California ISO

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

October 24, 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 September 2022 and is organized as follows:

- Section 2 provides a special 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 provides an overview of the changes implemented in June as part of phase 1 of resource sufficiency evaluation enhancements. This includes a discussion of several changes which were not implemented correctly.
- Section 5 summarizes the frequency and size of resource sufficiency evaluation failures.
- Section 6 summarizes WEIM import limits and transfers following a resource sufficiency evaluation failure.
- Section 7 summarizes imbalance conformance adjustments and provides some context with how it interacts with the resource sufficiency evaluation.
- Section 8 summarizes input differences between the resource sufficiency evaluation and latest 15-minute market run.
- Section 9 provides a discussion and metrics on net load uncertainty used in the tests.
- Section 10 summarizes current issues identified by DMM or the California ISO.

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

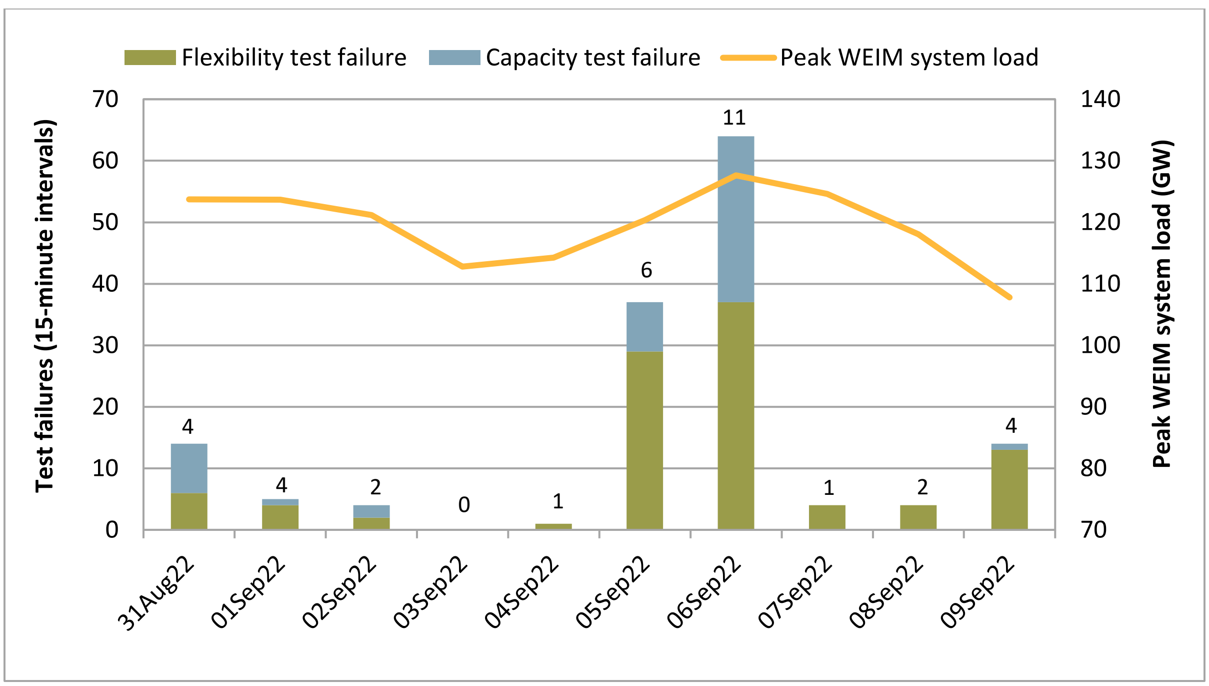
2 Resource sufficiency evaluation performance during the September heat wave

Between August 31 through September 9, the combined ISO and WEIM system experienced a prolonged heat event. This period was marked by extremely high or record 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



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 flexibility tests during the peak hours of these two days. Over this peak period:

- Three WEIM areas failed either test during 8 or more intervals (two or more hours): BANC, Idaho Power, and Salt River Project.
- Four WEIM areas failed between 4 and 7 intervals (between one and two hours): BPA, California ISO, NorthWestern Energy, and Puget Sound Energy.
- Five WEIM areas failed between 1 and 3 intervals (less than one hour): LADWP, PacifiCorp East, PacifiCorp West, 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 net load uncertainty on top of the requirement, which reflects 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 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 December 2022. Following implementation of this new methodology, the ISO expects to reconsider 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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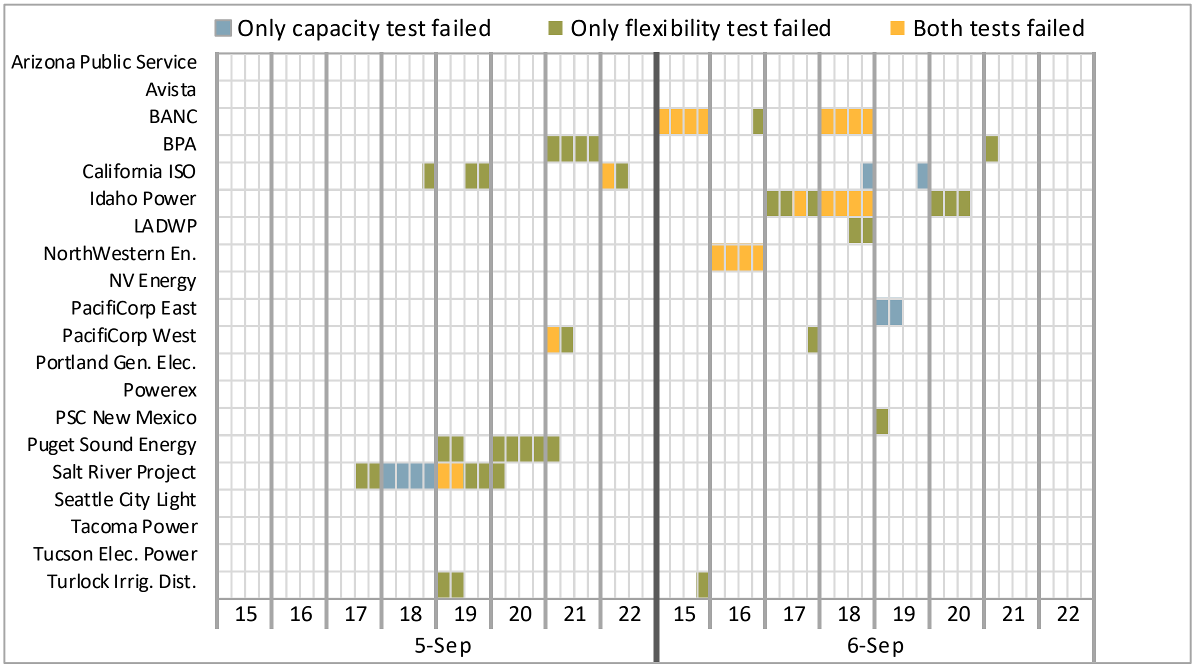
3 This uncertainty is net of any diversity benefit discount. The diversity benefit reflects that system-level flexible ramping needs are typically smaller than the sum of the needs of individual balancing areas because of reduced uncertainty across a larger footprint.

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 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, CAISO failed the resource sufficiency evaluation during two intervals despite being in an EEA2 or EEA3 for more than five hours. Similar figures for all balancing areas with a test failure on September 5 or 6 are shown at the end of Section 2.

[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)

