluation failures

If a balancing area fails either the flexible ramp sufficiency test (flexibility test) or the bid range capacity test (capacity test) in the upward direction, then WEIM transfers into that area cannot be increased.[2] The bars in Figure 2.1 show flexibility or capacity test failures across the WEIM footprint (including CAISO) between August 31 and September 9. The amounts above each bar show the number of distinct balancing areas with a test failure on these dates. The figure also shows the peak WEIM system load on each date (right axis). Around 69 percent of test failures during this period occurred on September 5 and 6. The analysis in this section focuses on September 5 and 6 during the most critical period of the heat wave.

Figure 2.1 Flexibility or capacity test failures across WEIM footprint by date (August 31 to September 9, 2022)



[2] If an area fails either test in the upward direction, net WEIM imports during the interval cannot exceed the greater of either the base transfer or transfer from the last 15-minute interval prior to the hour.

On September 5 and 6, 87 percent of test failures occurred during the peak period between hours 15 and 22. Figure 2.2 shows 15-minute intervals in which each WEIM area failed either the capacity or the flexibility tests during the peak hours of these two days. Over this period:

Three WEIM areas failed either test during 8 or more intervals (two or more hours): Balancing Authority of Northern California (BANC), Idaho Power, and Salt River Project.

Four WEIM areas failed between 4 and 7 intervals (between one and two hours): Bonneville Power Administration (BPA), California ISO, NorthWestern Energy, and Puget Sound Energy.

Five WEIM areas failed between 1 and 3 intervals (less than one hour): Los Angeles Department of Water and Power (LADWP), PacifiCorp East, PacifiCorp West, Public Service Company of New Mexico (PNM), and Turlock Irrigation District.

In 12 percent of resource sufficiency evaluation failures during this period, only the capacity test was failed. In 55 percent of failures, only the flexibility test was failed. In the remaining 32 percent of failures, both tests were failed.

The flexibility test and the capacity test measure two different perspectives, but there are several other factors contributing to more flexibility test failures than capacity test failures. The flexibility test includes an adder for net load uncertainty in addition to the basic requirement. This uncertainty adder is designed to reflect a 95 percent confidence interval for expected uncertainty needs.[3] Net load uncertainty has not been included in the capacity test since February 2022.

The California ISO plans to implement the new quantile regression methodology for calculating the uncertainty included in the flexibility test as part of the flexible ramping product enhancements expected in February 2023. Following implementation of this new methodology, the California ISO expects to reconsider adding net load uncertainty back into the capacity test.[4]

In addition, accuracy issues identified in the capacity test resulted in fewer CAISO capacity test failures than expected. This is discussed in the following section.

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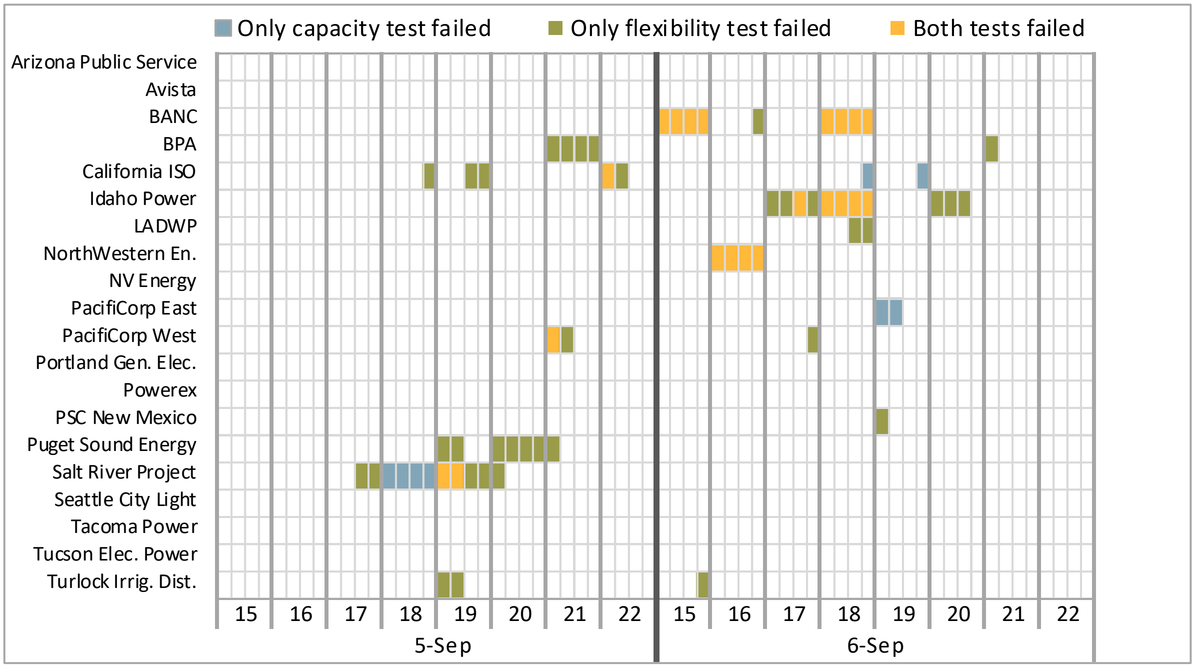
[3] This uncertainty is net of any diversity benefit discount. The diversity benefit reflects that system-level flexible ramping needs are typically smaller than the sum of the needs of individual balancing areas because of reduced uncertainty across a larger footprint.

[4] California ISO, *EIM Resource Sufficiency Evaluation Enhancements Phase 2 Final Proposal,* September 30, 2022: http://www.caiso.com/InitiativeDocuments/Final%20Proposal%20-%20WEIM%20Resource%20Sufficiency%20Evaluation%20Enhancements%20Phase2.pdf

Figure 2.2 Resource sufficiency evaluation failures (peak hours, September 5-6, 2022)



Example of capacity test requirements

Figure 2.3 provides an example that highlights how the upward capacity test requirements are determined. The bars show generation and import base schedules. For the California ISO (CAISO), the base schedules used in the requirement are the advisory schedules that cleared in the 15-minute market horizon immediately prior to the resource sufficiency evaluation. The capacity test requirement is the difference between (1) the load forecast plus any export base schedule and (2) generation plus import base schedules. The difference in the values is shown by the gap between the red line and bars in Figure 2.3.

The requirement does not include WEIM transfers or any operator load conformance. When the test requirement is positive, this indicates that the balancing area must show incremental available capacity above base schedules to meet this imbalance between load, intertie, and generation base schedules (without WEIM transfers). When the test requirement is instead negative, the balancing area will automatically pass the test. This reflects that internal generation and import base schedules (without WEIM or load adjustments) exceeded export base schedules and load.

Figure 2.4 shows the CAISO incremental capacity counted toward the capacity test requirement during the peak hours of September 6. The bars show incremental capacity above base schedules by resource type.[5] The line shows the capacity test requirement (as illustrated in Figure 2.3). The dotted regions highlight Energy Emergency Alert (EEA) periods. On this day, the CAISO failed the resource sufficiency evaluation during two intervals despite being in an EEA2 or EEA3 for more than five hours.

[5] The dark green bars show 15-minute dispatchable exports that can be dispatched down (decremental). This is shown as upward available capacity.

Figure 2.3 CAISO upward capacity test requirement (peak hours, September 6, 2022)

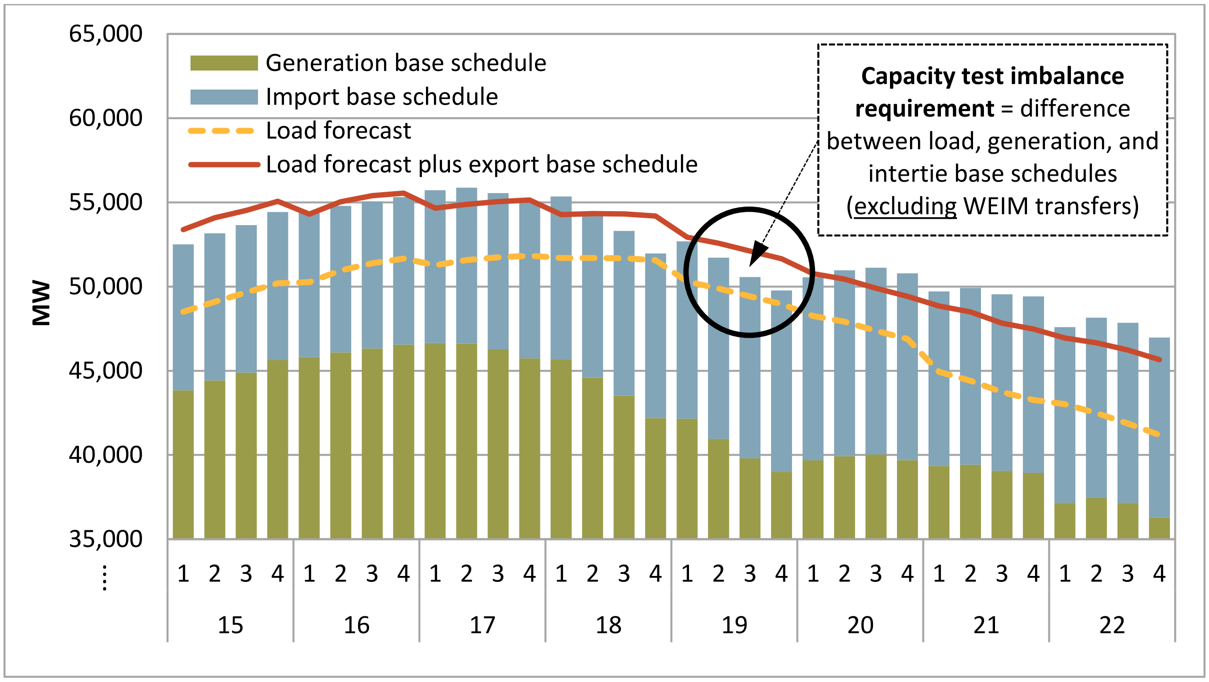
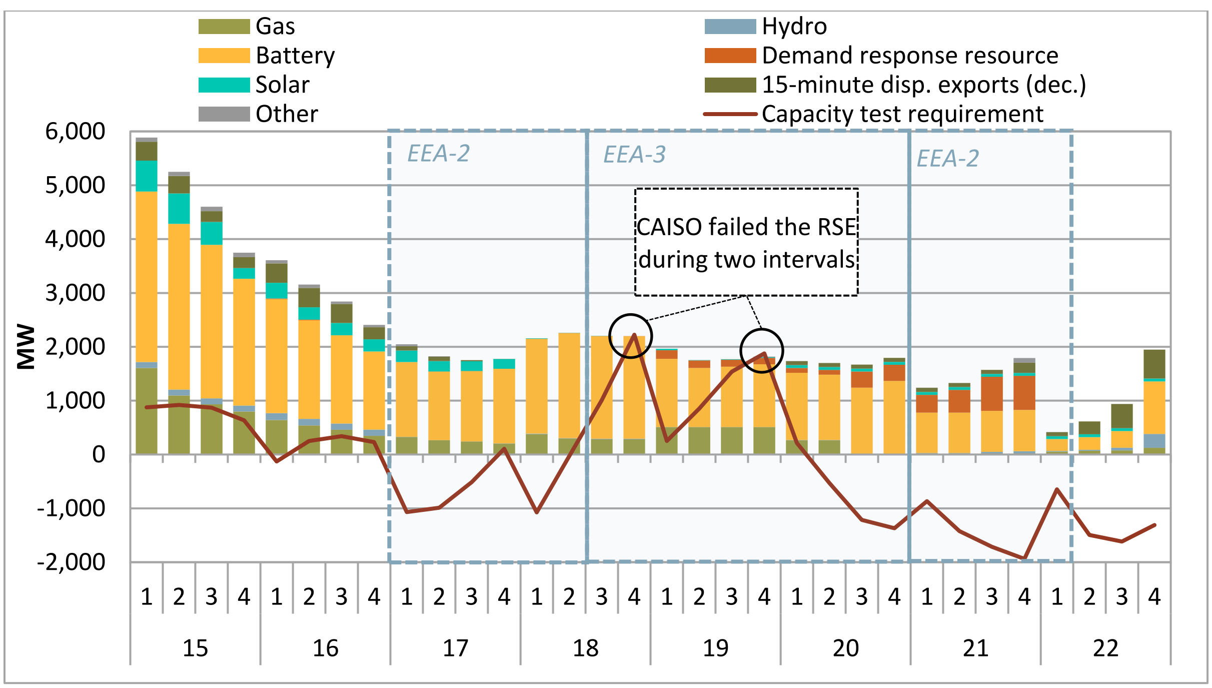


Figure 2.4 CAISO incremental capacity (peak hours, September 6, 2022)



Accuracy issues in the capacity test

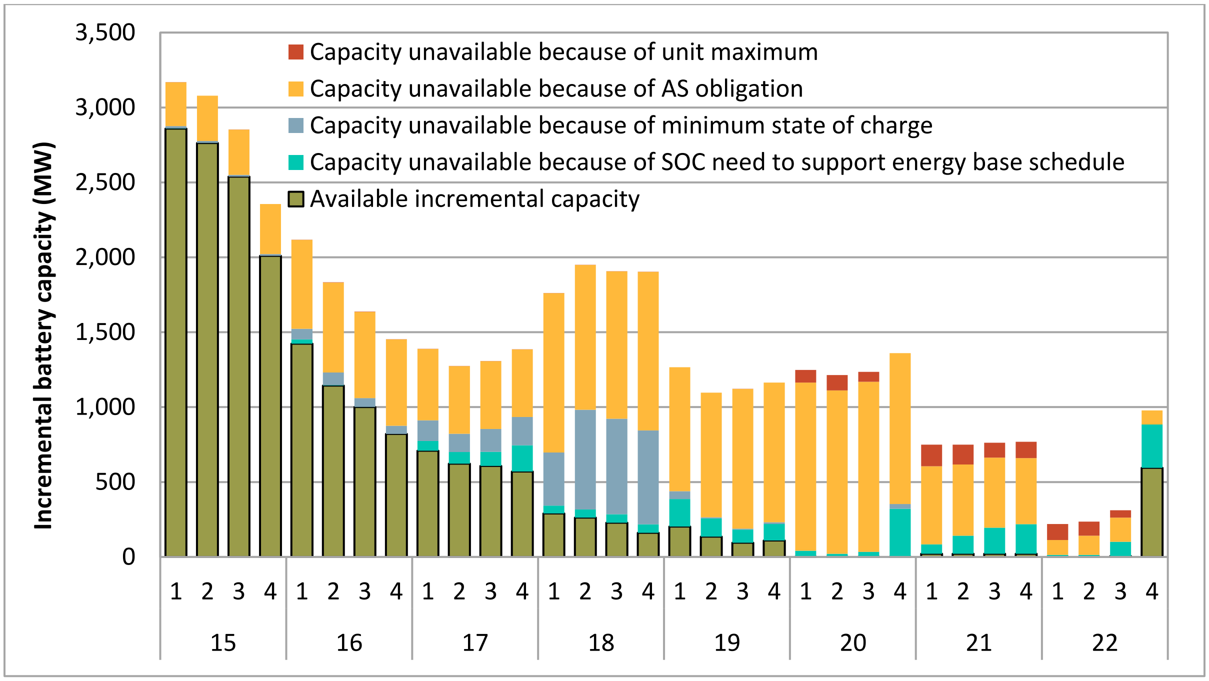
As part of phase 1 enhancements implemented on June 1, the California ISO implemented new logic to consider the initial state-of-charge for a battery unit in the tests. However, due to errors in how these changes were implemented, battery resources have been over-counted in the capacity test. As a result, battery storage capacity counted in the capacity test significantly exceeded the actual available capacity from batteries during the September heatwave.

The different reasons that battery capacity was incorrectly counted in the test (i.e. unavailable) include the following:

1. **Capacity unavailable because of unit maximum.** In these cases, base scheduled energy plus incremental capacity exceeded either the economic or physical maximum.
2. **Capacity unavailable because of ancillary service obligation.** In these cases, base scheduled energy plus incremental capacity did not account for an existing ancillary service award (mainly regulation up). This accounted for the majority of unavailable battery capacity.
3. **Capacity unavailable because of minimum state-of-charge (SOC).** The minimum state-of-charge constraint is activated for storage resources during tight system conditions to maintain SOC for the critical period. In these cases, the capacity test counted upward capacity that would exist after consuming this charge, but the market would not have been able to dispatch into this region because of a need to maintain charge for peak hours.
4. **Capacity unavailable because state-of-charge was needed to instead support energy base schedule.** The energy base schedule for a resource is accounted for in the test imbalance requirement. Any incremental capacity above those base schedules is instead shown as capacity against the requirement. In these cases, incremental capacity counted in the test — considering the initial state-of-charge going into the evaluation hour — did not correctly account for the energy base schedule which also consumes charge. This can effectively double count the same initial state-of-charge to be used twice to support both energy base schedules and incremental capacity.