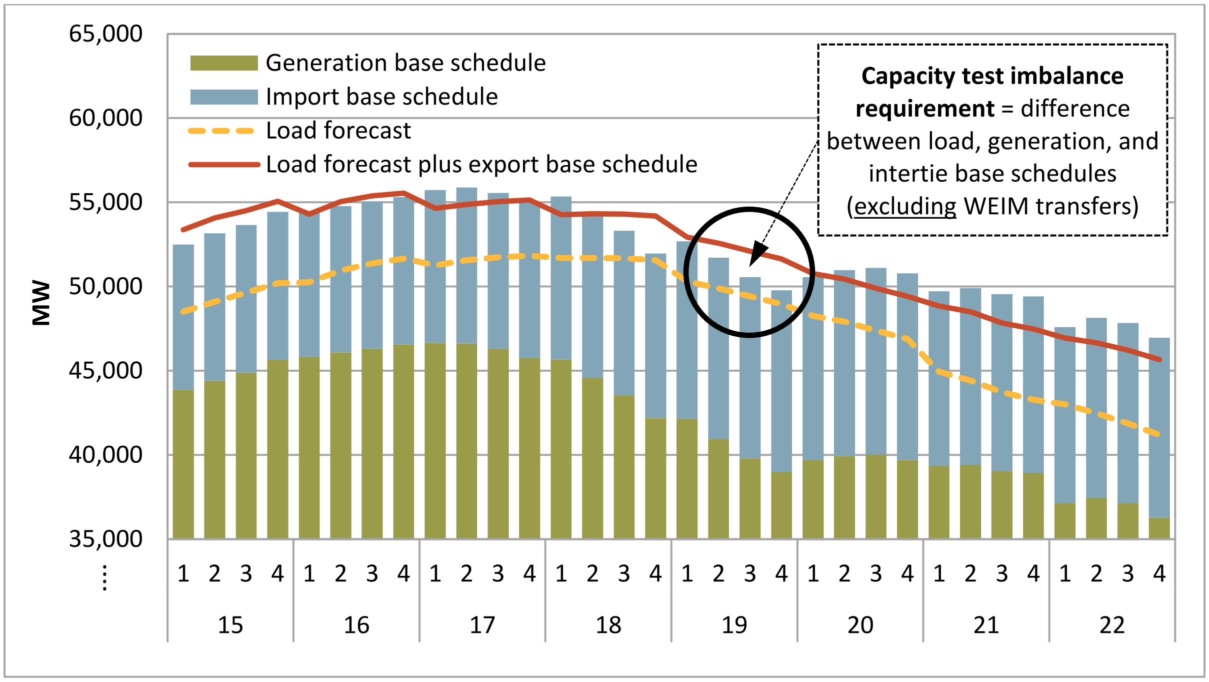
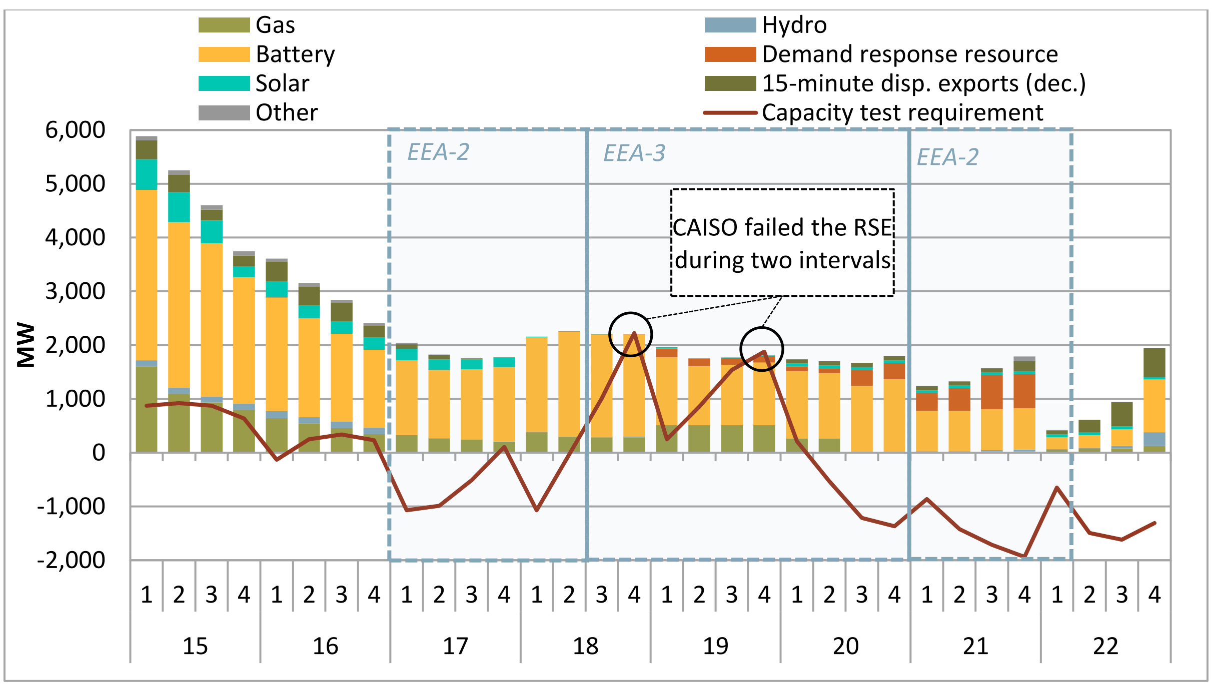


Figure 2.4 CAISO incremental capacity (peak hours, September 6, 2022)



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 results, battery storage capacity counted in the capacity test significantly exceeded the actual available capacity from batteries during the September heatwave.

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 a set of issues. The different reasons that battery capacity was incorrectly counted in the test (i.e. unavailable) are described below.

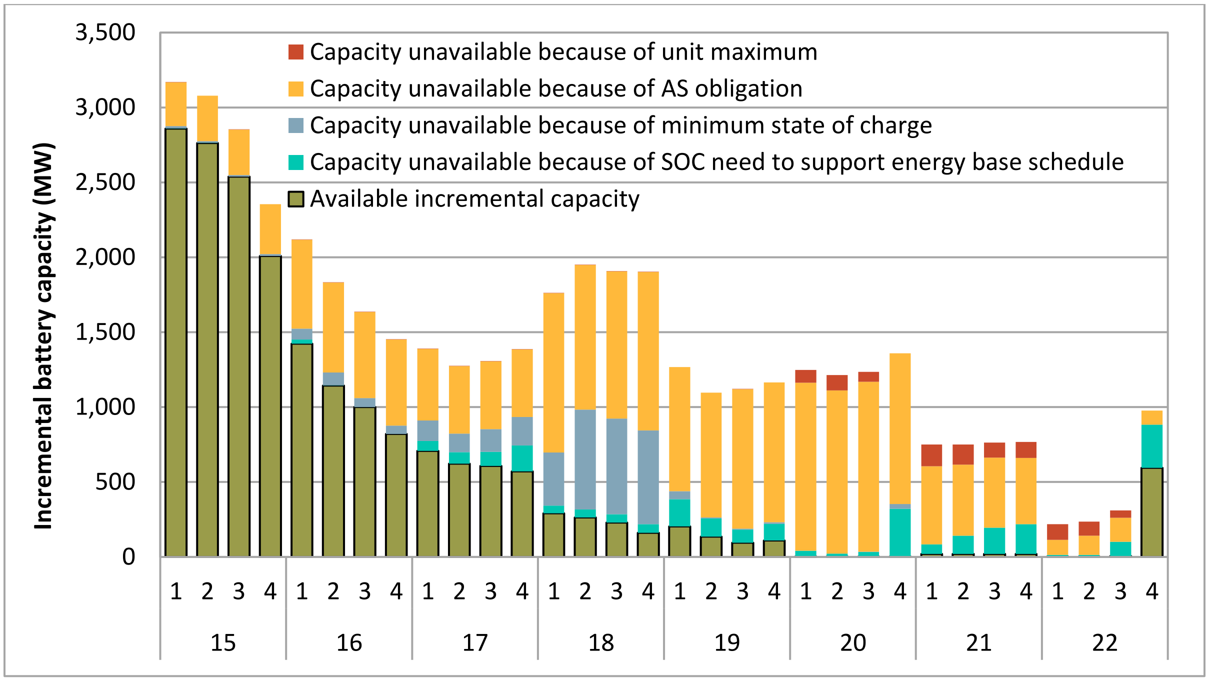
1. **Capacity unavailable because of unit maximum.** In these cases, base scheduled energy plus incremental capacity exceeded either the economic or physical maximum.

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 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, CAISO would have failed the capacity test in three additional intervals on this day.

After adjusting for unavailable battery capacity, CAISO would have failed the capacity test in 14 additional intervals between August 30 and September 9. Figure 2.7 shows the original CAISO capacity test failures as well as additional CAISO capacity test failures (after adjusting for these issues) during this heat wave event.

Failing either the capacity or the flexibility test has the same outcome of capping WEIM transfers. In some cases, CAISO already failed the flexibility test such that the additional capacity test failure would not have had any impact (yellow bars). On August 30, CAISO would have failed the capacity test in seven additional intervals had battery capacity been correctly counted in the test.