Figure 2.5 shows incremental battery capacity (above base schedules) counted in the CAISO capacity test during the peak hours of September 6, 2022. The total height of the bars show upward capacity counted from battery resources in the test. The green bars show the incremental capacity that was actually available in the real-time market after accounting for the four issues described above.

Figure 2.5 Incremental battery capacity counted in the CAISO bid-range capacity test (peak hours, September 6, 2022)



Battery capacity counted in the test in the CAISO area exceeded the actual available capacity of these resources by an average of about 1,300 MW between hours 18 and 20 on September 6. Figure 2.6 shows CAISO incremental capacity after adjusting for unavailable battery capacity during the peak hours of September 6.

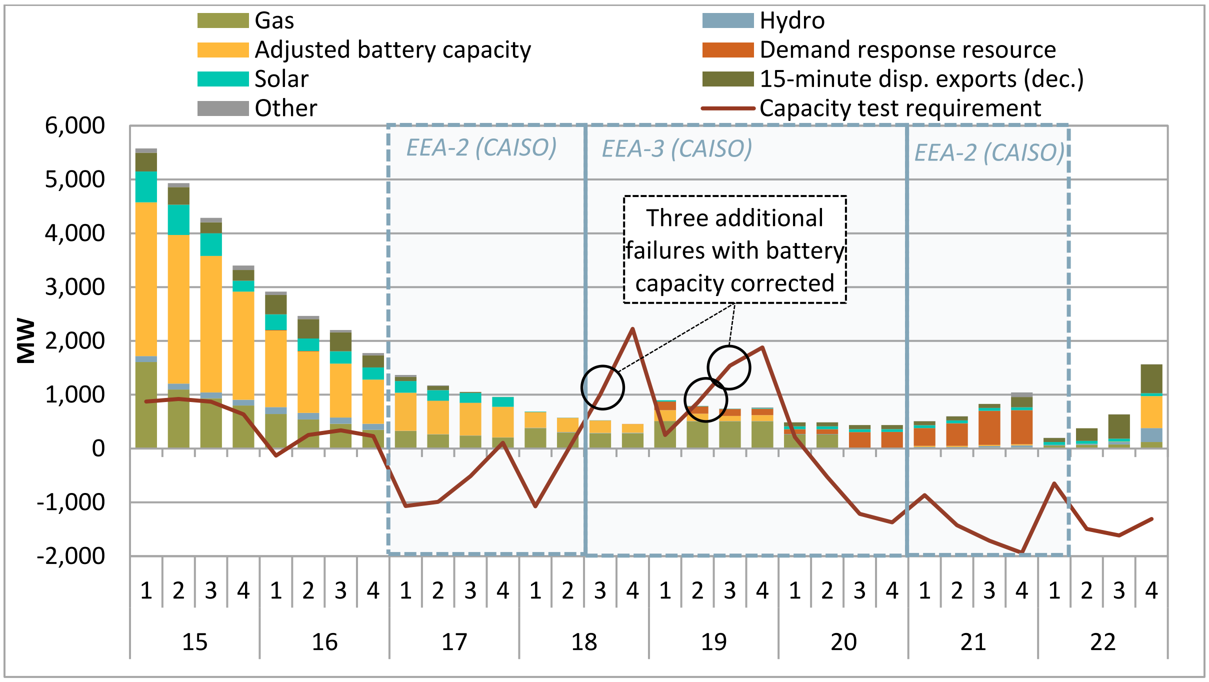
With the battery issues corrected, the CAISO would have failed the capacity test in three additional intervals on this day. Between August 30 and September 9, the CAISO would have failed the capacity test in 14 additional intervals after adjusting for unavailable battery capacity. As shown in the next section, during *all* of the additional intervals that the CAISO area would have failed the test after accounting for incorrect battery capacity, the CAISO area would have passed the test if lower priority exports were also removed from the test requirement. This is currently being proposed as part of phase 2 of the *resource sufficiency evaluation enhancements*.[6]

The issues associated with over-counting battery capacity due to not correctly accounting for either the unit maximum or the ancillary service obligation appear to have been fixed in mid-October. The California ISO is considering enhancements to account for cases when the incremental battery capacity is unavailable because the state-of-charge is instead needed to support the energy base schedule. DMM recommends that the California ISO and stakeholders also review the minimum state of charge constraint for potential consideration in the resource sufficiency evaluation. Capacity associated with consuming charge below this minimum is not made available for market dispatch because of a requirement to maintain charge for the peak hours.

[6] California ISO, *WEIM Resource Sufficiency Evaluation Enhancements Phase 2 Revised Final Proposal,* November 7, 2022: http://www.caiso.com/InitiativeDocuments/RevisedFinalProposal-WEIMResourceSufficiencyEvaluationEnhancementsPhase2.pdf

The battery issue described here did not impact the resource sufficiency evaluation of other WEIM balancing areas. The battery storage capacity in the CAISO balancing area is significant, while battery capacity in the rest of the WEIM is very limited. Further, battery capacity that does exist in the WEIM is largely non-participating or self-scheduled such that it is not counted as incremental capacity in the tests. Battery capacity outside of the CAISO that was bid-in above base schedules was minimal and did not impact test results.

Figure 2.6 CAISO incremental capacity, adjusted to correct for unavailable battery capacity (peak hours, September 6, 2022)



The California ISO *September 2022 Summer Market Performance Report* identifies additional discrepancies in the capacity test for the heat wave period.[7] Among others, this report highlights discrepancies with multi-stage-generation (MSG) capacity, imports, exports, and reliability demand response (RDR) resources.

Impact of excluding lower-priority exports from CAISO's resource sufficiency evaluation

As part of phase 2 of the *resource sufficiency evaluation enhancements*, the CAISO proposes to exclude real-time lower priority and economic exports from the capacity test requirement.[8] This is intended to correct the possibility of these exports to be scheduled against WEIM imports. Therefore, only high priority exports as well as lower priority exports that were scheduled through the CAISO's residual unit commitment (RUC) process are expected to be included in the test obligation.

[7] California ISO, *September 2022 Summer Market Performance Report,* November 2, 2022: http://www.caiso.com/Documents/SummerMarketPerformanceReportforSeptember2022.pdf

[8] California ISO, *WEIM Resource Sufficiency Evaluation Enhancements Phase 2 Revised Final Proposal,* November 7, 2022: http://www.caiso.com/InitiativeDocuments/RevisedFinalProposal-WEIMResourceSufficiencyEvaluationEnhancementsPhase2.pdf

Figure 2.7 summarizes export schedules included in the CAISO capacity test requirements during the peak hours of September 5 and 6. The blue and green bars show real-time low priority and economic exports, respectively, which *would have been* excluded from the test requirements had the proposal been in place. The remaining categories show existing transmission contract (ETC), transmission ownership right (TOR), high priority, and day-ahead low priority exports that would continue to be included in the CAISO's requirement under the proposal.

During the peak hours of September 5 and 6, an estimated average of just over 1,100 MW would have been excluded from the capacity test under the phase 2 proposal. This includes around 200 MW in economic exports and around 900 MW in real-time low priority exports. This analysis was conducted by mapping export schedules included in the capacity test to bids in the hour-ahead scheduling process (HASP) to identify the priority of exports in the test. Because of a known issue with export prioritization during the September heatwave, HASP export bids were first adjusted to reflect expected priorities relative to residual unit commitment (RUC) outcomes.

Figure 2.8 summarizes capacity test failures after correcting the issues leading to the over-counting of battery capacity and removing lower priority exports from test requirements, as is being proposed. During the summer, the CAISO failed the capacity test in three intervals. The CAISO would have still failed the capacity test in these same three intervals after accounting for both (1) incorrect accounting of battery capacity and (2) exports that would have been excluded under the phase 2 proposal. The CAISO would not have failed the capacity test in any additional intervals after accounting for these two items. All of the additional intervals that would have failed after accounting for incorrect battery capacity would have been reversed after also removing lower priority exports under the proposal.

The lower priority exports are also expected to be removed from the flexibility test. The flexibility test requirement does not include any exports. The flexibility test requirement is only the change in load from the start of the hour *plus* the net load uncertainty.[9] Instead, a lower priority export would be accounted for as ramping capacity meeting the requirement. In the flexibility test, ramping capacity includes both economic energy bids that can be dispatched as well as fixed unit schedules or renewable forecasts. So, if a lower priority export *increased* from the previous hour to the evaluation hour, this would be accounted for in the flexibility test as *negative ramping capacity* (or effectively a higher requirement). After removing any increase in lower priority exports from the test, the CAISO would have passed the flexibility test in one additional interval (that was a failure otherwise) during the September heatwave.

9 The net load uncertainty is discounted based on the diversity benefit and any flexible ramping credits. These discounts are further described in Section 3.

Figure 2.7 Export base schedules included in CAISO's capacity test requirement (peak hours, September 5-6, 2022)

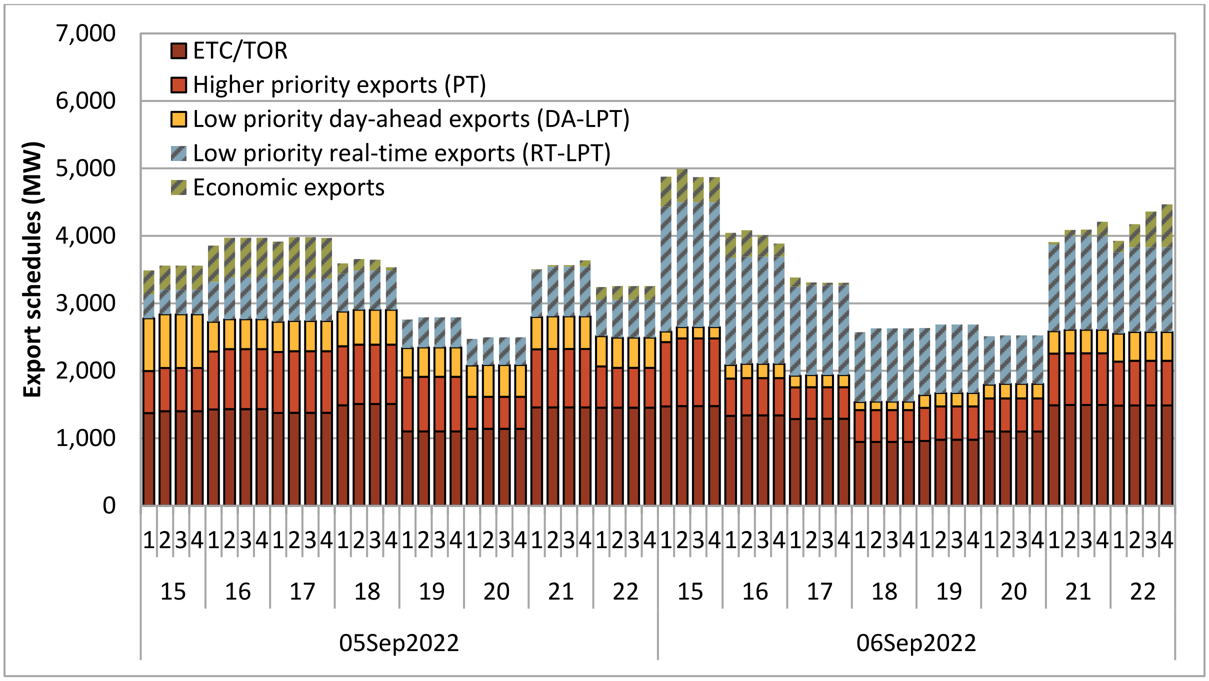
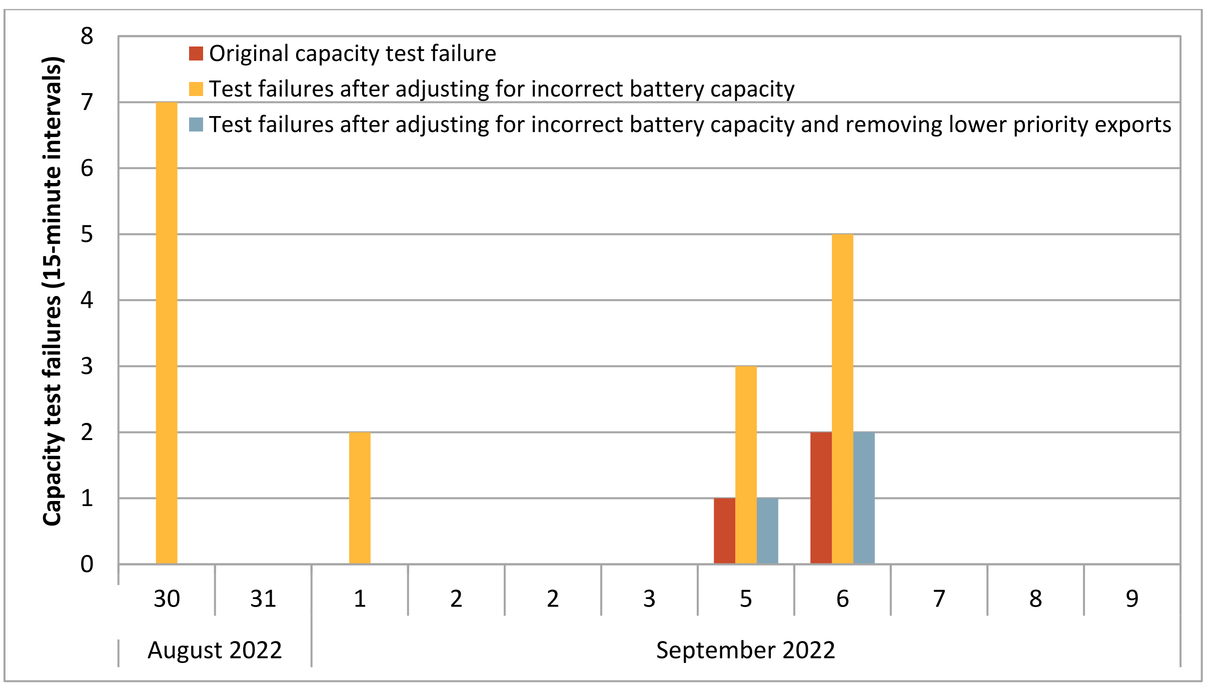


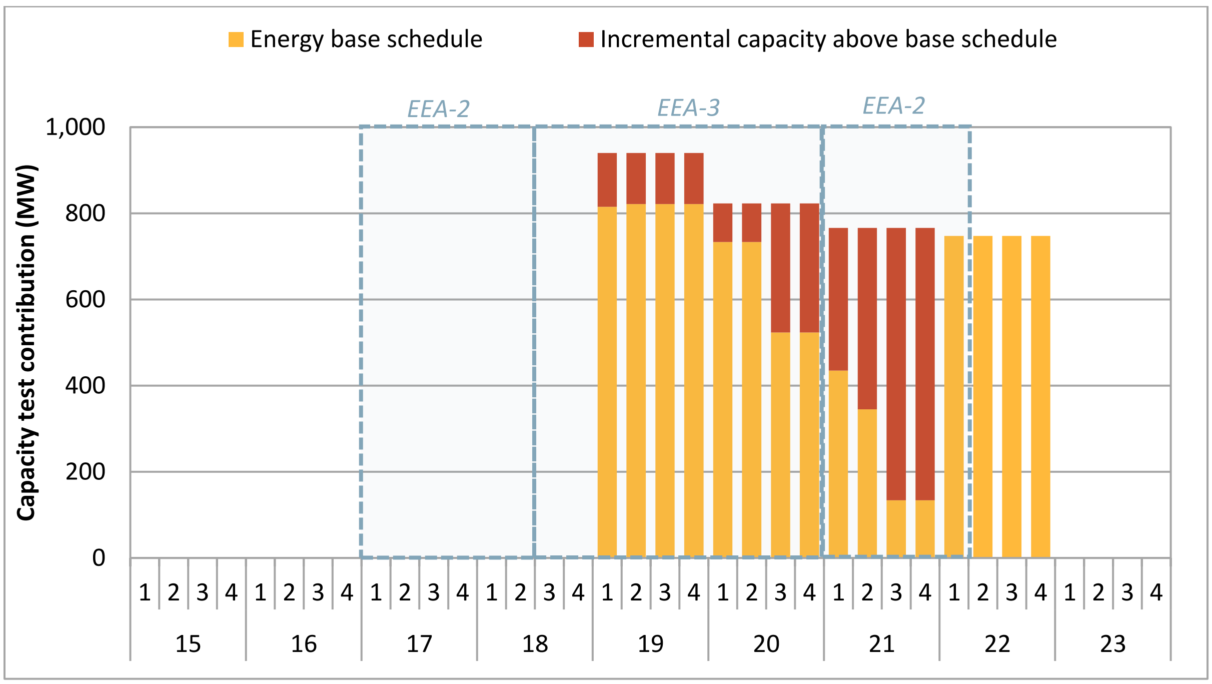
Figure 2.8 Capacity test failures after adjusting for unavailable battery capacity and removing lower-priority exports (August 30 – September 9, 2022)



Reliability demand response resources in the capacity test

Reliability demand response resources (RDRRs) helped the CAISO to pass the resource sufficiency evaluation after the energy emergency alerts (EEA) were issued. Most RDRRs are only called upon in real-time after the CAISO declares at least an EEA2.[10] Figure 2.9 summarizes all RDRR capacity included in the CAISO capacity test during the peak hours of September 6, either in the energy base schedule, or as incremental unloaded capacity above base schedules.[11] The resource sufficiency evaluation is based on available information in advance of the evaluation hours, so there is a delay between the activation of RDRR and its inclusion in the test. RDRRs were only counted in the CAISO capacity test after the CAISO declared at least an EEA2. The energy emergency alerts allowed access to the reliability demand response resources in the capacity test during the critical hours of the day.[12]

Figure 2.9 Reliability Demand Response Resources included in CAISO's capacity test (peak hours, September 6, 2022)



[10] Reliability demand response resources (RDRR) can also participate economically in the day-ahead market and be subsequently self-scheduled in real-time. Otherwise, incremental RDRR capacity in the real-time market must be bid between 95 to 100 percent of the energy bid cap, and can only be called on when an emergency is issued.