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 now 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 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)

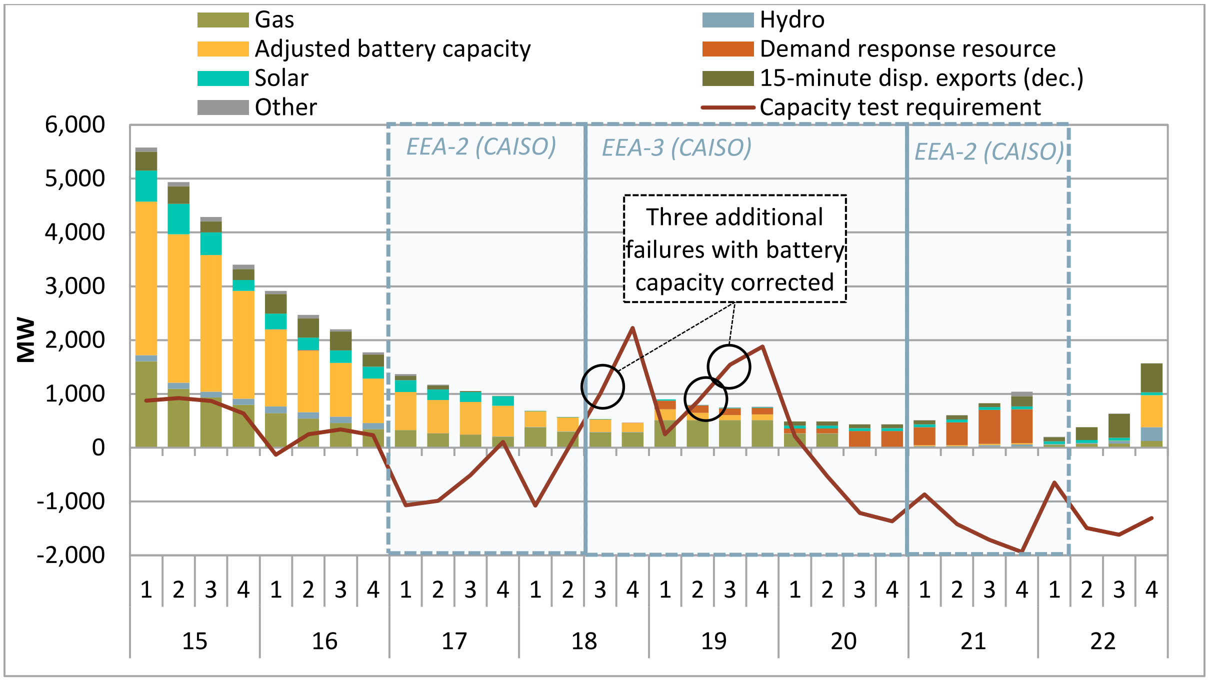
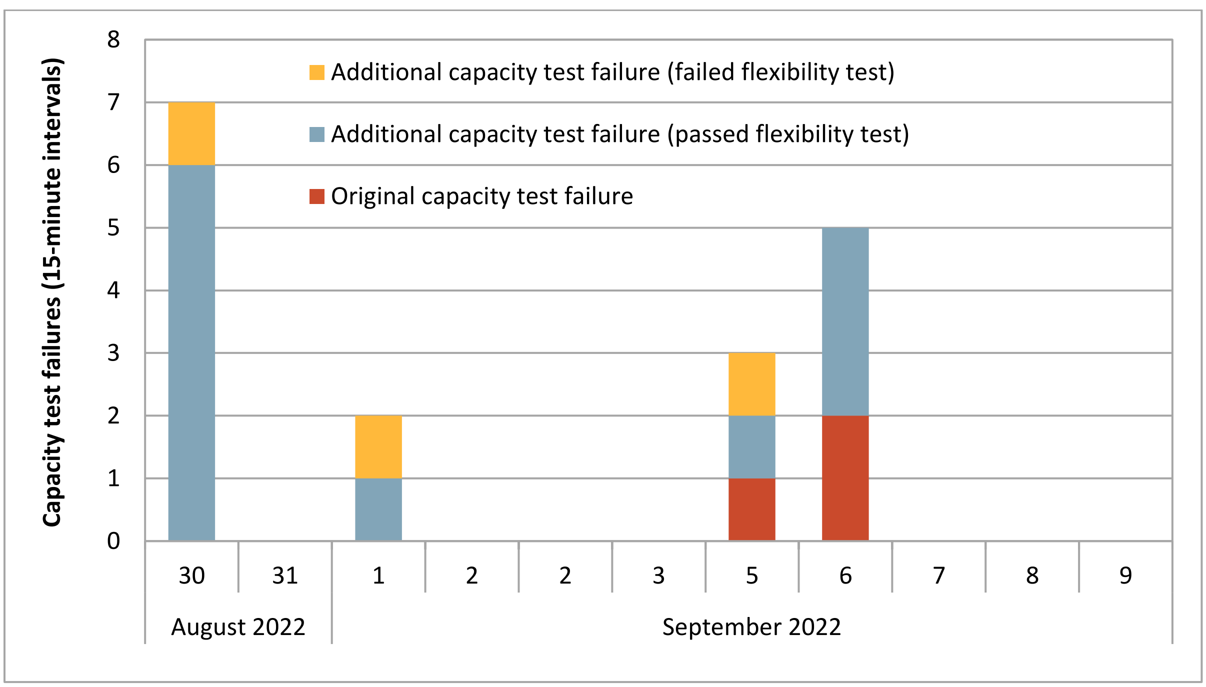


Figure 2.7 Additional capacity test failures after adjusting for unavailable battery capacity (August 30 – September 9, 2022)



The California ISO has identified additional discrepancies in the capacity test for the heat wave period. These are expected to be published in the forthcoming September 2022 Summer Market Performance Report. Among others, this report is expected to highlight discrepancies with multi-stage-generation (MSG) capacity, imports, exports, and reliability demand response (RDR) resources.

WEIM transfers and import limits

The majority of net imports in the WEIM were into the CAISO area during the heat wave event. Figure 2.8 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 2.9 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 2.10 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 2.10, 5-minute market adjustments were significantly lower.

Figure 2.11 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, 15-minute market net WEIM imports were between 1,770 and 4,650 MW — or almost 3,370 MW on average. 5-minute market imports in the same period 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. The CAISO failed the resource sufficiency evaluation during seven intervals over September 5 and 6, as shown by the yellow line in Figure 2.11, which shows the resulting import limit. CAISO net 15-minute market WEIM imports during these failures were between 1,770 MW and 4,110 MW — or around 2,870 MW on average. 5-minute market imports in the same period were much less at around 1,625 MW on average, 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 none of the 5-minute market intervals.

Figure 2.8 15-minute market Net WEIM transfers (peak hours, September 5-6)

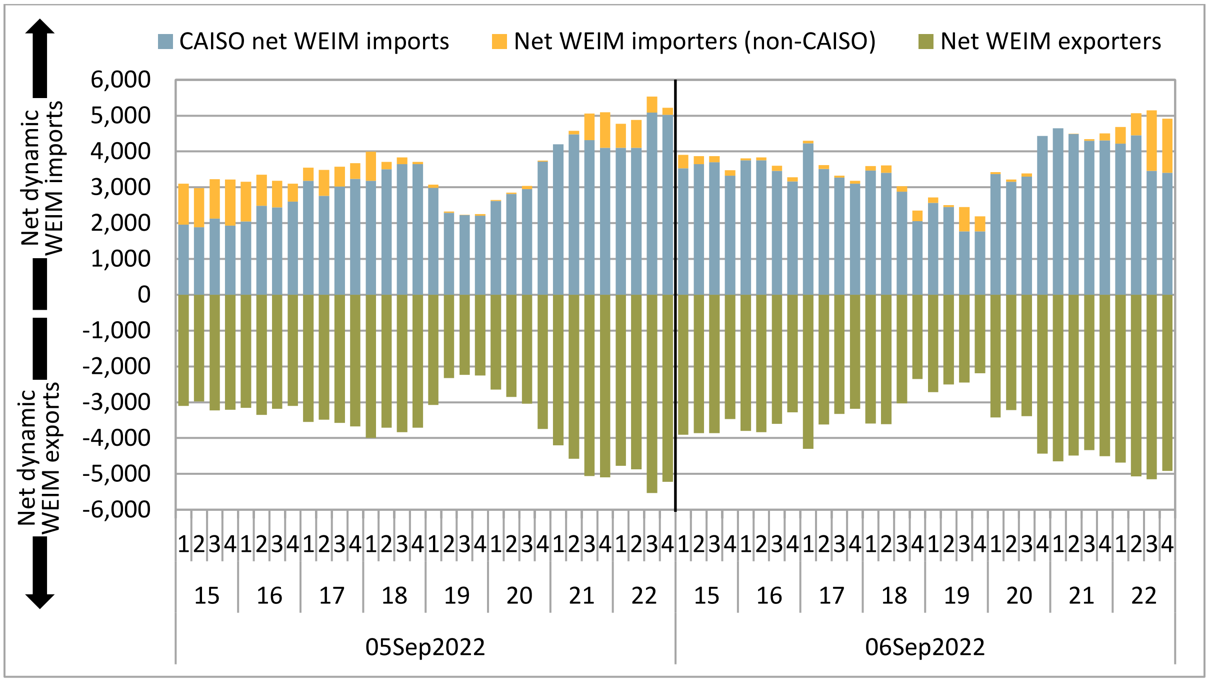


Figure 2.9 5-minute market net WEIM transfers (peak hours, September 5-6)