[11] The base schedule for a CAISO resource is the expected schedule going into the evaluation hour. These are the advisory schedules from the latest 15-minute market run.

[12] The California ISO *September 2022 Summer Market Performance Report* describes that capacity accounted for from reliability demand response resources in the test was higher than what was made available in real-time by about 130 MW (pp. 115): http://www.caiso.com/Documents/SummerMarketPerformanceReportforSeptember2022.pdf

Variable energy resources in the capacity test

The capacity test can include incremental capacity from variable energy resources (VERs). As an example, Figure 2.10 summarizes all solar capacity included in the CAISO capacity test — either in the energy base schedule, or as incremental capacity above base schedules — between hours 8 and 19 on September 6. Figure 2.11 shows the same information, except with only the incremental capacity above base schedules. During this period, incremental capacity counted in the CAISO capacity test from solar resources reached just under 600 MW, which can also be seen in Figure 2.4.

The capacity test measures any bid-in capacity that exists above the energy base schedules at the time of the resource sufficiency evaluation as incremental capacity. The base schedules for resources within the ISO (including VERs) are pulled from advisory schedules from the last market run prior to the resources sufficiency evaluation. When a CAISO wind or solar resource is dispatched down (or curtailed), due to either local congestion or system-wide conditions, this will impact the energy base schedule for that resource accordingly. The capacity test will then measure incremental capacity from the expected schedule to the unit's forecast. In particular, the majority of incremental capacity counted from solar resources on September 6 was because of downward dispatch associated with local congestion.

Figure 2.10 Solar resources included in the CAISO capacity test (hours 8-19, September 6, 2022)

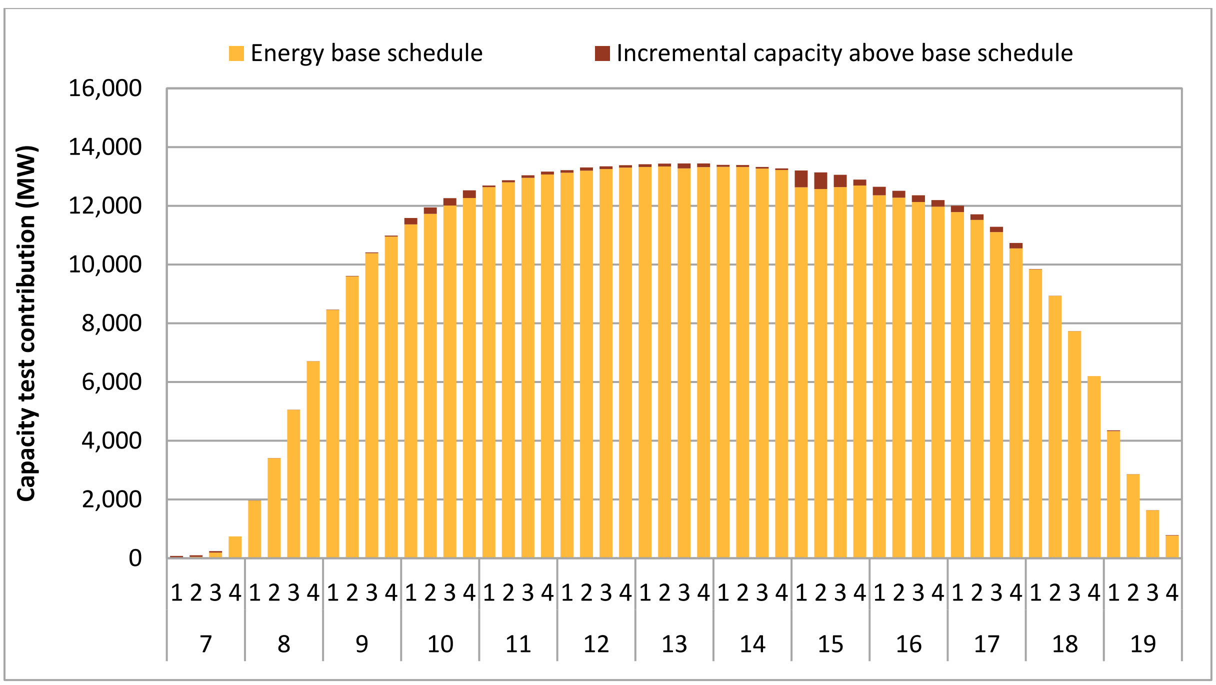
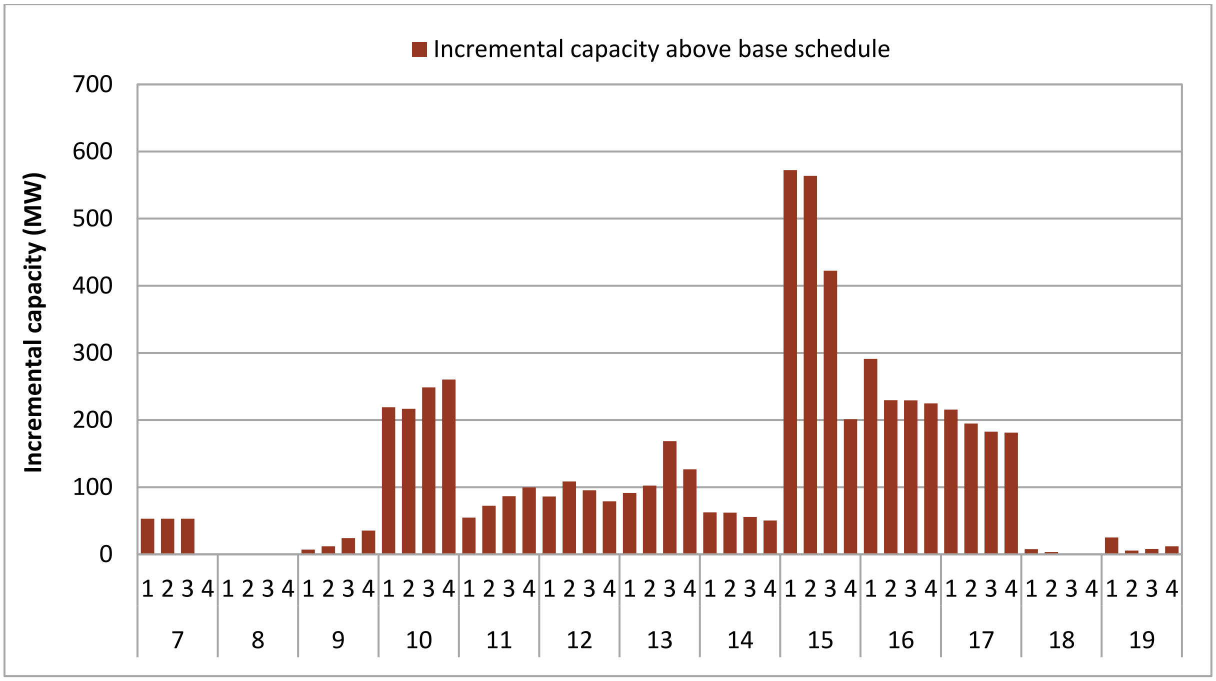


Figure 2.11 Incremental capacity from solar resources in the CAISO capacity test (hours 8-19, September 6, 2022)



Demand-response-based load adjustments in the resource sufficiency evaluation

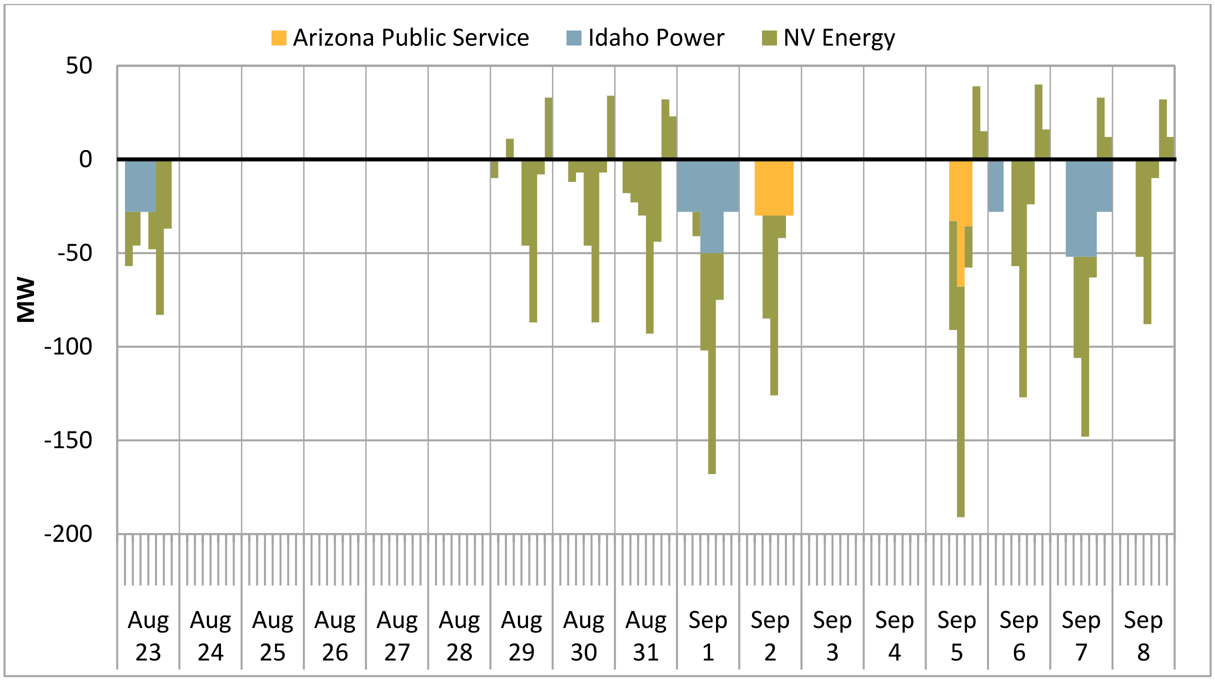
As part of phase 1 of the resource sufficiency evaluation enhancements initiative, the California ISO implemented a new feature to allow WEIM entities to submit load forecast adjustments to reflect demand response programs that could not be accounted for otherwise in the real-time market. This adjustment is included in both the capacity and the flexibility tests and also impacts the load used in the test requirements.

Figure 2.12 summarizes hourly demand-response-based load adjustments during the peak hours between August 23 and September 8. There have not been any adjustments to test requirements following this period. A negative adjustment reflects a lower load forecast as a result of a demand response program. This will *decrease* the requirement for the *upward* capacity and flexibility tests, but will *increase* the requirement for the *downward* tests. The adjustments can also be entered as a positive load adjustment. This can reflect additional demand because of expected pre-cooling or post-demand-response-event increases (sometimes referred to as snapback).

The feature to adjust the load forecast in the tests based on a demand-response program has been used by three balancing areas: NV Energy, Arizona Public Service, and Idaho Power. NV Energy was the most frequent user of this feature, with negative adjustments in 38 hours at -47 MW on average (or -127 MW at its lowest). NV Energy has also submitted positive adjustments following the demand-response events. This occurred for over 15 hours at 24 MW on average. Arizona Public Service and Idaho Power used this feature in 20 and 8 hours, respectively, with adjustments for each entity being -36 MW on average.

During this period, these adjustments did not have any impact on any area passing or failing the *capacity* test. However, these adjustments allowed Idaho Power to pass the *flexibility* test in three intervals that *would have been* failures had the demand response program not been accounted for in the test.

Figure 2.12 Demand-response-based load adjustments included in the resource sufficiency evaluation (peak hours, August 23 – September 8, 2022)



WEIM transfers and import limits

The majority of net imports in the WEIM were into the CAISO area during the heat wave event. Figure 2.13 shows dynamic 15-minute market transfers across the WEIM footprint during the peak hours of September 5 and 6. Net imports are shown as positive and net exports are shown as negative. The blue bars show CAISO net WEIM imports. All other balancing areas were identified individually as net importers or net exporters with the corresponding transfers shown collectively in the yellow and green bars. Most balancing areas were net exporters in the 15-minute market during the peak hours.

Figure 2.14 shows the same information for 5-minute market WEIM transfers. In comparison to the 15-minute market, net WEIM imports into the CAISO area were considerably lower while net WEIM imports into other balancing areas were higher. The drop in WEIM imports into the CAISO between the 15-minute and 5-minute markets is driven by the significant imbalance conformance adjustments (or *bias*) entered by CAISO operators in the hour-ahead and 15-minute markets. These adjustments increase CAISO load in the 15-minute market well above the load realized in the 5-minute market.

Figure 2.15 shows imbalance conformance adjustments for the CAISO area on September 5 and 6. Between August 31 and September 9, CAISO hour-ahead and 15-minute market imbalance conformance reached 5,000 MW during the net peak hours. During more typical summer days, the hour-ahead and 15-minute load conformance in these net peak hours usually reaches about 3,000 MW. As shown in Figure 2.15, 5-minute market adjustments were significantly lower.

Figure 2.16 shows net WEIM imports into CAISO during the peak hours of September 5 and 6 along with any limit imposed following a resource sufficiency evaluation failure. The dashed red regions highlight Energy Emergency Alert (EEA) periods. During the critical EEA periods on these two days, the 15-minute market net WEIM imports were between 1,770 and 4,650 MW — or almost 3,370 MW on average. Imports in the 5-minute market during these same hours were much less.

The California ISO was not the only balancing area with an Energy Emergency Alert (EEA) during the September heatwave. Since other balancing areas do not make these alerts public, this report does not include similar analysis of these areas during EEAs. However, analysis by DMM indicates that net imports into other WEIM areas declaring EEAs in September were small and in some cases limited by resource sufficiency failures.

During the September heat wave, failure of the resource sufficiency evaluation did not have a significant impact on limiting transfers into the CAISO area. The CAISO failed the resource sufficiency evaluation during seven intervals over September 5 and 6, as shown by the yellow line in Figure 2.16, which shows the resulting import limit. The CAISO net 15-minute market WEIM imports during these failures was between 1,770 MW and 4,110 MW — or around 2,870 MW on average. The 5-minute market imports in the same period were much less at around 1,625 MW on average, which was less than the limit imposed following the failure. During the CAISO resource sufficiency evaluation failures over these two days, the resulting import limit was binding in 57 percent of 15-minute market intervals, but in none of the 5-minute market intervals.