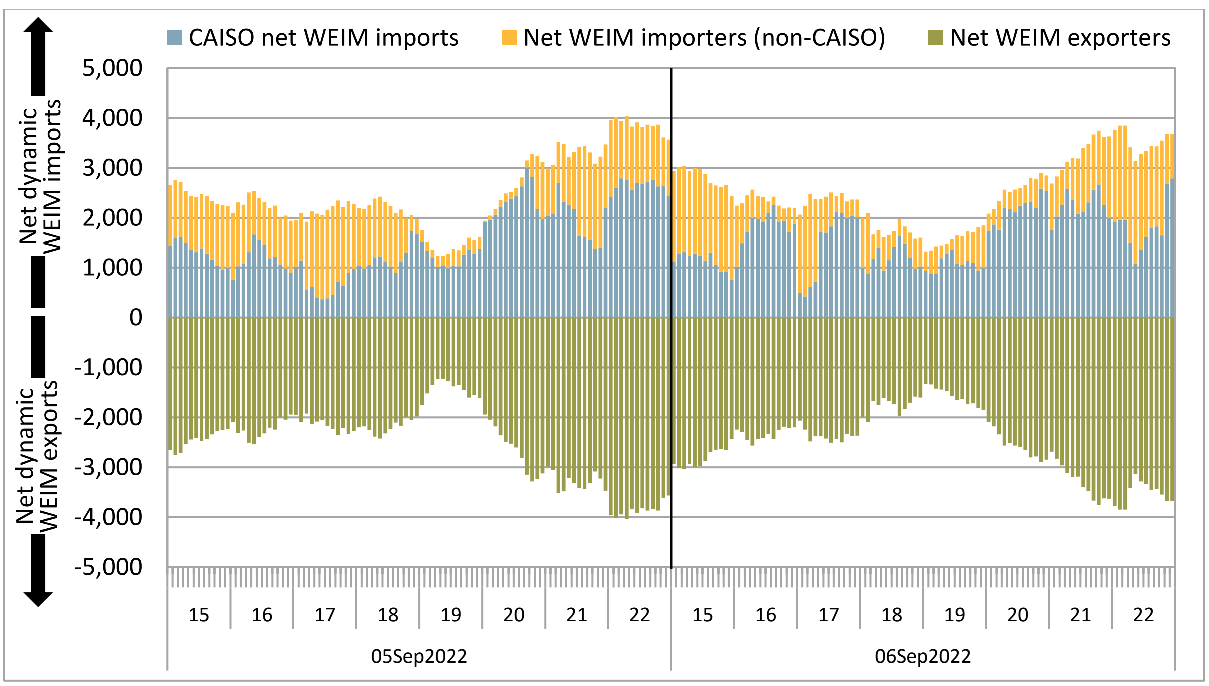


Figure 2.10 California ISO imbalance conformance adjustments (September 5-6)

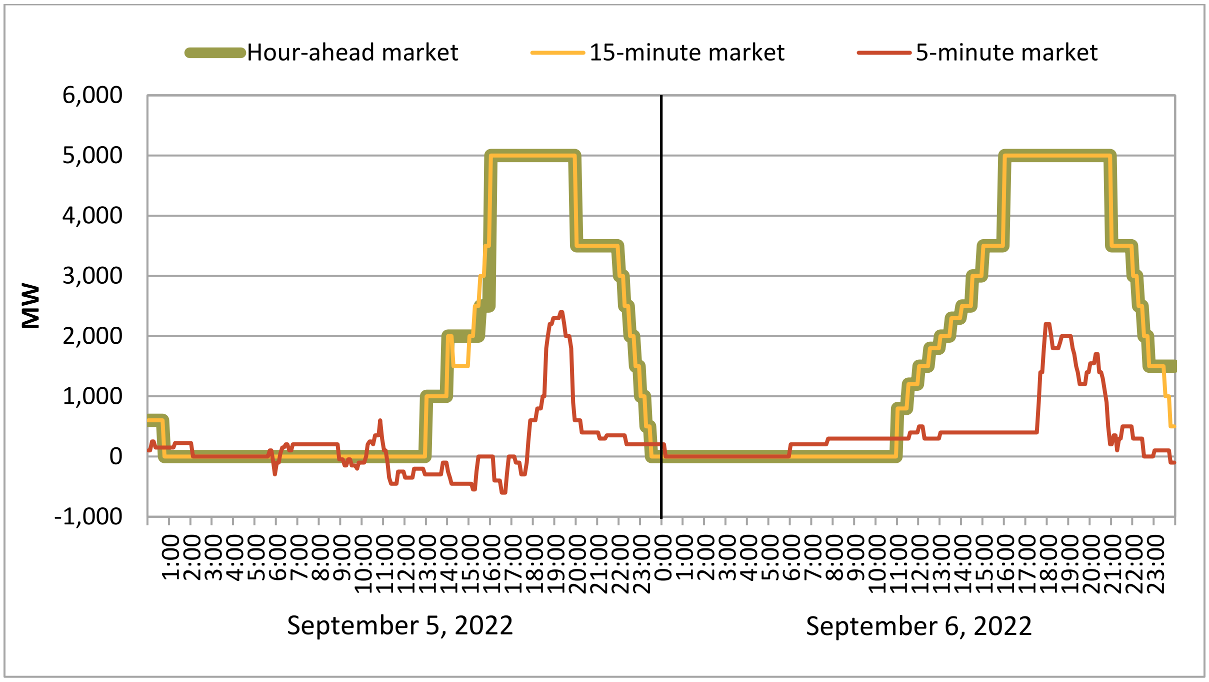
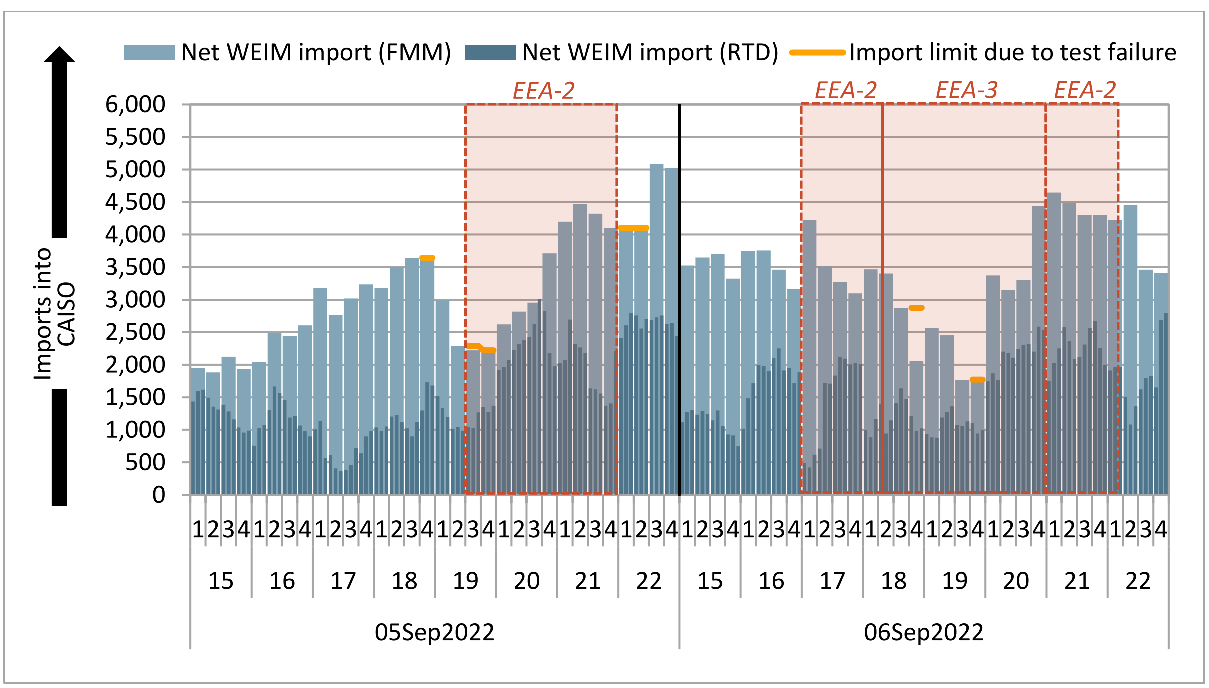


Figure 2.11 CAISO WEIM transfers and any import limit following resource sufficiency evaluation failure (peak hours, September 5-6)



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 2.12 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 2.13 provides the same information, except with CAISO excluded.