Figure 2.13 15-minute market Net WEIM transfers (peak hours, September 5-6)

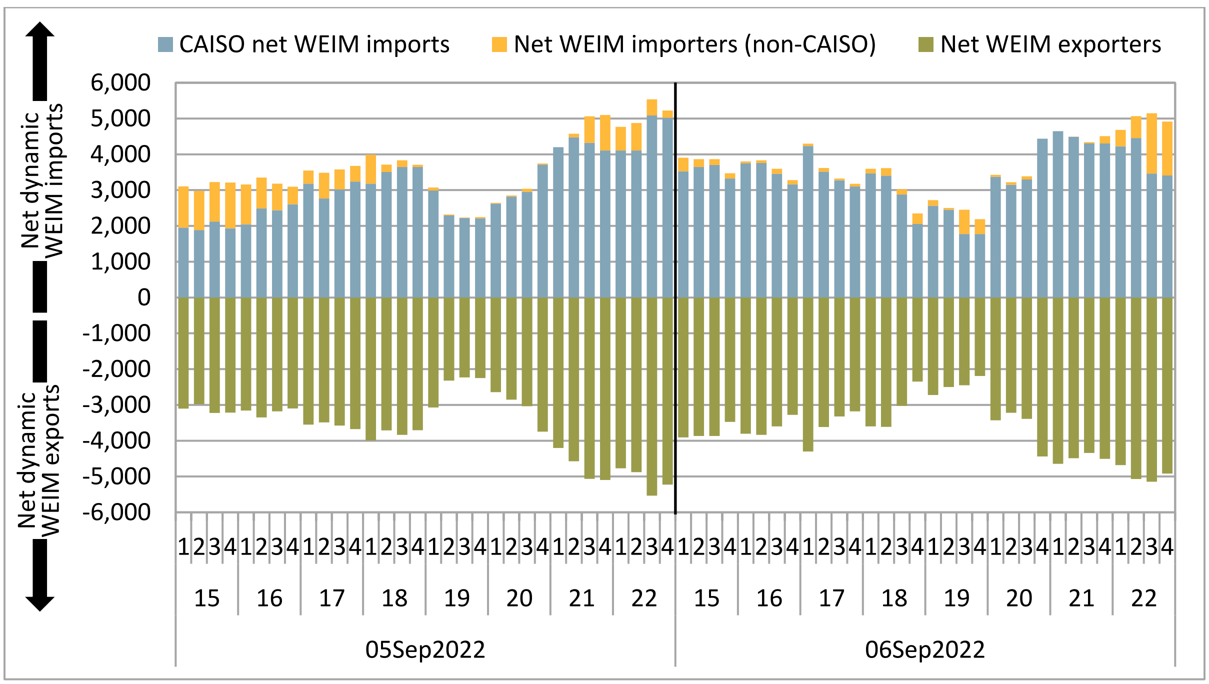


Figure 2.14 5-minute market net WEIM transfers (peak hours, September 5-6)

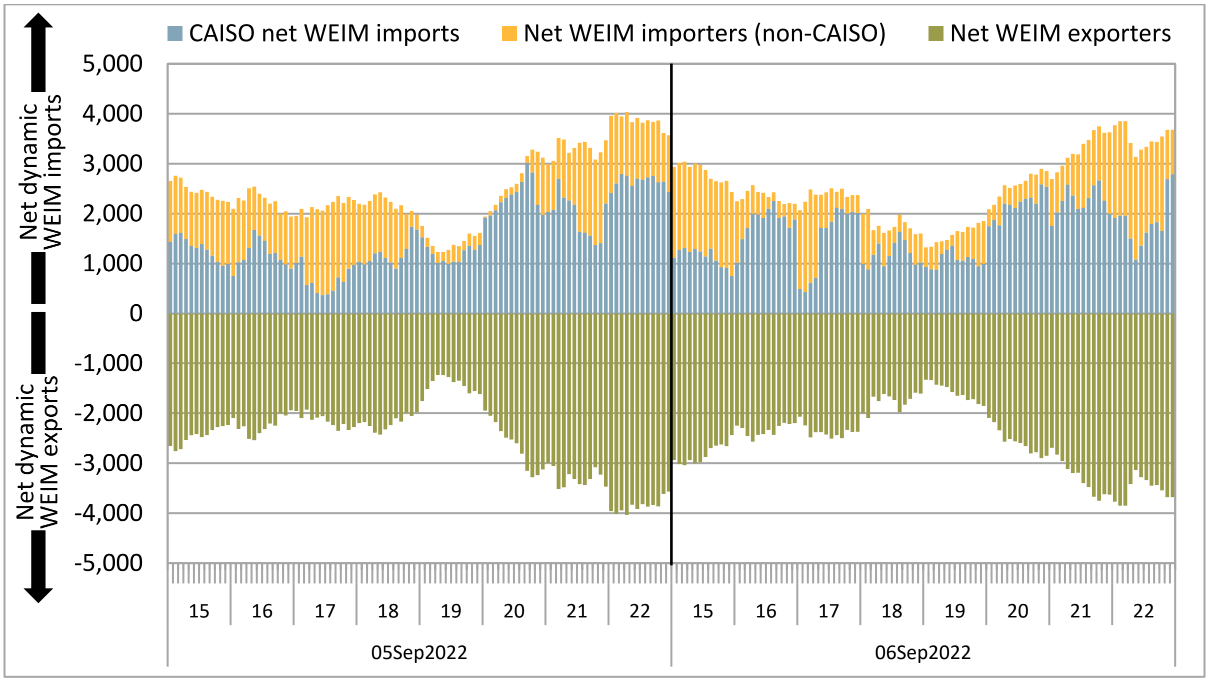


Figure 2.15 California ISO imbalance conformance adjustments (September 5-6)

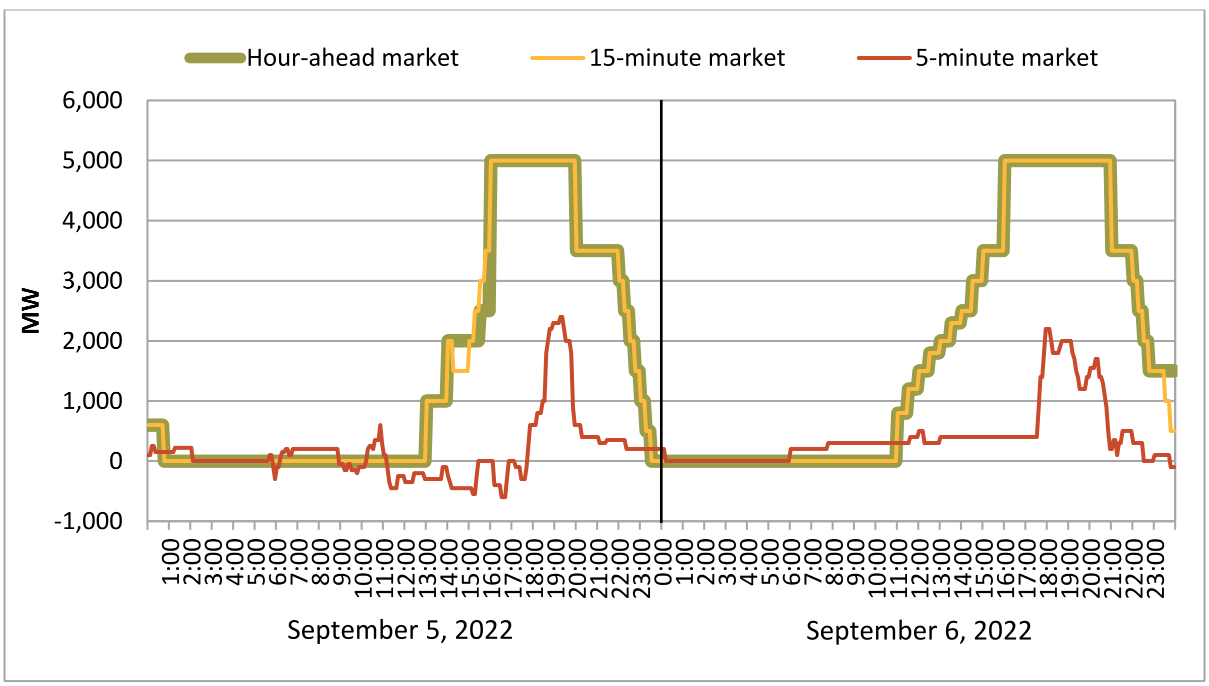
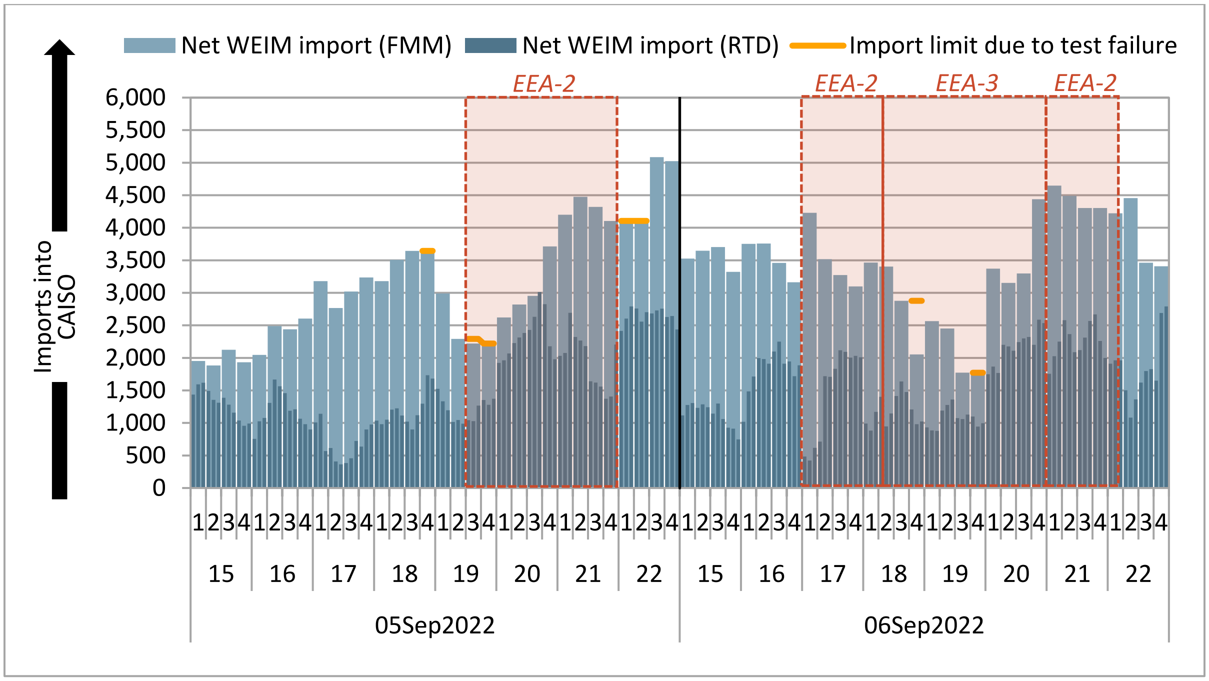


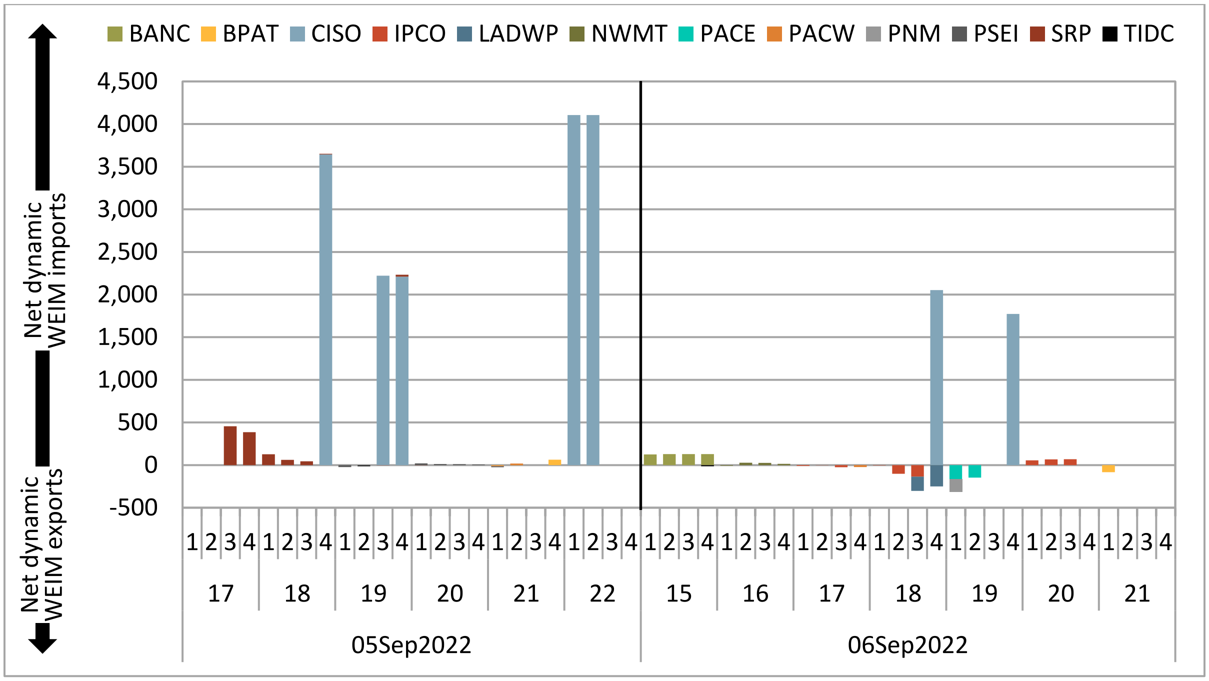
Figure 2.16 CAISO WEIM transfers and any import limit following resource sufficiency evaluation failure (peak hours, September 5-6)



The resource sufficiency evaluation is intended to measure whether enough resources are available to meet expected demand without leaning on other balancing areas from a capacity or flexibility perspective. Currently, when a BAA fails the resource sufficiency evaluation, imports from other areas through the WEIM are capped at the level of imports that occurred during the last interval (or the base WEIM transfer if greater.

Following a resource sufficiency evaluation failure during the heat wave event, most WEIM balancing areas either imported relatively small amounts or were net exporters. Figure 2.17 shows dynamic 15-minute market WEIM transfers for any balancing area following a test failure during the peak hours of September 5 and 6.

Figure 2.17 15-minute market WEIM transfers following resource sufficiency evaluation failure (peak hours, September 5-6, 2022)



As part of phase 2 of the *resource sufficiency evaluation enhancements*, the California ISO proposes to introduce an energy assistance mechanism that could relax the limitation on incremental WEIM transfers following a test failure at an ex-post settlement surcharge.[13] For a balancing area that elects to utilize this energy assistance, the settlement quantity will be set by the lower of (1) the level of upward resource sufficiency evaluation failure or (2) dynamic WEIM net imports.[14] The settlement price will be set by either $1,000/MWh or $2,000 depending on whether the market was accepting bids above the $1,000 soft bid cap.

Table 2.1 summarizes 5-minute market WEIM imports and limits following a resource sufficiency evaluation failure during the critical days of the heat wave, between September 5 and 8.[15] The first and second columns highlight the number of resource sufficiency evaluation failures (15-minute intervals) for each balancing area. The remainder of the table is broken up into two sections.

The *left* section of Table 2.1 summarizes the corresponding 5-minute market failure intervals in which optimized WEIM transfers were *below* the import limit imposed following the test failure. In these cases, the cap placed on imports after the test failure did not impact WEIM transfers. An energy assistance option would not have resulted in additional imports.

13 California ISO, *WEIM Resource Sufficiency Evaluation Enhancements Phase 2 Revised Final Proposal,* November 7, 2022: http://www.caiso.com/InitiativeDocuments/RevisedFinalProposal-WEIMResourceSufficiencyEvaluationEnhancementsPhase2.pdf

14 If the balancing area is exporting on net, the settlement quantity will be zero.

15 In some cases, the import limit imposed following a resource sufficiency evaluation failure had no impact on transfers. This can occur when the import limit after failing the test (i.e. the greater of the last 15-minute interval transfer or base transfer) is at or above the unconstrained total import capacity. In other cases, the WEIM entity has flagged a contingency event such that transfers are not optimized in the market (fixed). These cases were removed from the analysis in the table.

The *right* section summarizes the corresponding 5-minute market failure intervals in which optimized WEIM transfers were *constrained* at the import limit imposed following the test failure. In these cases, an energy assistance option may have resulted in additional imports.

In particular, Table 2.1 highlights the following findings:

1. During many intervals, 5-minute market WEIM transfers were below the import limit imposed following the test failure. In these cases, relaxing the cap placed on imports would not have had the effect of procuring additional WEIM imports. This was true of all the intervals during which the CAISO failed the test during the September heat wave.
2. Following a resource sufficiency evaluation failure during the heat wave event, most other WEIM balancing areas either imported relatively small amounts or were net exporters.

Table 2.1. 5-minute market limits and transfers following resource sufficiency evaluation failure (September 5 – 8, 2022)

		Market transfers below the imposed import limit			Market transfers at the imposed import limit		
BAA	Resource Sufficiency	Percent of RTD failure intervals	Average RTD dynamic import limit	Average RTD dynamic net WEIM import	Percent of RTD failure intervals	Average RTD dynamic import limit	Average RTD dynamic net WEIM import
BANC	9	41%	84	56	59%	65	65
BPA	7	10%	24	-65	90%	13	13
California ISO	14	100%	3,238	1,572	0%	—	—
Idaho Power	11	11%	78	63	89%	18	18
LADWP	2	100%	0	-59	0%	—	—
NorthWestern En.	5	27%	27	-67	73%	29	29
PacifiCorp East	2	33%	0	-69	67%	186	186
PacifiCorp West	3	33%	0	-260	67%	1	1
PSC New Mexico	1	100%	0	-153	0%	—	—
Puget Sound Energy	7	48%	17	-26	52%	16	16
Seattle City Light	9	100%	26	-7	0%	—	—
Salt River Project	11	42%	71	-20	58%	0	0
Turlock Irrig. Dist.	3	89%	2	-20	11%	0	0

3 Overview of the flexible ramp sufficiency and capacity tests

As part of the Western Energy Imbalance Market (WEIM) design, each balancing area (including the California ISO) is subject to a resource sufficiency evaluation. The evaluation is performed prior to each hour to ensure that generation in each area is sufficient without relying on transfers from other balancing areas. The evaluation is made up of four tests: the power flow feasibility test, the balancing test, the flexible ramp sufficiency test, and the bid range capacity test.