As part of phase 2 of resource sufficiency evaluation enhancements, the CAISO proposed to introduce an energy assistance mechanism that could relax the limitation on incremental WEIM transfers following a test failure at a preset penalty. 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.[6] 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.
- 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.

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

6 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.

Figure 2.12 15-minute market WEIM transfers following resource sufficiency evaluation failure (peak hours, September 5-6, 2022)

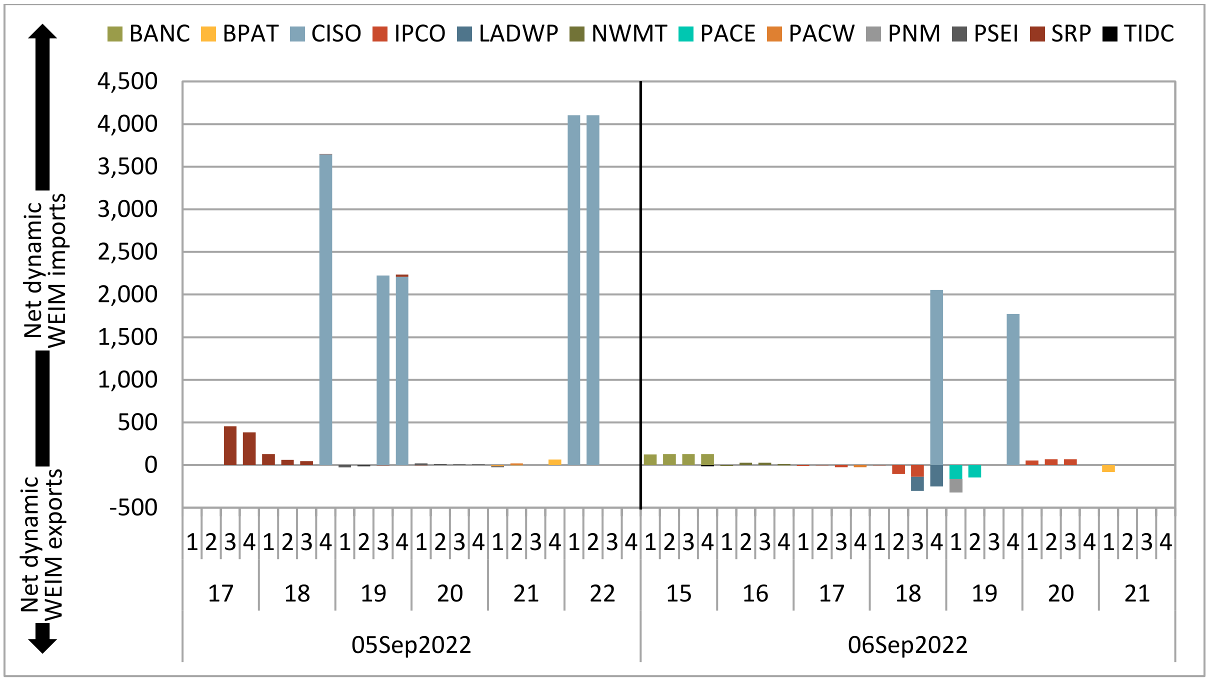
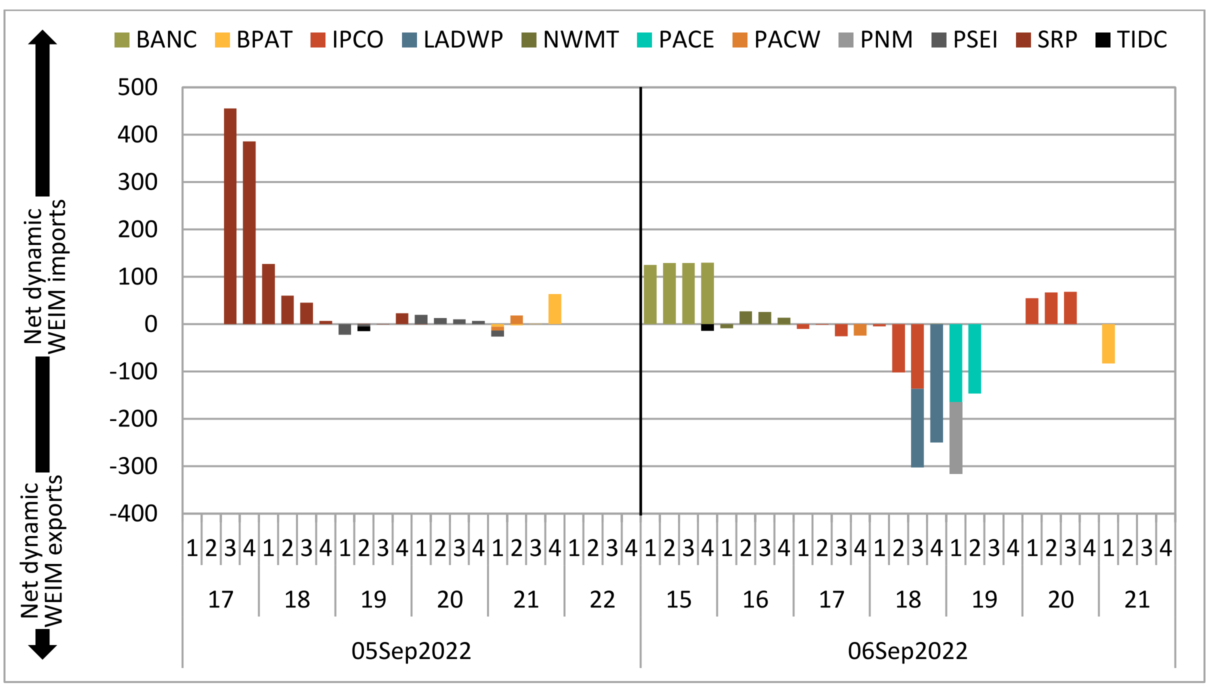


Figure 2.13 15-minute market WEIM transfers following resource sufficiency evaluation failure excluding CAISO (peak hours, September 5-6, 2022)



The penalty under the energy assistance option was proposed to apply to all real-time market imbalance transactions rather than only the incremental WEIM transfer above what could have been procured otherwise because of transfer limits imposed following a test failure. DMM submitted supplemental comments and quantitative analysis on how the energy assistance proposal would have worked for each WEIM balancing area during the first two weeks of September that included the heat wave period.[7] This analysis is intended to help each balancing area and other stakeholders assess the potential impacts and benefits of electing to participate in the energy assistance option.

Analysis provided in DMM's comments included results such as those shown in Table 2.1 of this report. As explained in DMM's comments, this analysis indicates that the energy assistance proposal in the Revised Draft Proposal may result in limited amounts of additional WEIM transfers into balancing areas failing the resource sufficiency evaluation. These findings reflect several trends also highlighted in in Table 2.1 of this report.

- 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.
- 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.

Incremental capacity counted during capacity test failures

This section summarizes incremental capacity above base schedules in the bid-range capacity test for all balancing areas with a failure during the critical hours of September 5 and 6. The bars shows incremental capacity above base schedules by resource type. The line shows the capacity test requirement (imbalance between load, generation, and intertie base schedules).

[7] Department of Market Monitoring, *Supplemental Comments on WEIM Resource Sufficiency Evaluation Enhancements Phase 2 Revised Draft Final Proposal,* September 27, 2022: http://www.caiso.com/Documents/DMM-Comments-WEIM-Resource-Sufficiency-Evaluation-Enhancements-Phase2-Draft-Final-Proposal-Sep-27-2022.pdf

Figure 2.14 BANC incremental capacity (peak hours, September 6, 2022)