The market software automatically limits transfers into a balancing area from other WEIM areas if a balancing area fails either of the following two tests:

- **The flexible ramp sufficiency test (flexibility test)** requires that each balancing area have enough ramping flexibility over an hour to meet the forecasted change in demand as well as uncertainty.
- **The bid range capacity test (capacity test)** requires that each area provide incremental bid-in capacity to meet the imbalance between load, intertie, and generation base schedules.

If an area fails either the flexible ramp sufficiency test or bid range capacity test in the *upward* direction, WEIM transfers into that area cannot be *increased*.[16] Similarly, if an area fails either test in the *downward* direction, transfers out of that area cannot be *increased*.

Flexible ramp sufficiency test

The *flexible ramp sufficiency test* requires that each balancing area have enough ramping resources to meet expected upward and downward ramping needs in the real-time market without relying on transfers from other balancing areas. Each area must show sufficient ramping capability from the start of the hour to each of the four 15-minute intervals within the hour.

Equation 1 shows the different components and mathematical formulation of the flexible ramp sufficiency test. As shown in Equation 1, the requirement for the flexible ramp sufficiency test is calculated as the *forecasted change in load* plus the *uncertainty component* minus two components: (1) the *diversity benefit* and (2*) flexible ramping credits.* Any undersupply infeasibility in the last 15-minute market interval is also accounted for in the flexibility test requirement as of June 1, 2022.

Equation 1. Flexible Ramp Sufficiency Test Formulation

$$Up\ Requirement = \Delta Load + Up\ uncertainty - \min\begin{bmatrix} Net\ import\ capability, \\ Diversity\ benefit + Up\ credit \end{bmatrix} + Undersupply\ infeasibility$$

$$Down\ Requirement = \underbrace{-\Delta Load}_{\text{Change in load forecast}} + \underbrace{Down\ uncertainty}_{\text{Net load uncertainty}} - \underbrace{\min\begin{bmatrix} Net\ export\ capability, \\ Diversity\ benefit + Down\ credit \end{bmatrix}}_{\text{Discounts: diversity benefit and credit reduction capped by transfer capability}} - \underbrace{Undersupply\ infeasibility}_{\text{Undersupply infeasibility in last 15-minute market interval, excluding imbalance conformance}}$$

The diversity benefit reflects that system-level flexible ramping needs are typically smaller than the sum of the needs of individual balancing areas because of reduced uncertainty across a larger footprint. As a result, balancing areas receive a prorated diversity benefit discount based on this proportion.

The flexible ramping credits reflect the ability to reduce exports from a balancing area to increase upward ramping capability or to reduce imports to increase downward ramping capability.

[16] If an area fails either test in the upward direction, net WEIM imports during the interval cannot exceed the greater of either the base transfer or transfer from the last 15-minute interval prior to the hour.

As shown in Equation 1, the reduction in the flexibility test requirement because of any diversity benefit or flexible ramping credit is capped by the area's net import capability for the upward direction, or net export capability for the downward direction.

Last, as part of phase 1 of *resource sufficiency evaluation enhancements*, the flexibility test requirement now includes any undersupply infeasibility (power balance constraint relaxation) from the 15-minute market solution immediately prior to the resource sufficiency evaluation hour. This amount excludes any operator imbalance conformance.

The uncertainty component currently used in the flexible ramp sufficiency test is calculated from the historical net load error observation. The 2.5 percentile of historical net load error observations is used for the downward requirement and the 97.5 percentile if used for the upward requirement.[17] The uncertainty component is expected to be enhanced in February 2023 to scale and account for net load currently in the system.[18]

Bid range capacity test

The *bid range capacity test* requires that each area provide incremental (or decremental) bid-in capacity to meet the imbalance between load, intertie, and generation base schedules. Equation 2 shows the different components and mathematical formulation of the bid range capacity test. As shown in Equation 2, the requirement for the bid range capacity test is calculated as the *load forecast* plus *export base schedules* minus *import and generation base schedules*. Intertie uncertainty was removed on June 1, 2022.

Equation 2. Bid Range Capacity Test Formulation

$$Requirement = \underbrace{Load}_{\text{Load forecast}} + \underbrace{Export_{base} - Import_{base} - Generation_{base}}_{\text{Intertie and generation base schedules}}$$

If the requirement is positive, then the area must show sufficient incremental bid range capacity to meet the requirement and if the requirement is negative, then sufficient decremental bid range capacity must be shown.

The bid range capacity used to the meet the requirement is calculated relative to the base schedules. For the California ISO (CAISO), the "base" schedules used in the requirement are the advisory schedules from the last binding 15-minute market run. For all other WEIM areas, the export, import, and generation schedules used in the requirement are the base schedules submitted as part of the hourly resource plan.

[17] Net load error in the 15-minute market is calculated from the difference between binding net load forecasts in the 5-minute market and the advisory net load forecast in the 15-minute market. Weekdays use data for the same hour from the last 40 weekdays. For weekends, the last 20 weekend days are used.

[18] California ISO, *Flexible Ramping Product Refinements Final Proposal*, August 31, 2020. http://www.caiso.com/InitiativeDocuments/FinalProposal-FlexibleRampingProductRefinements.pdf

Since the bid range capacity is calculated relative to the base schedules, the upward capacity test can generally be expressed as follows:[19]

$$\underbrace{Generation_{maximum} + Net\ Import_{maximum}}_{\text{Upward capacity}} \geq \underbrace{Load}_{\text{Load forecast (requirement)}}$$

Incremental bid-in generation capacity is calculated as the range between the generation base schedule and the economic maximum, accounting for upward ancillary services and any de-rates (outages). Other resource constraints including start-times and ramp rates are not considered in the capacity test; 15-minute dispatchable imports and exports are included as bid range capacity.

[19] DMM has identified cases when the existing incremental approach for the capacity test relative to base schedules does not equal maximum capacity expected under a total approach. The incremental bid-range capacity can be positive only. If maximum capacity at the time of the test run is below base schedules, this difference will not be accounted for in the test. For more information see DMM's *comments on EIM Resource Sufficiency Evaluation Enhancements Issue Paper,* September 8, 2021: https://stakeholdercenter.caiso.com/Common/DownloadFile/25df1561-236b-4a47-9b1c-717b4a9cf9f0

4 Frequency of resource sufficiency evaluation failures

This section summarizes the frequency and shortfall amount for bid-range capacity test and flexible ramping sufficiency test failures.[20] If a balancing area fails either (or both) of these tests, then transfers between that and the rest of the WEIM areas are limited.

Figure 4.1 through Figure 4.4 show the number of 15-minute intervals in which each WEIM area failed the upward capacity or the flexibility tests as well as the average shortfall of those test failures. Figure 4.5 through Figure 4.8 provide the same information for the downward direction. The dash indicates that the area did not fail the test during the month.

Net load uncertainty was removed from the bid-range capacity test on February 15, 2022. Intertie uncertainty was removed on June 1, 2022. Net load uncertainty is proposed to return to the capacity test in the summer of 2023.[21] This is following the introduction of the new quantile regression methodology for calculating uncertainty that will be deployed as part of the flexible ramping product enhancements expected in February 2023. The CAISO is also proposing to permanently remove intertie uncertainty from the capacity test.

Figure 4.9 summarizes the overlap between failure of the upward capacity and the flexibility tests during the month. The black horizontal line (right axis) shows the number of 15-minute intervals with either a capacity or a flexibility test failure for each WEIM area. The areas are shown in descending number of failure intervals. The bars (left axis) show the percent of the failure intervals that meet the condition.

Figure 4.10 shows the same information for the downward direction. Areas that did not fail either the capacity or the flexibility tests during this period were omitted from the figure.

[20] Results in this section exclude known invalid test failures. These can occur because of a market disruption, software defect, or other errors. Data on invalid test failures may be included in future reports if sufficient interest exists.

[21] California ISO, *EIM Resource Sufficiency Evaluation Enhancements Phase 2 Straw Proposal*, July 1, 2022. http://www.caiso.com/InitiativeDocuments/StrawProposal-WEIMResourceSufficiencyEvaluationEnhancementsPhase2.pdf

Figure 4.1 Frequency of upward capacity test failures (number of intervals)

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
	2021						2022								
Arizona PS	5	—	9	1	—	—	1	1	—	—	—	—	—	—	—
Avista							—	1	—	5	5	1	—	—	—
BANC	1	—	—	—	—	—	—	—	—	—	—	1	8	—	—
BPA									—	3	—	1	13	—	—
California ISO	5	—	—	—	—	—	—	—	—	—	—	—	3	—	—
Idaho Power	3	—	—	—	—	3	—	—	—	—	—	5	5	—	—
LADWP	—	8	5	2	—	—	—	—	—	—	1	—	—	—	—
NorthWestern	6	253	34	7	9	2	—	1	—	—	—	4	4	—	5
NV Energy	7	8	—	—	—	—	—	5	4	1	3	—	—	—	—
PacifiCorp East	6	4	—	—	—	—	—	—	—	—	—	—	2	—	—
PacifiCorp West	3	2	14	11	8	3	9	1	6	1	29	5	1	—	1
Portland GE	41	13	6	11	3	—	—	—	—	—	—	2	—	—	8
Powerex	2	15	6	6	6	—	—	4	—	—	—	7	—	—	1
PSC New Mexico	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Puget Sound En	17	29	18	10	—	—	—	1	1	5	—	—	5	4	1
Salt River Proj.	56	3	20	—	—	—	6	42	30	7	5	13	12	5	1
Seattle City Light	14	4	—	4	—	—	2	—	—	—	5	4	6	1	1
Tacoma Power							—	17	3	1	1	6	1	—	—
Tucson Elec.									—	—	—	2	—	—	—
Turlock ID	22	46	—	—	—	—	—	—	—	4	—	—	—	—	—

Figure 4.2 Average shortfall of upward capacity test failures (MW)

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
	2021						2022								
Arizona PS	97	—	80	20	—	—	64	3	—	—	—	—	—	—	—
Avista							—	1	—	6	27	5	—	—	—
BANC	6	—	—	—	—	—	—	—	—	—	—	37	264	—	—
BPA									—	81	—	8	336	—	—
California ISO	125	—	—	—	—	—	—	—	—	—	—	—	141	—	—
Idaho Power	6	—	—	—	—	3	—	—	—	—	—	60	37	—	—
LADWP	—	95	103	40	—	—	—	—	—	—	0	—	—	—	—
NorthWestern	9	38	31	14	39	3	—	1	—	—	—	86	64	—	91
NV Energy	42	57	—	—	—	—	—	37	67	2	36	—	—	—	—
PacifiCorp East	63	79	—	—	—	—	—	—	—	—	—	—	124	—	—
PacifiCorp West	36	2	15	85	33	41	77	3	11	50	24	36	4	—	17
Portland GE	38	31	32	15	32	—	—	—	—	—	—	1	—	—	25
Powerex	22	78	70	148	216	—	—	364	—	—	—	142	—	—	50
PSC New Mexico	57	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Puget Sound En	46	33	54	39	—	—	—	13	1	27	—	—	13	24	5
Salt River Proj.	74	27	27	—	—	—	28	50	44	51	41	214	132	30	17
Seattle City Light	151	53	—	16	—	—	13	—	—	—	15	9	7	5	2
Tacoma Power							—	77	2	1	3	6	0	—	—
Tucson Elec.									—	—	—	20	—	—	—
Turlock ID	7	8	—	—	—	—	—	—	—	104	—	—	—	—	—

Figure 4.3 Frequency of upward flexibility test failures (number of intervals)

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
	2021						2022								
Arizona PS	7	—	10	1	1	5	2	—	—	—	1	2	—	—	2
Avista							—	7	15	28	14	4	—	2	—
BANC	—	—	—	—	—	—	—	—	—	—	—	—	9	—	—
BPA									24	90	99	30	33	5	2
California ISO	11	—	3	—	—	—	—	—	—	—	—	2	13	1	—
Idaho Power	—	—	—	1	—	6	—	—	—	—	5	6	13	—	3
LADWP	—	1	1	10	—	—	3	—	—	—	—	—	2	2	—
NorthWestern	46	247	14	14	—	4	4	8	—	4	9	30	5	—	13
NV Energy	4	8	1	1	1	20	11	28	22	6	—	3	4	4	7
PacifiCorp East	4	—	2	1	1	1	—	4	4	3	5	4	—	3	—
PacifiCorp West	—	—	16	7	1	1	2	7	4	1	—	2	3	—	4
Portland GE	—	1	—	5	10	1	—	—	—	1	12	4	2	6	29
Powerex	—	7	5	8	7	1	—	4	—	—	—	10	3	—	—
PSC New Mexico	2	—	2	—	—	—	2	1	4	—	11	—	1	7	4
Puget Sound En	—	—	2	—	—	—	1	2	—	2	13	7	8	—	1
Salt River Proj.	24	5	36	1	5	—	19	14	5	13	19	34	17	19	13
Seattle City Light	4	—	—	—	—	—	2	—	—	—	6	1	7	—	3
Tacoma Power							—	—	4	3	1	2	4	—	5
Tucson Elec.									2	—	—	—	11	1	—
Turlock ID	2	5	—	—	—	—	—	—	—	—	—	—	3	—	—

Figure 4.4 Average shortfall of upward flexibility test failures (MW)

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
	2021						2022								
Arizona PS	42	—	45	33	37	45	120	—	—	—	28	28	—	—	15
Avista							—	18	29	26	19	30	—	5	—
BANC	—	—	—	—	—	—	—	—	—	—	—	—	237	—	—
BPA									68	71	50	56	232	43	42
California ISO	735	—	540	—	—	—	—	—	—	—	—	684	671	53	—
Idaho Power	—	—	—	5	—	31	—	—	—	—	13	34	45	—	14
LADWP	—	10	11	97	—	—	106	—	—	—	—	—	36	9	—
NorthWestern	25	31	27	12	—	33	59	20	—	10	15	22	83	—	45
NV Energy	94	82	110	31	37	42	55	61	66	89	—	80	88	41	91
PacifiCorp East	21	—	57	10	124	59	—	83	77	9	34	43	—	16	—
PacifiCorp West	—	—	74	67	3	7	33	58	24	5	—	31	28	—	62
Portland GE	—	11	—	18	36	37	—	—	—	8	72	25	16	19	46
Powerex	—	50	88	41	202	26	—	366	—	—	—	318	101	—	—
PSC New Mexico	47	—	69	—	—	—	46	23	33	—	70	—	22	38	39
Puget Sound En	—	—	82	—	—	—	3	32	—	49	46	17	21	—	29
Salt River Proj.	50	32	65	10	43	—	45	36	43	89	45	156	72	61	38
Seattle City Light	14	—	—	—	—	—	8	—	—	—	17	2	8	—	4
Tacoma Power							—	—	206	6	3	5	3	—	16
Tucson Elec.									22	—	—	—	44	5	—
Turlock ID	2	18	—	—	—	—	—	—	—	—	—	—	3	—	—

Figure 4.5 Frequency of downward capacity test failures (number of intervals)

	2021 Sep	2021 Oct	2021 Nov	2021 Dec	2021 Jan	2021 Feb	2022 Mar	2022 Apr	2022 May	2022 Jun	2022 Jul	2022 Aug	2022 Sep	2022 Oct	2022 Nov
Arizona PS	—	—	5	—	10	—	—	—	1	1	—	—	—	—	—
Avista							—	—	—	—	5	—	—	1	—
BANC	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
BPA									—	—	—	—	3	—	—
California ISO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Idaho Power	—	—	4	—	—	—	—	—	17	—	—	—	—	—	—
LADWP	—	5	—	—	10	—	—	—	7	—	—	—	—	—	—
NorthWestern	—	29	—	—	—	—	—	—	—	—	—	—	—	—	—
NV Energy	—	—	—	—	—	—	—	—	3	12	—	—	—	—	—
PacifiCorp East	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PacifiCorp West	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Portland GE	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
Powerex	24	9	1	—	4	—	4	—	4	—	—	1	—	—	1
PSC New Mexico	—	7	4	—	—	—	4	—	2	—	—	—	—	—	—
Puget Sound En	—	1	—	—	—	—	—	—	1	20	2	—	—	—	—
Salt River Proj.	—	—	—	1	—	5	10	—	12	15	2	6	32	5	8
Seattle City Light	1	—	7	5	—	—	2	—	—	1	3	—	6	—	—
Tacoma Power							—	22	2	—	19	8	—	4	—
Tucson Elec.									—	1	—	—	—	—	—
Turlock ID	5	20	3	1	2	1	—	4	—	—	—	—	—	—	—

Figure 4.6 Average shortfall of downward capacity test failures (MW)

	2021 Sep	2021 Oct	2021 Nov	2021 Dec	2021 Jan	2021 Feb	2022 Mar	2022 Apr	2022 May	2022 Jun	2022 Jul	2022 Aug	2022 Sep	2022 Oct	2022 Nov
Arizona PS	—	—	63	—	240	—	—	—	33	19	—	—	—	—	—
Avista							—	—	—	—	52	—	—	14	—
BANC	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
BPA									—	—	—	—	31	—	—
California ISO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Idaho Power	—	—	38	—	—	—	—	—	7	—	—	—	—	—	—
LADWP	—	30	—	—	33	—	—	—	34	—	—	—	—	—	—
NorthWestern	—	55	—	—	—	—	—	—	—	—	—	—	—	—	—
NV Energy	—	—	—	—	—	—	—	—	53	41	—	—	—	—	—
PacifiCorp East	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PacifiCorp West	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Portland GE	—	—	—	—	—	—	—	—	—	23	—	—	—	—	—
Powerex	144	51	7	—	48	—	90	—	175	—	—	13	—	—	12
PSC New Mexico	—	22	65	—	—	—	40	—	6	—	—	—	—	—	—
Puget Sound En	—	33	—	—	—	—	—	—	61	31	19	—	—	—	—
Salt River Proj.	—	—	—	8	—	12	12	—	41	46	8	72	27	11	14
Seattle City Light	5	—	18	10	—	—	9	—	—	2	7	—	6	—	—
Tacoma Power							—	29	3	—	5	8	—	33	—
Tucson Elec.									—	6	—	—	—	—	—
Turlock ID	2	5	1	3	1	1	—	3	—	—	—	—	—	—	—

Figure 4.7 Frequency of downward flexibility test failures (number of intervals)

	Sep 2021	Oct 2021	Nov 2021	Dec 2021	Jan 2022	Feb 2022	Mar 2022	Apr 2022	May 2022	Jun 2022	Jul 2022	Aug 2022	Sep 2022	Oct 2022	Nov 2022
Arizona PS	2	3	15	11	43	11	25	10	15	6	—	—	4	7	5
Avista							—	—	—	2	—	—	3	5	—
BANC	—	—	—	4	—	—	3	1	2	2	—	—	—	—	—
BPA									4	7	—	1	10	—	6
California ISO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Idaho Power	—	—	8	1	—	1	—	8	13	—	—	1	—	—	—
LADWP	—	2	—	—	4	—	—	—	—	—	—	—	—	—	—
NorthWestern	33	68	4	1	—	—	—	—	16	56	6	—	—	—	1
NV Energy	48	34	11	13	17	111	50	92	39	52	19	7	13	14	18
PacifiCorp East	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PacifiCorp West	—	—	1	—	—	—	1	1	3	11	16	—	—	2	—
Portland GE	—	—	—	—	—	—	—	—	—	7	—	—	—	—	—
Powerex	29	12	1	4	—	1	7	1	9	6	—	4	2	3	—
PSC New Mexico	4	11	20	4	9	1	36	10	53	19	1	1	6	6	4
Puget Sound En	—	—	1	—	—	—	—	—	6	66	2	—	—	4	—
Salt River Proj.	1	2	1	2	2	28	46	6	11	14	6	7	28	7	25
Seattle City Light	—	—	1	1	—	—	2	4	4	9	2	23	10	—	6
Tacoma Power							—	11	8	—	14	6	—	—	—
Tucson Elec.									—	—	—	—	—	—	1
Turlock ID	—	18	3	5	6	—	14	16	4	13	3	2	—	—	4

Figure 4.8 Average shortfall of downward flexibility test failures (MW)

	Sep 2021	Oct 2021	Nov 2021	Dec 2021	Jan 2022	Feb 2022	Mar 2022	Apr 2022	May 2022	Jun 2022	Jul 2022	Aug 2022	Sep 2022	Oct 2022	Nov 2022
Arizona PS	27	36	81	51	69	32	42	54	58	33	—	—	81	20	28
Avista							—	—	—	20	—	—	11	20	—
BANC	—	—	—	71	—	—	18	7	5	15	—	—	—	—	—
BPA									212	55	—	4	149	—	77
California ISO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Idaho Power	—	—	31	40	—	43	—	18	55	—	—	13	—	—	—
LADWP	—	5	—	—	43	—	—	—	—	—	—	—	—	—	—
NorthWestern	17	25	21	7	—	—	—	—	12	27	14	—	—	—	2
NV Energy	83	39	34	24	44	92	55	86	49	98	151	59	58	43	28
PacifiCorp East	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PacifiCorp West	—	—	32	—	—	—	4	15	55	28	11	—	—	12	—
Portland GE	—	—	—	—	—	—	—	—	—	18	—	—	—	—	—
Powerex	121	101	16	163	—	15	184	3	257	244	—	87	62	86	—
PSC New Mexico	102	56	41	223	77	15	64	40	144	34	3	9	40	16	15
Puget Sound En	—	—	16	—	—	—	—	—	54	33	47	—	—	11	—
Salt River Proj.	100	22	4	11	45	35	49	74	62	34	54	155	42	42	113
Seattle City Light	—	—	2	3	—	—	10	6	7	11	10	21	10	—	24
Tacoma Power							—	5	14	—	5	4	—	—	—
Tucson Elec.									—	—	—	—	—	—	14
Turlock ID	—	16	3	94	9	—	5	20	5	6	3	2	—	—	5

Figure 4.9 Upward capacity/flexibility test failure intervals by concurrence (November 2022)

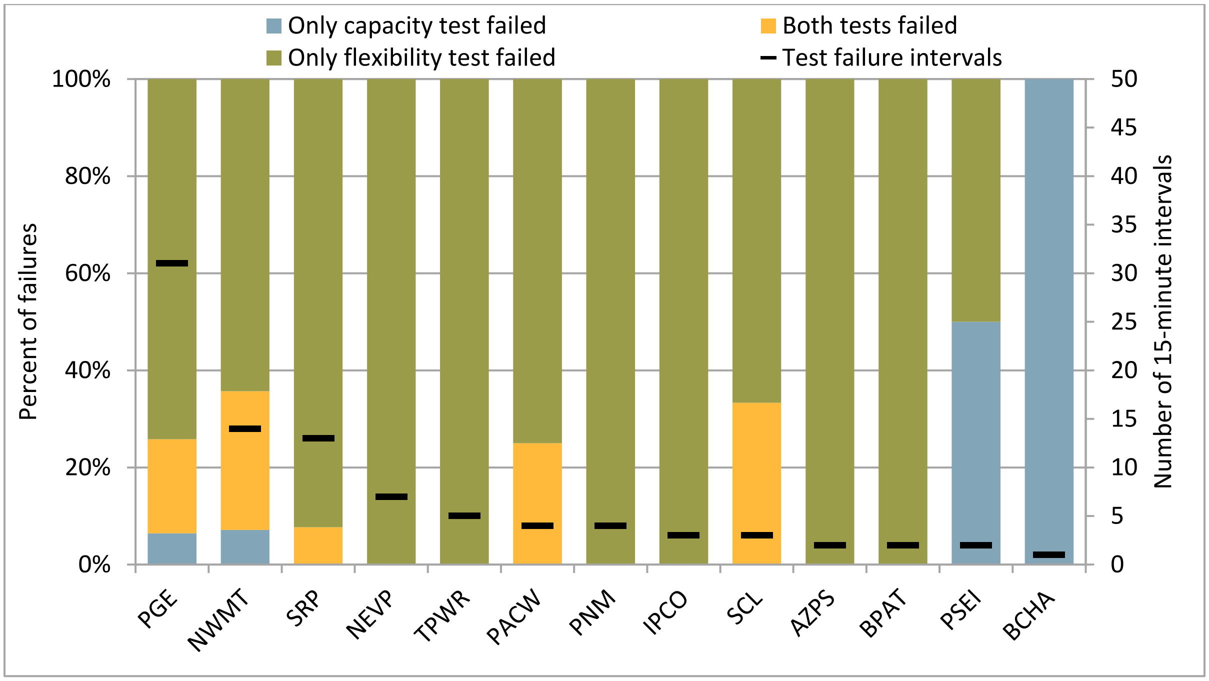
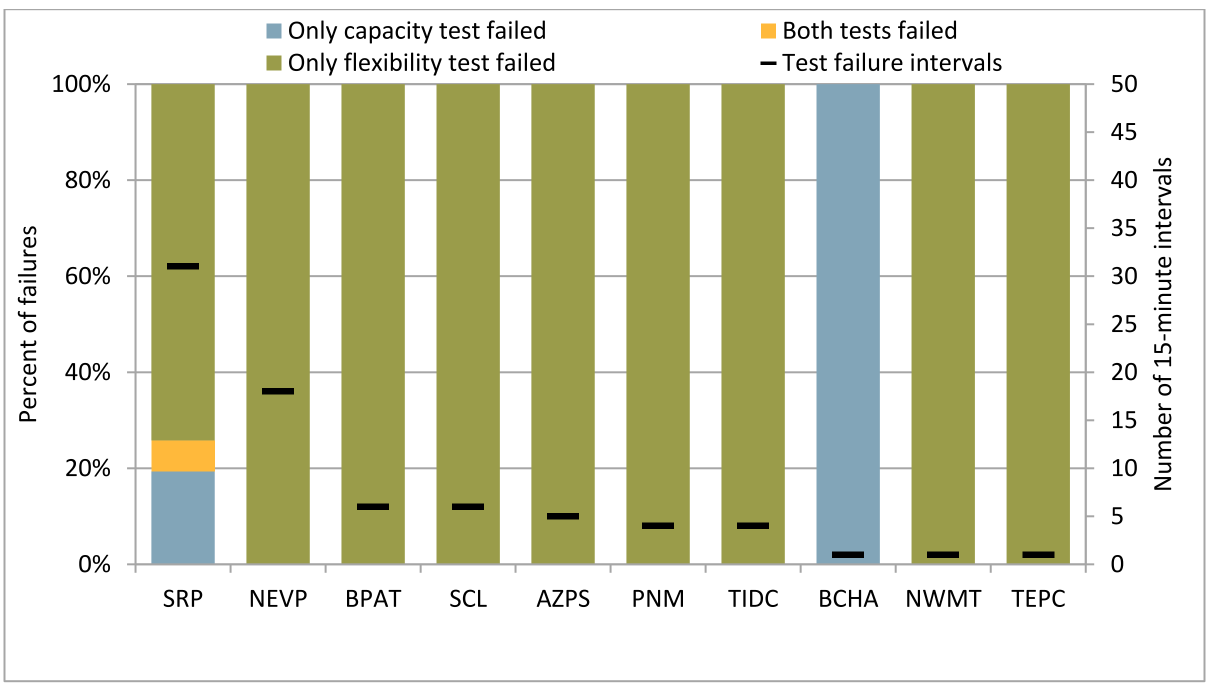


Figure 4.10 Downward capacity/flexibility test failure intervals by concurrence (November 2022)



5 WEIM limits and transfers following test failure

This section summarizes the import limits that are imposed when a WEIM entity fails either the bid-range capacity or the flexible ramping sufficiency test in the upward direction. These limits are also compared against actual WEIM transfers during these insufficiency periods.

WEIM import limits following test failure

When either test fails in the upward direction, imports will be capped at the greater of (1) the base transfer or (2) the transfer from the last 15-minute market interval. Figure 5.1 summarizes the import limits after failing either test by the source of the limit. The black horizontal line (right axis) shows the number of 15-minute intervals with either a capacity or a flexibility test failure while the bars (left axis) show the percent of failure intervals in which the WEIM import limit was capped by either the base transfer or the last 15-minute market transfer.

Figure 5.1 Upward capacity/flexibility test failure intervals by source of import limit (November 2022)

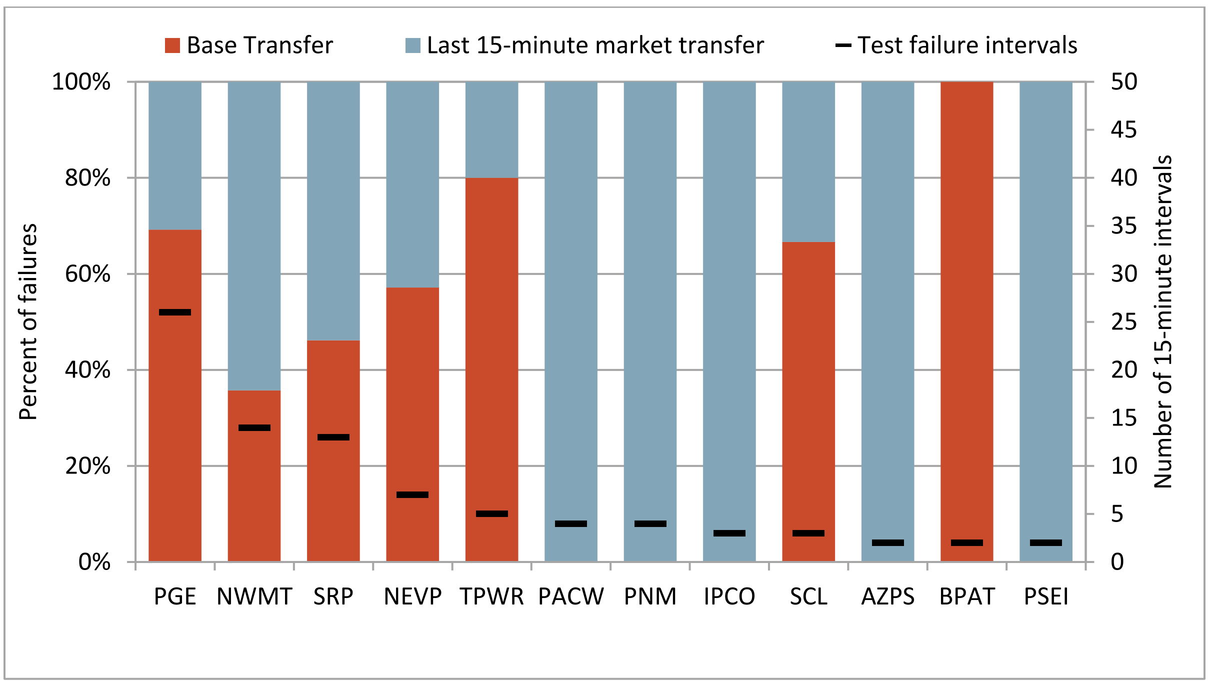
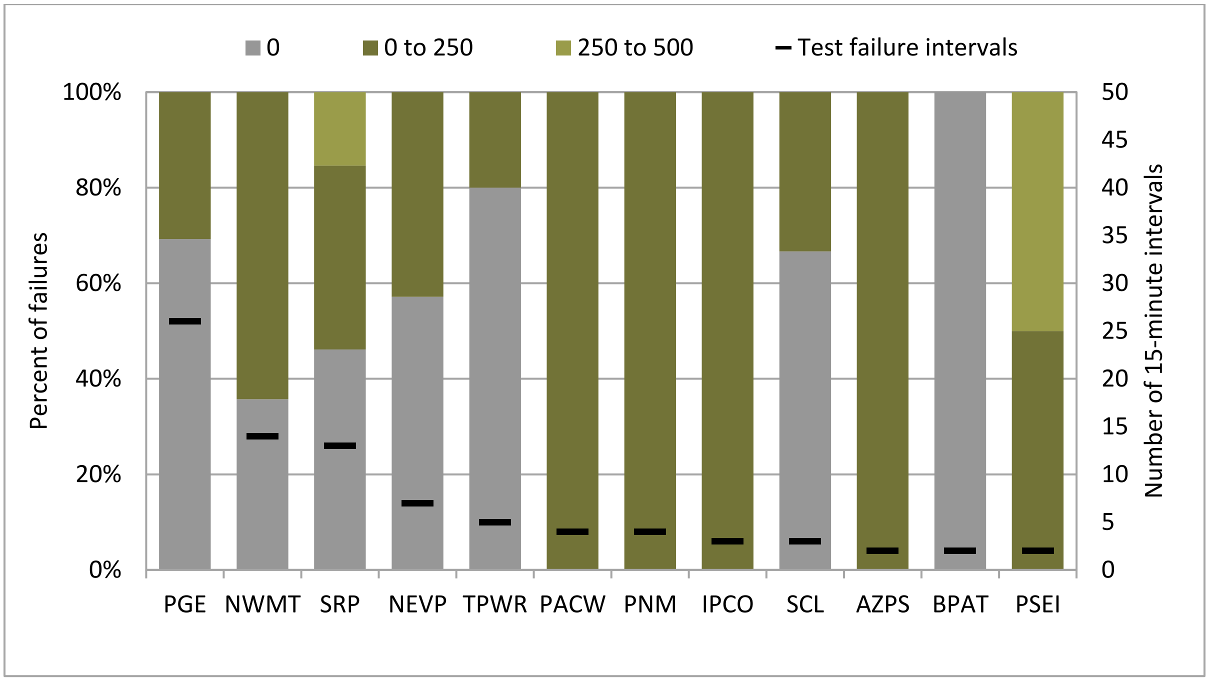


Figure 5.2 summarizes dynamic WEIM import limits above base transfers (fixed bilateral transactions between WEIM entities) after failing either test in the upward direction.[22] From this perspective, the incremental WEIM import limit after a test failure is set by the greater of (1) zero or (2) the transfer from the last 15-minute market interval minus the current base transfer. Therefore, the dynamic import limits show the incremental flexibility available through the WEIM after a resource sufficiency evaluation failure. The black horizontal line (right axis) shows the number of 15-minute intervals with an import limit imposed after a test failure. Areas without any upward test failures during the month were excluded.