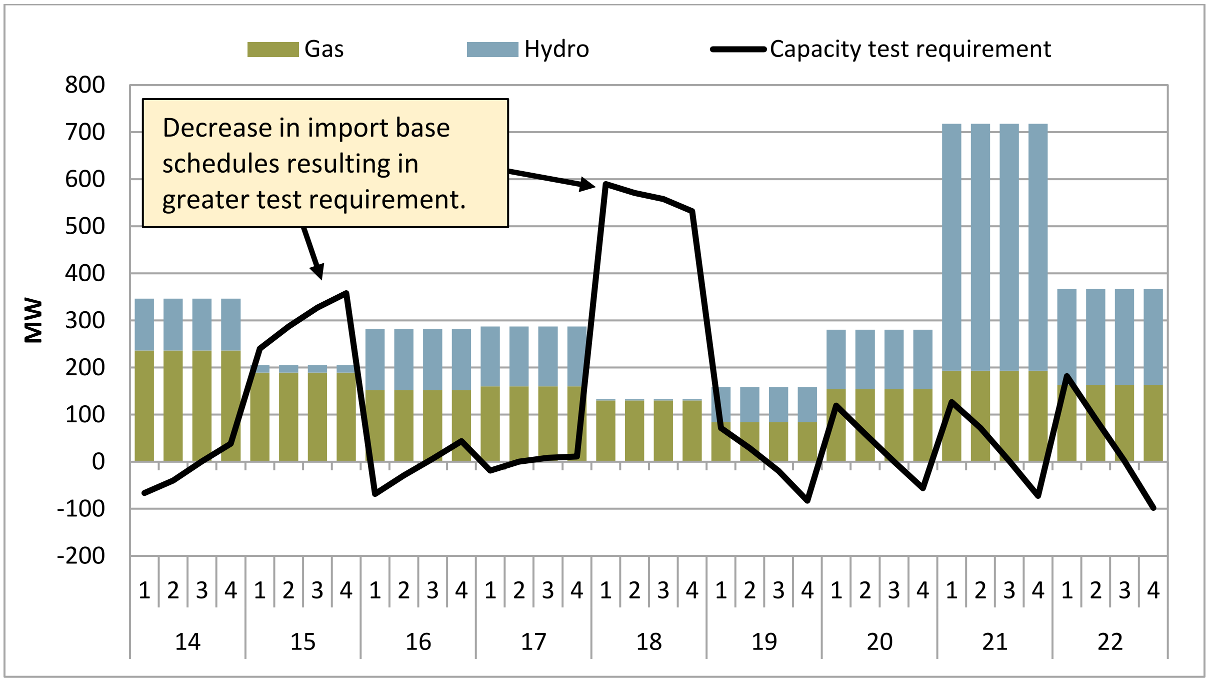


Figure 2.15 CAISO incremental capacity (peak hours, September 5, 2022)

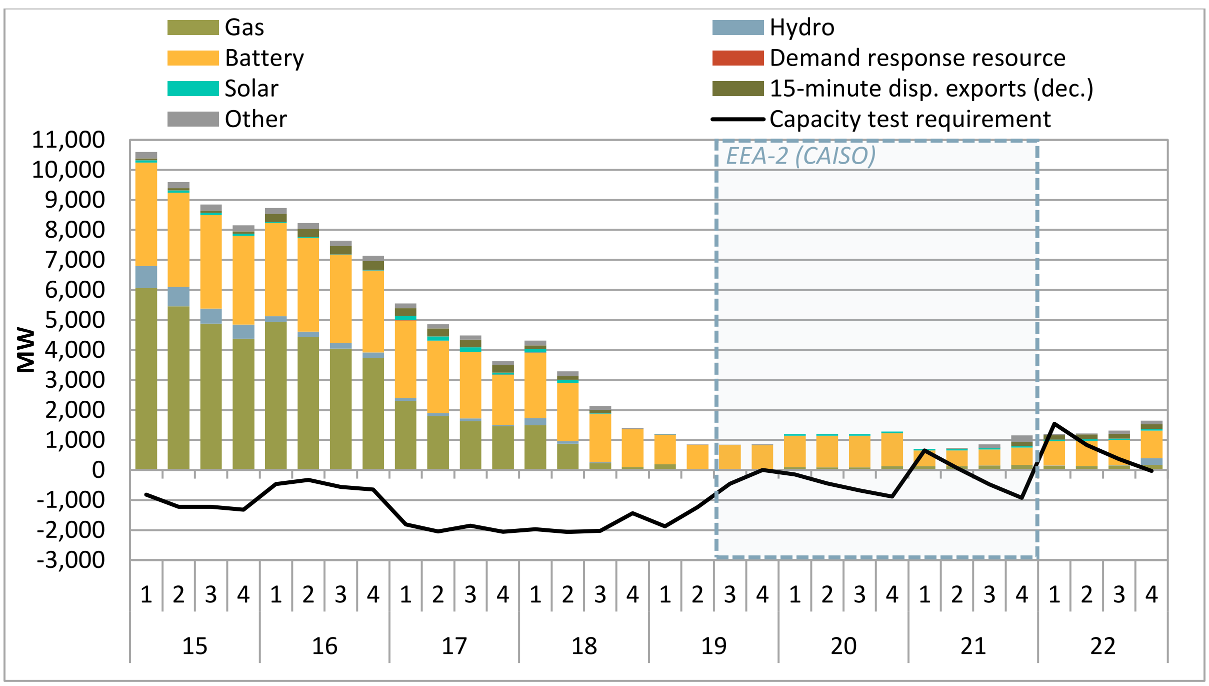


Figure 2.16 Idaho Power incremental capacity (peak hours, September 6)

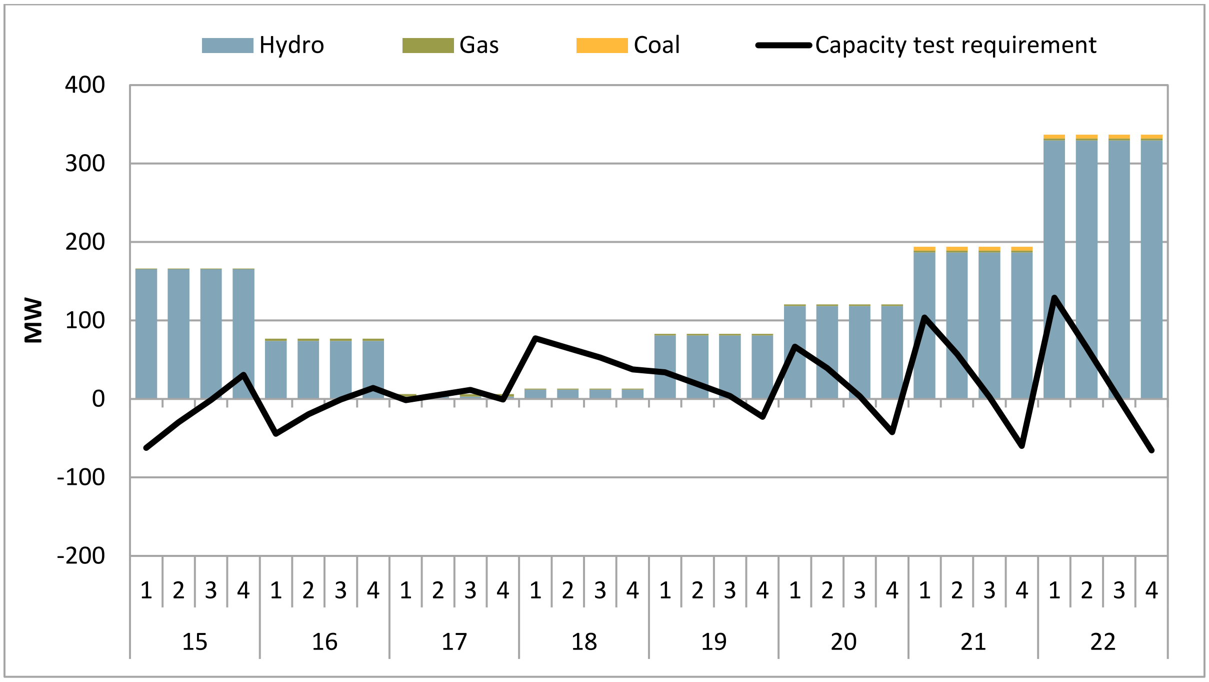


Figure 2.17 NorthWestern Energy incremental capacity (peak hours, September 6)

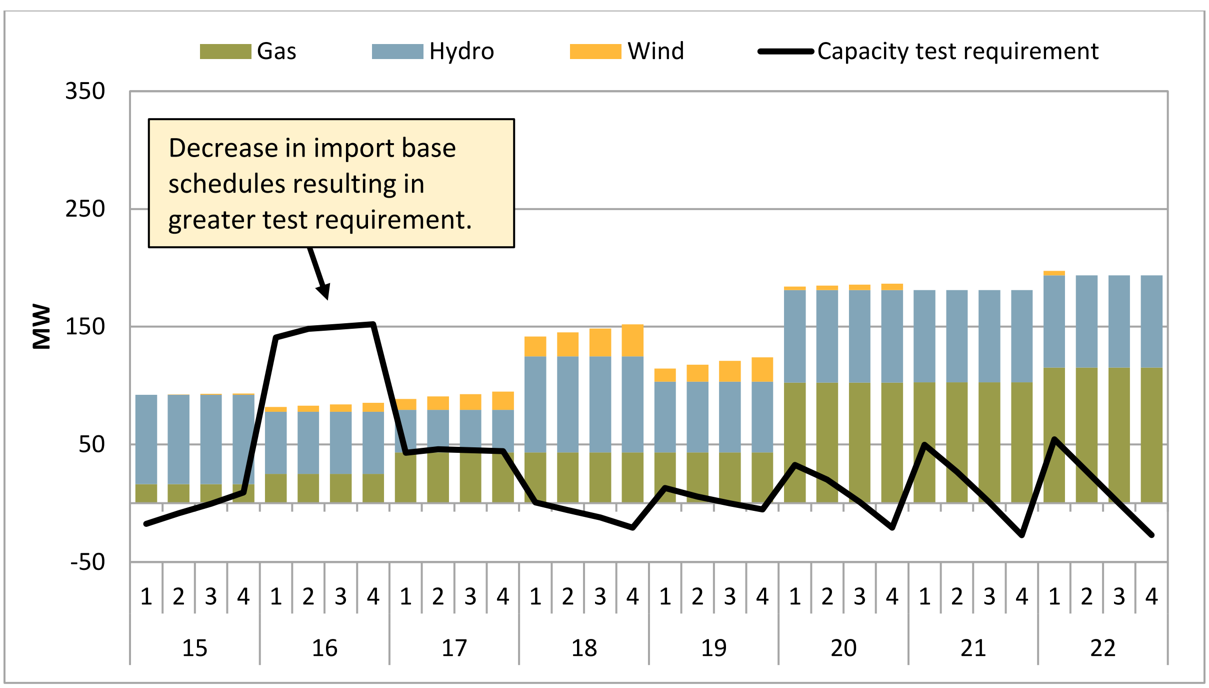


Figure 2.18 PacifiCorp East incremental capacity (peak hours, September 6)

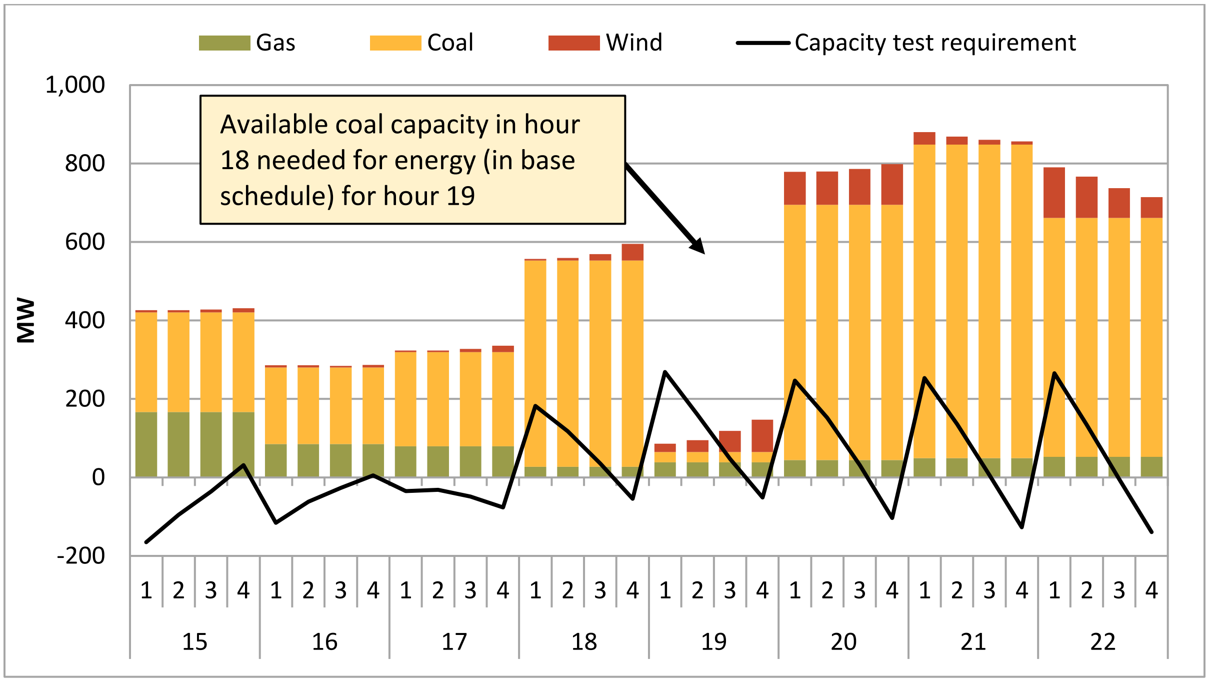


Figure 2.19 PacifiCorp West incremental capacity (peak hours, September 5)

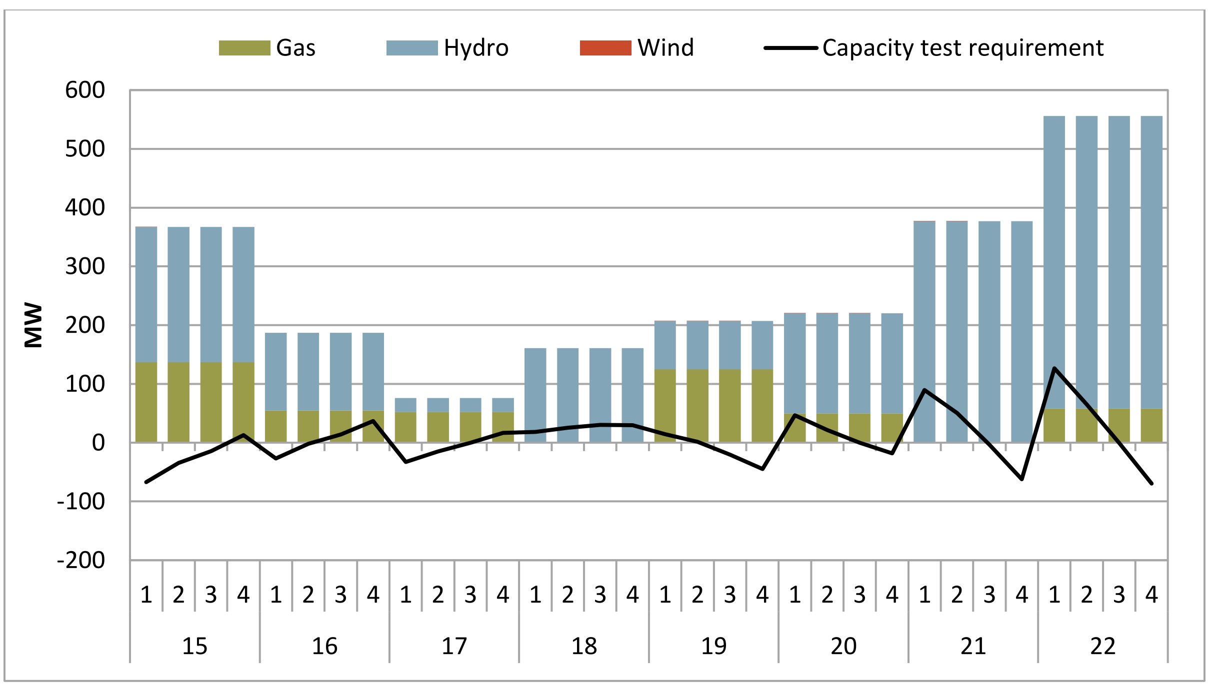
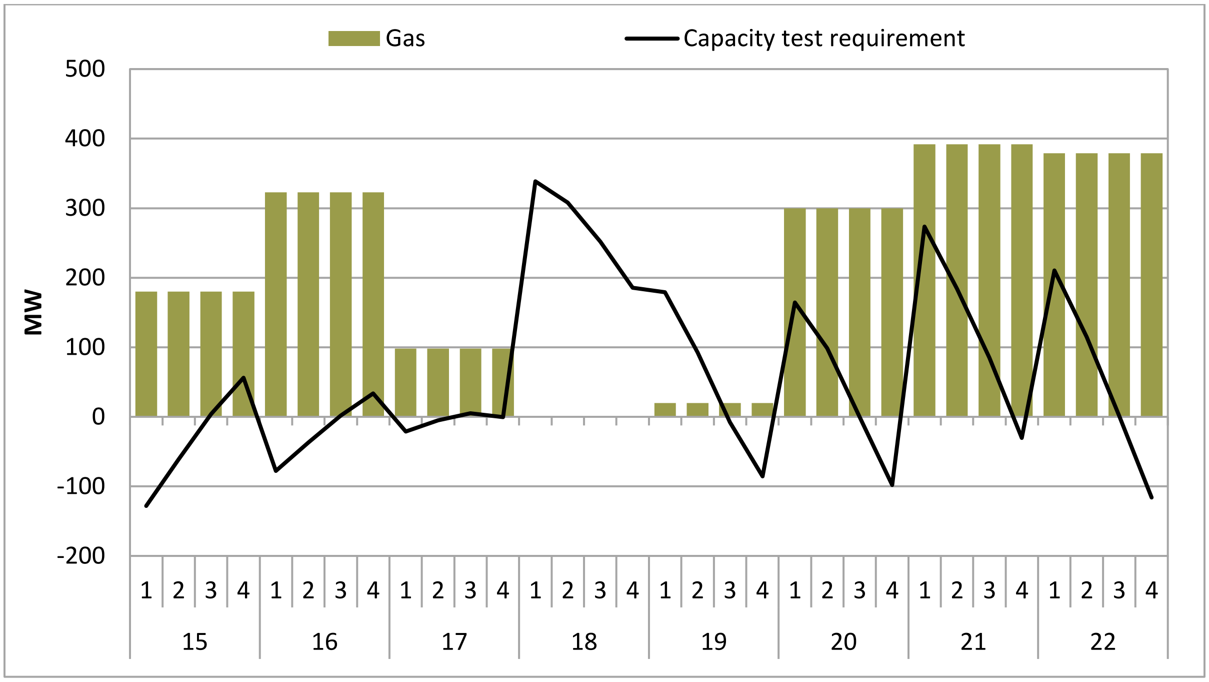