[22] Test failure intervals in which an import limit was not imposed because it was at or above the unconstrained total import capacity were excluded from this summary.

Figure 5.2 Upward capacity/flexibility test failure intervals by dynamic import limit (November 2022)



WEIM transfers following a test failure

The previous section looked at WEIM import limits imposed following a resources sufficiency evaluation failure. This section instead summarizes optimized WEIM transfers during these failure periods.

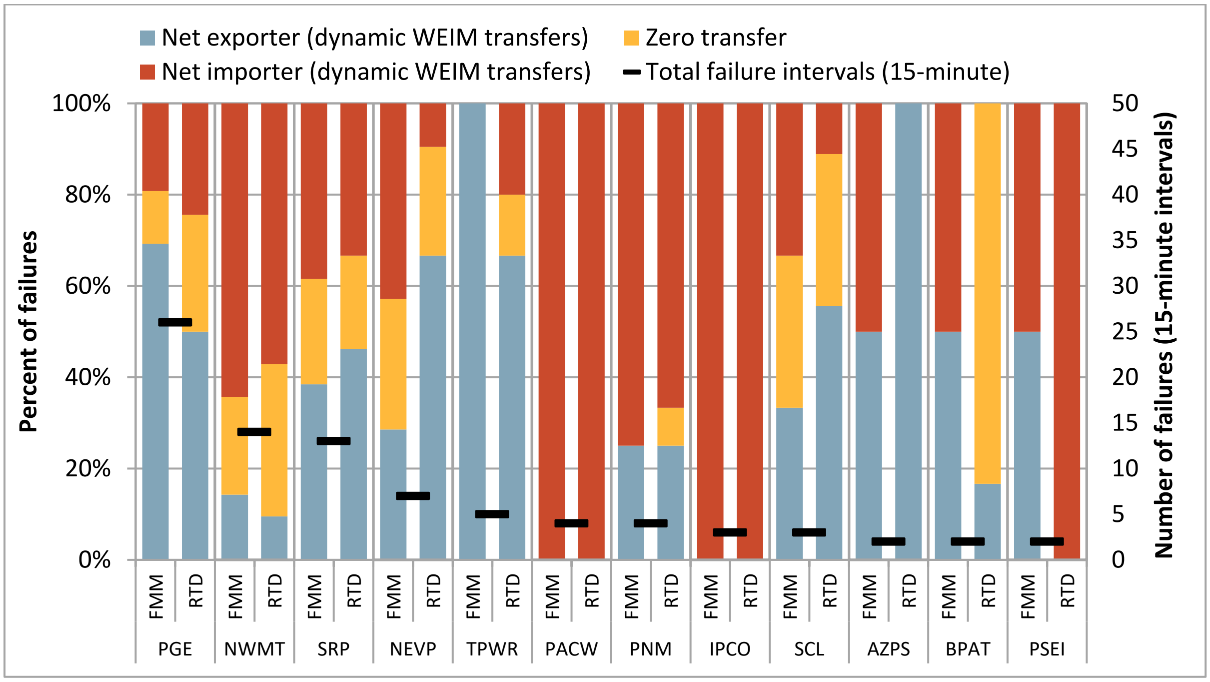
Figure 5.3 summarizes dynamic WEIM transfers (excluding any base transfer) on net for each area during an upward resource sufficiency evaluation failure in the month. Again, the black horizontal line (right axis) shows the number of 15-minute intervals with either a capacity or a flexibility test failure while the bars (left axis) show the percent of failure intervals in which the balancing area was a net importer or net exporter in the corresponding real-time market interval. Figure 5.4 summarizes the same information with the net transfer quantity categorized by various levels.

As shown by Figure 5.3, WEIM balancing areas were commonly optimized as a net exporter during the month despite failing the resource sufficiency evaluation. This result is in part driven from net load uncertainty that is included in the flexibility test. In some cases, the balancing area would fail the resource sufficiency evaluation in part because of the uncertainty component, but then in the real-time market it could then be economically optimal to export if that uncertainty does not materialize.

Other factors can also contribute to this outcome as a net exporter. First, a decrease in the load forecast (or increase in wind or solar forecasts) from the resource sufficiency evaluation to the real-time market run can lead to greater resource sufficiency and WEIM exports. A negative imbalance conformance adjustment entered by WEIM operators can also be included in the market run as effectively lower load, but will not be included in the resource sufficiency evaluation.

Figure 5.5 summarizes whether the import limit that was imposed after failing either test in the upward direction ultimately impacted market transfers.[23] It shows the percent of failure intervals in which the resulting transfers are constrained to the limit imposed after failing the test. These results are shown separately for the 15-minute (FMM) and 5-minute (RTD) markets.

Figure 5.3 Upward test failure by dynamic net WEIM transfer status (November 2022)



[23] Again, test failure intervals in which an import limit was not imposed because it was at or above the unconstrained total import capacity were excluded from this summary.

Figure 5.4 Upward test failure by dynamic net WEIM transfer amount (November 2022)

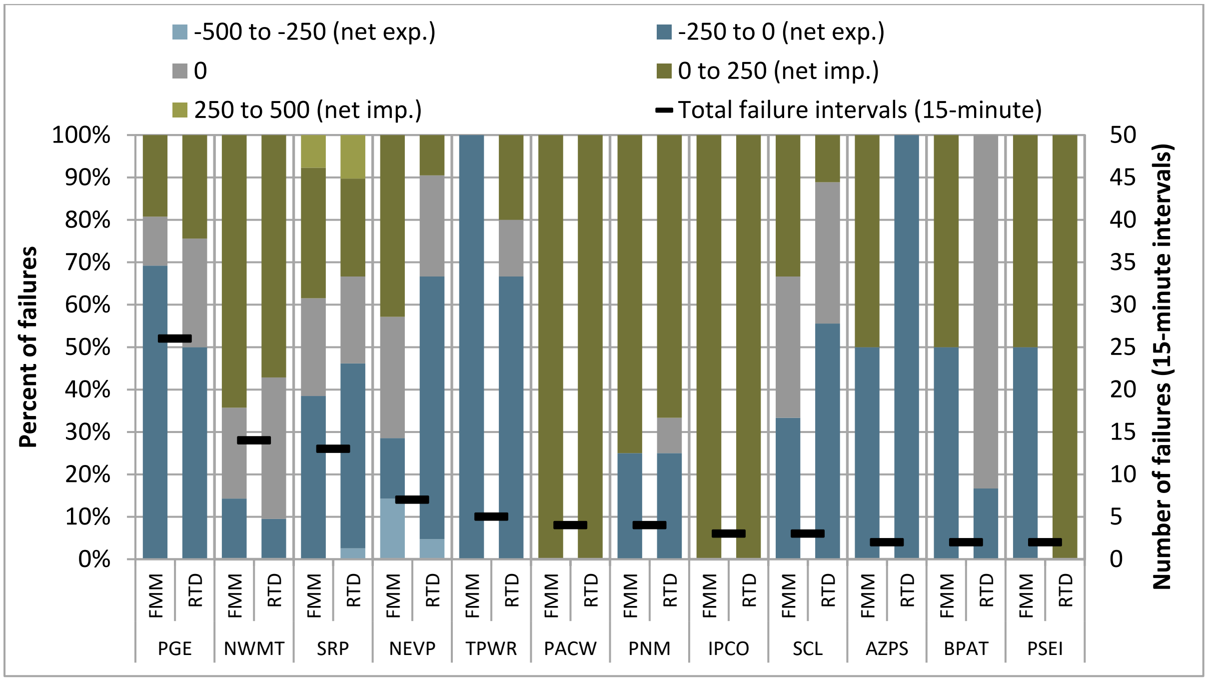
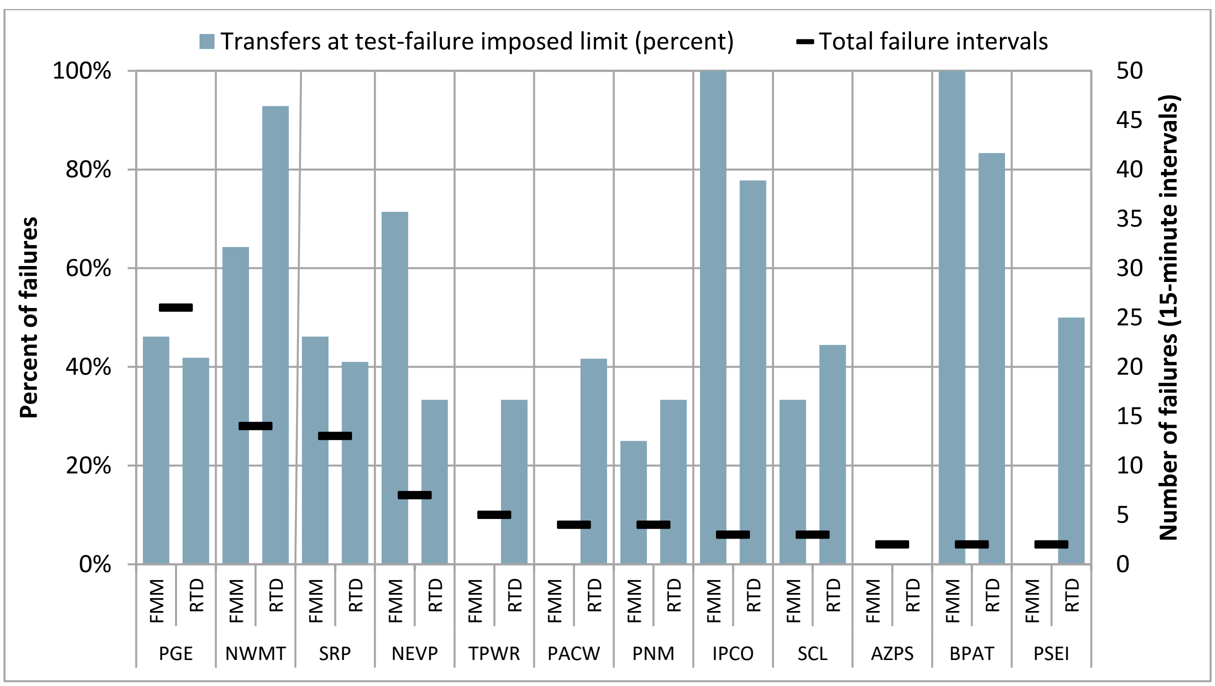


Figure 5.5 Percent of upward test failure intervals with market transfers at the imposed cap (November 2022)



6 Load conformance in the Western Energy Imbalance Market

Operators in every balancing area of the Western Energy Imbalance Market, including the California ISO, can manually adjust the load through load conformance adjustments. These adjustments, sometimes referred to as *load bias* or *imbalance conformance,* are not used directly in either the bid range capacity or the flexible ramp sufficiency tests; however, they can indirectly impact test results in several ways.

The flexible ramp sufficiency test measures ramping capacity from the start of the hour (*i.e. last binding 15-minute interval*) compared to the load forecast. Here, imbalance conformance adjustments entered prior to the test-hour can impact internal generation at the initial reference point and ramping capacity measured from that point.

The bid-range capacity test requirement includes all import and export base schedules.[24] Additional imports and exports (relative to these base schedules) that are *15-minute-dispatchabale* are then included as incremental or decremental capacity. Thus, the maximum of 15-minute-dispatchable imports would be included in the capacity test regardless of the dispatch. However, imbalance conformance adjustments made by the CAISO operators in the hour-ahead market can impact non-15-minute dispatchable import and export schedules included in the requirement.

The penalty for failing either the upward capacity or the flexibility test is that WEIM transfers are capped by the greater of the transfer in the last 15-minute interval prior to the hour or base transfers. Due to this, a higher imbalance conformance adjustment entered prior to the hour can increase transfers into the balancing area resulting in higher transfer limits following a failure, than would have occurred otherwise.

The CAISO is not proposing any changes in the *WEIM resource sufficiency evaluation* to account for operator imbalance conformance.[25]

Figure 6.1 summarizes average hour-ahead and 15-minute market imbalance conformance adjustments entered by the CAISO operators during the month. Between peak hours 17 and 21, 15-minute market imbalance conformance averaged around 1,675 MW. Figure 6.2 shows the hourly distribution of 15-minute market imbalance conformance.

Figure 6.3 shows imbalance conformance adjustments for WEIM entities with substantial imbalance conformance and Figure 6.4 shows adjustments as a percent of total load.[26]

Table 6.1 summarizes the average frequency and size of 15-minute and 5-minute market imbalance conformance for all balancing authority areas.

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[24] For the CAISO, the base schedules used in the requirement are the advisory schedules from the last 15-minute market run.

[25] California ISO, *EIM Resource Sufficiency Evaluation Enhancements Phase 2 Straw Proposal*, July 1, 2022. http://www.caiso.com/InitiativeDocuments/StrawProposal-WEIMResourceSufficiencyEvaluationEnhancementsPhase2.pdf

[26] WEIM entities with an average absolute 15-minute market imbalance conformance of less than 1 MW or less than 0.1 percent of load were omitted from the chart.

Figure 6.1 Average CAISO hour-ahead and 15-minute market load conformance (November 2022)

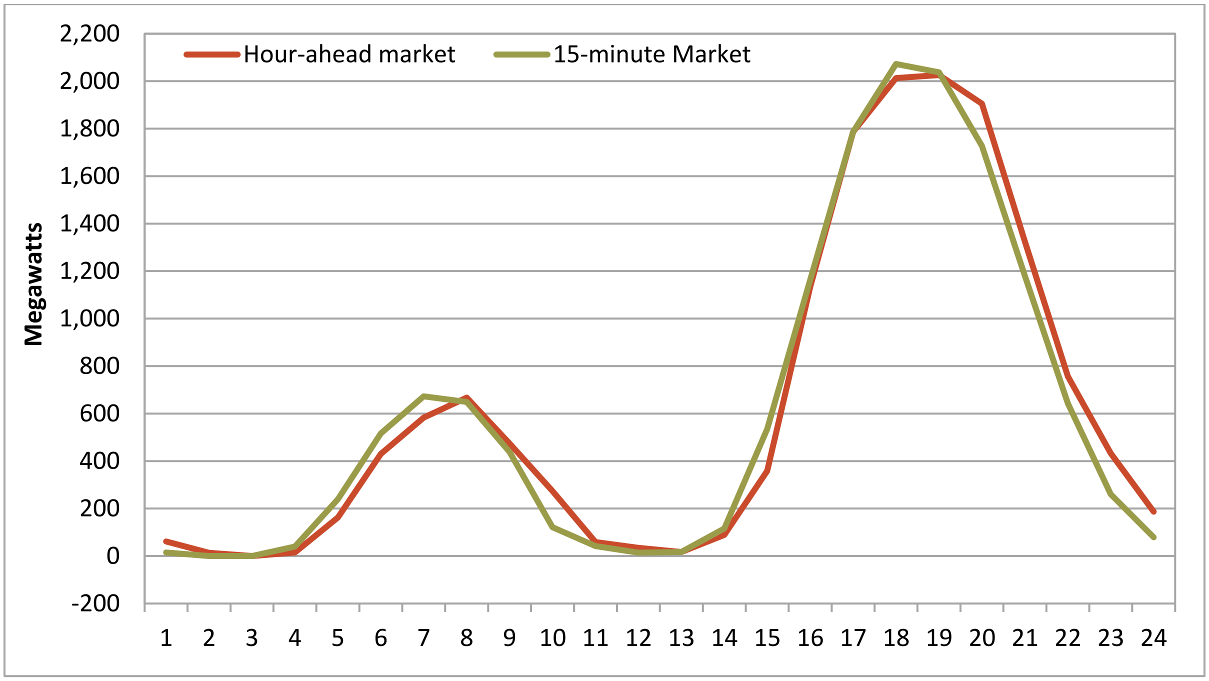


Figure 6.2 Distribution of CAISO load conformance (November 2022)

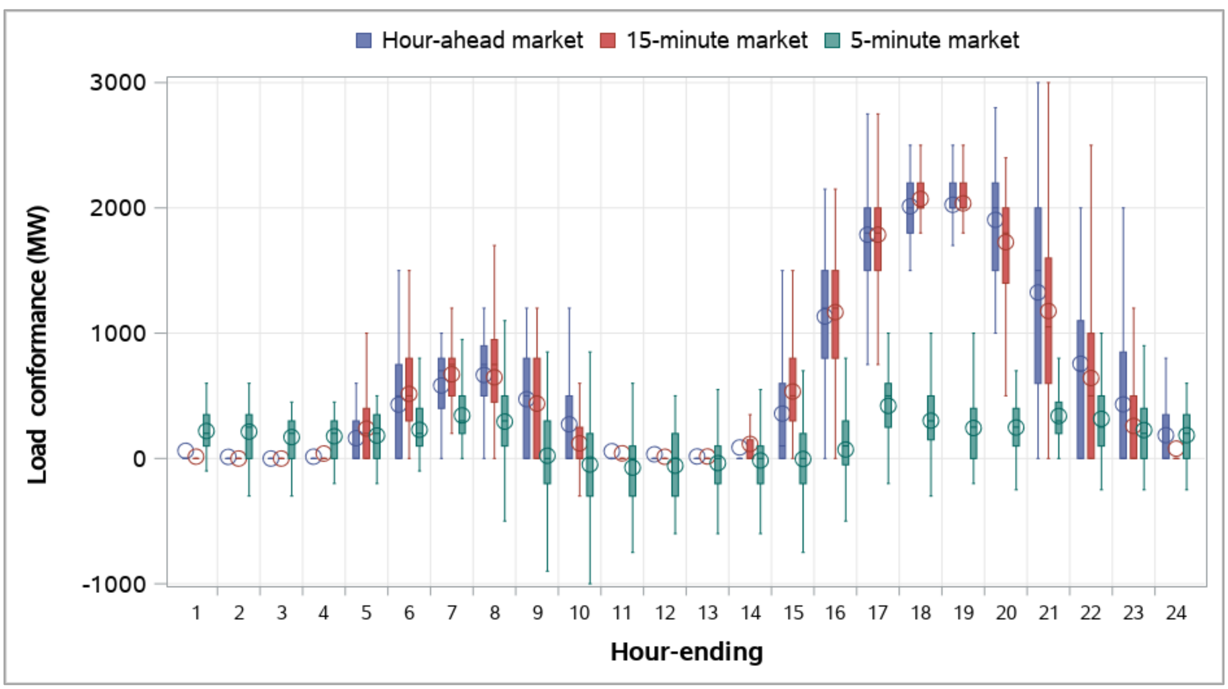


Figure 6.3 Average hourly 15-minute market load conformance (November 2022)

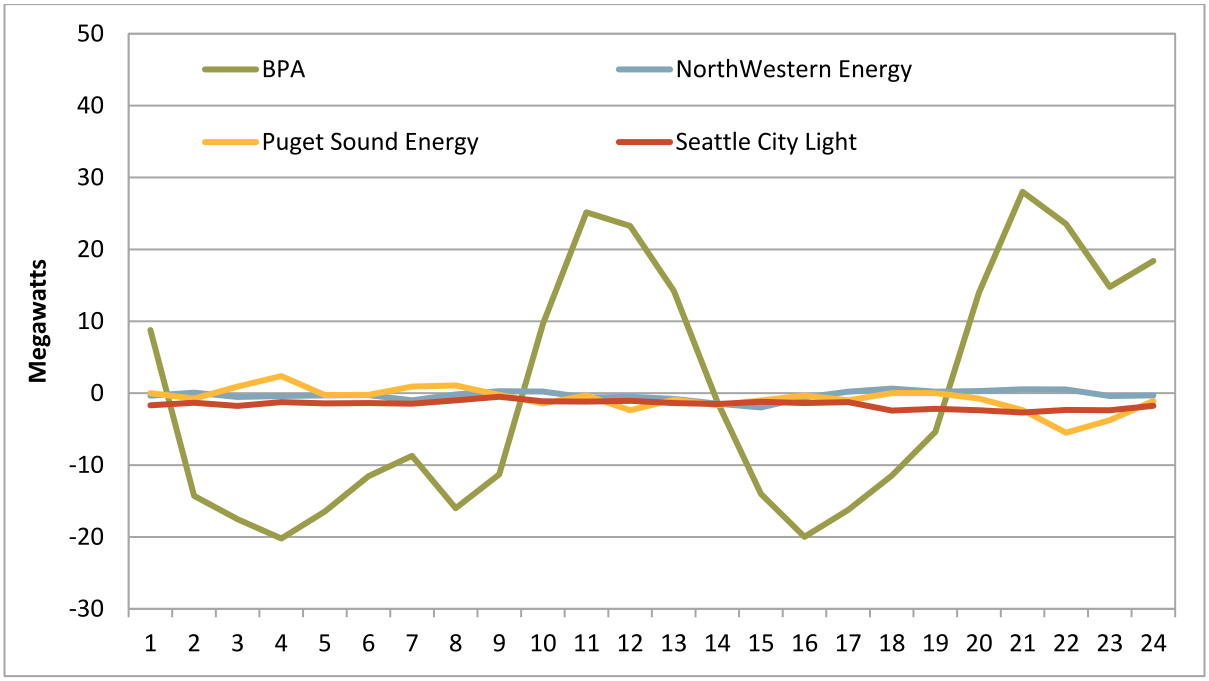


Figure 6.4 Average hourly 15-minute market load conformance *as a percent of load* (November 2022)

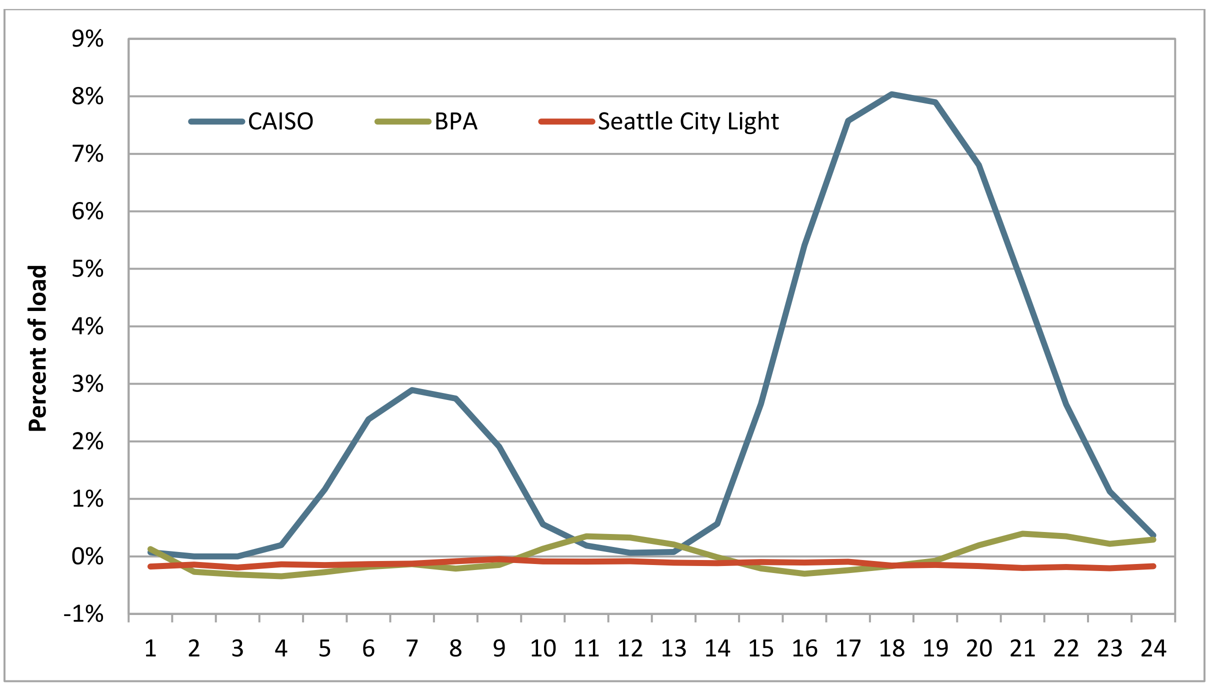


Table 6.1 Average frequency and size of load conformance (November 2022)

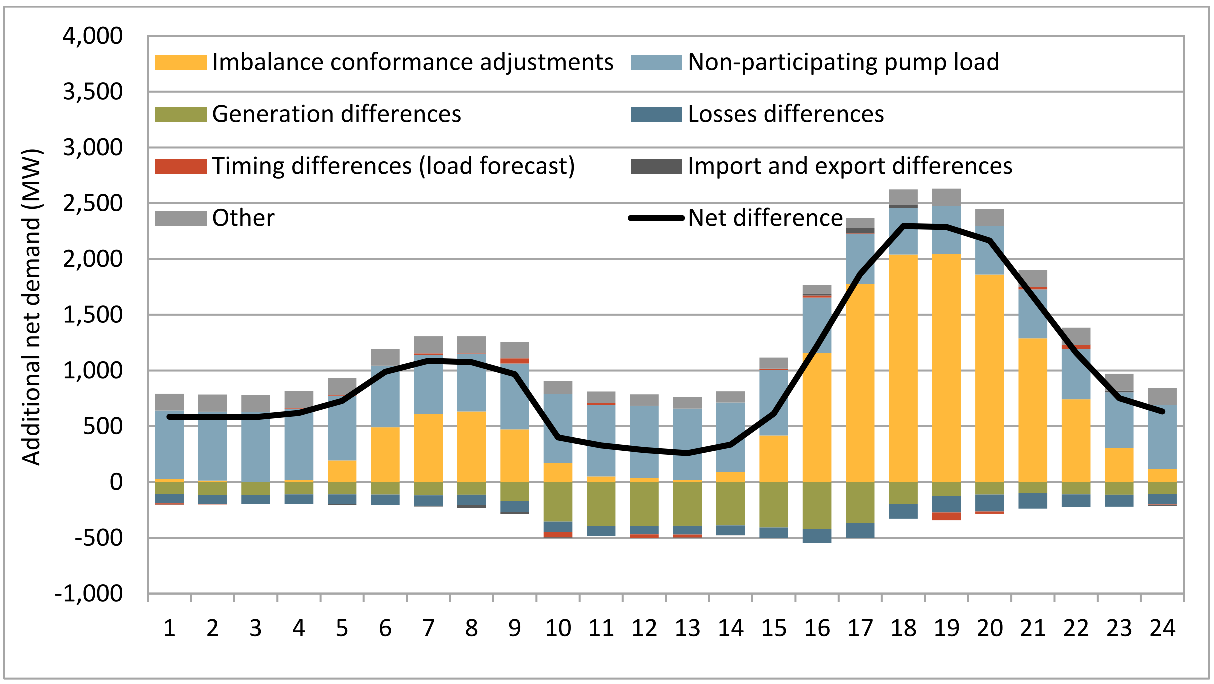
		Positive load conformance			Negative load conformance			Average hourly adjustment MW
Balancing area	***Market***	**Percent of intervals**	**Average MW**	**Percent of total load**	**Percent of intervals**	**Average MW**	**Percent of total load**	
Arizona Public Service	15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
	5-minute market	44%	97	3.4%	25%	-69	2.6%	26
Avista	15-minute market	0%	N/A	N/A	0.3%	-26	1.7%	0
	5-minute market	1%	18	1.3%	44%	-21	1.5%	-9
Balancing Authority of Northern California	15-minute market	0.03%	100	5.8%	0.1%	-50	3.0%	0
	5-minute market	0.1%	100	5.7%	0.7%	-43	2.6%	0
Bonneville Power Administration	15-minute market	50%	30	0.4%	49%	-31	0.5%	0
	5-minute market	49%	30	0.4%	49%	-31	0.5%	0
California ISO	15-minute market	52%	1160	5.0%	0.3%	-300	1.4%	599
	5-minute market	64%	332	1.5%	16%	-293	1.4%	166
Idaho Power	15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
	5-minute market	18%	47	2.4%	15%	-45	2.4%	2
Los Angeles Department of Water and Power	15-minute market	0.5%	47	2.0%	0.6%	-63	3.0%	0
	5-minute market	11%	45	1.9%	21%	-49	2.2%	-5
NorthWestern Energy	15-minute market	3%	12	0.8%	6%	-11	0.8%	0
	5-minute market	8%	14	1.0%	14%	-13	0.9%	-1
NV Energy	15-minute market	0.07%	100	2.7%	0%	N/A	N/A	0
	5-minute market	48%	101	2.7%	9%	-107	3.0%	39
PacifiCorp East	15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
	5-minute market	14%	95	1.7%	32%	-115	2.1%	-23
PacifiCorp West	15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
	5-minute market	14%	66	2.7%	4%	-50	1.9%	8
Portland General Electric	15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
	5-minute market	4%	30	1.0%	2%	-62	2.3%	0
Public Service Company of New Mexico	15-minute market	0.3%	60	4.0%	0%	N/A	N/A	0
	5-minute market	55%	66	4.5%	2%	-62	4.3%	35
Puget Sound Energy	15-minute market	0.9%	49	1.6%	3%	-45	1.4%	-1
	5-minute market	2%	46	1.5%	45%	-39	1.2%	-17
Salt River Project	15-minute market	1%	62	2.1%	0%	N/A	N/A	1
	5-minute market	10%	62	2.1%	0.9%	-66	2.4%	5
Seattle City Light	15-minute market	0.3%	13	1.0%	8%	-20	1.7%	-2
	5-minute market	3%	17	1.4%	77%	-23	1.9%	-17
Tacoma Power	15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
	5-minute market	5%	12	2.0%	6%	-13	2.2%	0
Tucson Electric Power	15-minute market	0.03%	100	9.5%	0%	N/A	N/A	0
	5-minute market	9%	49	4.5%	15%	-52	4.8%	-3
Turlock Irrigation District	15-minute market	0%	N/A	N/A	0.1%	-50	19.6%	0
	5-minute market	0%	N/A	N/A	0.2%	-40	15.6%	0

7 Input differences between the resource sufficiency evaluation and latest 15-minute market run

This section summarizes supply and demand input differences between those considered in the bid-range capacity test requirement and those considered in the advisory intervals from the latest market run immediately prior to the resource sufficiency evaluation for the same period. The bid-range capacity test requires that each area show sufficient incremental bid-in capacity to meet the imbalance between load, intertie, and generation base schedules that exists without WEIM transfers. For the CAISO, the base schedules used in the requirement are from the advisory schedules from the latest 15-minute market run.

The capacity test measures whether an area can meet its own load forecast without WEIM transfers. However, the inputs used in the capacity test requirement can differ from those in the market (beyond removing WEIM transfers). Figure 7.1 summarizes these differences by source. The figure shows additional net demand in the latest 15-minute market run that is not accounted for by the capacity test, on average for the month. These categories are listed and described further below.

Figure 7.1 Additional CAISO net demand in the latest 15-minute market run not accounted for in the bid-range capacity test (November 2022)



The list below summarizes some of the differences identified between inputs in the resource sufficiency evaluation and in the latest 15-minute market run.

- **Imbalance conformance adjustments.** These adjustments are included in the market optimization as changes in load, but are not included in the bid-range capacity test. This accounted for most of the differences.
- **Non-participating pump load.** This is pumping load that is bid and scheduled as non-participating load in the day-ahead market, and is included as a component of total load in the market optimization. This is not included in the bid-range capacity test requirement.

- **Hourly block import schedules versus intertie ramping.** The bid-range capacity test imbalance requirement uses the hourly block schedules for import and export resources. The market optimization uses more granular 15-minute values, which account for intertie ramping between hours. This can create import and export differences at the start and end of the hour.
- **Losses differences.** The bid-range capacity test uses the raw load forecast directly, which already factors in losses. The market optimization uses this, instead as an input, removes the estimated portion of losses, and allows the market to solve for it. Thus, there can be differences between the estimated losses considered in the bid-range capacity test and the market losses.
- **Timing differences.** There are slight timing differences between the latest 15-minute market run and the binding resource sufficiency evaluation, which can impact some of the generation and load inputs.
- **Generation differences.** There is a subset of resources that do not have bids and are not receiving energy instructions but are injecting power into the system. This generation is accounted for in the market to balance power but is not included in the bid-range capacity test.

DMM recommends that the CAISO and stakeholders review some of these differences to potentially improve the accuracy of the test. In particular, the non-participating pump load is actual load that is considered in the market optimization, but is not accounted for in the resource sufficiency evaluation.