Figure 2.20 Salt River Project incremental capacity (peak hours, September 5)



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.[8] 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

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

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

[8]. 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.

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.

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 amounts 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.[9] The uncertainty component is expected to be enhanced in fall 2022 to scale and account for net load currently in the system.[10]

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.

9 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.

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

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.

Since the bid range capacity is calculated relative to the base schedules, the upward capacity test can generally be expressed as follows:[11]

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

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.

[11] 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 Resource sufficiency evaluation enhancements phase 1

Phase 1 of resource sufficiency evaluation enhancements was implemented on June 1, 2022. This includes the following enhancements:

- **Consideration of offline resources in the capacity test.** The capacity test will now omit offline long-start capacity from the bid-range capacity test.[12] Short-start units which failed-to-start per the unit's telemetry will also be excluded.
- **Accounting for CAISO interchange awards that have not submitted Transmission Profile e-Tag.** CAISO hour-ahead import and export schedules are expected to be reduced based on the transmission profile e-Tag at T-40. This is intended to help align the interchange schedules used in the resource sufficiency evaluation with what is reasonably expected to be delivered. DMM analysis indicates that this change was not implemented correctly. In some cases, CAISO import and export schedules were not correctly capped by the transmission profile e-tag at 40 minutes prior to the test hour. The outcome here was effectively no adjustment. DMM's understanding is that this issue is persistent and ongoing.
- **Adjustment to initial reference point used in the flexibility test.** The flexibility test requirement will now consider any power balance constraint shortage that is present in the interval immediately prior to the test hour.
- **Accounting for storage resource's state of charge in the resource sufficiency evaluation.** The capacity and flexibility test should consider the state-of-charge of batteries from the market run immediately prior to the test hour. DMM analysis indicates this this change was not implemented correctly. Following implementation, battery capacity counted in the test has often exceeded actual availability. For more information including the impact on test failure, see *Accuracy issues in the capacity test* in Section 2.
- **Submission of load forecast adjustments to reflect non-participating demand response schedules.** Demand response programs, which cannot be accounted for otherwise in the real-time market, can be submitted as a load forecast adjustment to be accounted for in the resource sufficiency evaluation.
- **Suspension of uncertainty in the capacity test.** Intertie uncertainty was removed from the capacity test on June 1. Net load uncertainty was previously removed from the capacity test on February 15, 2022.
- **Exclusion of CAISO from allocation of funds associated with balancing test failure.** CAISO is now excluded from potential revenues from failures of the balancing test. The CAISO is not subject to the balancing test as it does make supply available through the base scheduling process.

[12] Capacity for a unit that is offline in the last 15-minute interval prior to the test hour will only be considered for short-start units (start-up time plus minimum up time at or below 255 minutes).

Additional changes and details associated with phase 1 implementation can be found in the Business Requirements Specification.[13]

5 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.[14] 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 5.1 through Figure 5.4 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 5.5 through Figure 5.8 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.[15] 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 the fall of 2022. The CAISO is also proposing to permanently remove intertie uncertainty from the capacity test.

Figure 5.9 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 5.10 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.

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[13] California ISO, *Business Requirements Specification for WEIM Resource Sufficiency Evaluation Enhancements – Phase-1 (RSEE-1),* April 7, 2022: http://www.caiso.com/Documents/Business-Requirements-Specification-WEIM-Resource-Sufficiency-Evaluation-Enhancements-Phase1.pdf

[14] 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.

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

Figure 5.1 Frequency of upward capacity test failures (number of intervals)

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Arizona PS	5	8	5	—	9	1	—	—	1	1	—	—	—	—	—
Avista									—	1	—	5	5	1	—
BANC	7	—	1	—	—	—	—	—	—	—	—	—	—	1	8
BPA											—	3	—	1	13
California ISO	6	1	5	—	—	—	—	—	—	—	—	—	—	—	3
Idaho Power	13	25	3	—	—	—	—	3	—	—	—	—	—	5	5
LADWP	—	—	—	8	5	2	—	—	—	—	—	—	1	—	—
NorthWestern	36	18	6	253	34	7	9	2	—	1	—	—	—	4	4
NV Energy	15	6	7	8	—	—	—	—	—	5	4	1	3	—	—
PacifiCorp East	9	4	6	4	—	—	—	—	—	—	—	—	—	—	2
PacifiCorp West	7	2	3	2	14	11	8	3	9	1	6	1	29	5	1
Portland GE	25	30	41	13	6	11	3	—	—	—	—	—	—	2	—
Powerex	1	—	2	15	6	6	6	—	—	4	—	—	—	7	—
PSC New Mexico	11	—	5	—	—	—	—	—	—	—	—	—	—	—	—
Puget Sound En	16	21	17	29	18	10	—	—	—	1	1	5	—	—	5
Salt River Proj.	90	76	56	3	20	—	—	—	6	42	30	7	5	13	12
Seattle City Light	—	1	14	4	—	4	—	—	2	—	—	—	5	4	6
Tacoma Power									—	17	3	1	1	6	1
Tucson Elec.											—	—	—	2	—
Turlock ID	—	33	22	46	—	—	—	—	—	—	—	4	—	—	—
	2021							2022							

Figure 5.2 Average shortfall of upward capacity test failures (MW)

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Arizona PS	92	45	97	—	80	20	—	—	64	3	—	—	—	—	—
Avista									—	1	—	6	27	5	—
BANC	53	—	6	—	—	—	—	—	—	—	—	—	—	37	264
BPA											—	81	—	8	336
California ISO	601	274	125	—	—	—	—	—	—	—	—	—	—	—	141
Idaho Power	17	34	6	—	—	—	—	3	—	—	—	—	—	60	37
LADWP	—	—	—	95	103	40	—	—	—	—	—	—	0	—	—
NorthWestern	24	61	9	38	31	14	39	3	—	1	—	—	—	86	64
NV Energy	55	25	42	57	—	—	—	—	—	37	67	2	36	—	—
PacifiCorp East	40	38	63	79	—	—	—	—	—	—	—	—	—	—	124
PacifiCorp West	26	16	36	2	15	85	33	41	77	3	11	50	24	36	4
Portland GE	46	36	38	31	32	15	32	—	—	—	—	—	—	1	—
Powerex	3	—	22	78	70	148	216	—	—	364	—	—	—	142	—
PSC New Mexico	129	—	57	—	—	—	—	—	—	—	—	—	—	—	—
Puget Sound En	58	74	46	33	54	39	—	—	—	13	1	27	—	—	13
Salt River Proj.	75	121	74	27	27	—	—	—	28	50	44	51	41	214	132
Seattle City Light	—	4	151	53	—	16	—	—	13	—	—	—	15	9	7
Tacoma Power									—	77	2	1	3	6	0
Tucson Elec.											—	—	—	20	—
Turlock ID	—	7	7	8	—	—	—	—	—	—	—	104	—	—	—
	2021							2022							

Figure 5.3 Frequency of upward flexibility test failures (number of intervals)

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	2021							2022							
Arizona PS	1	—	7	—	10	1	1	5	2	—	—	—	1	2	—
Avista									—	7	15	28	14	4	—
BANC	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9
BPA											24	90	99	30	33
California ISO	10	3	11	—	3	—	—	—	—	—	—	—	—	2	13
Idaho Power	—	—	—	—	—	1	—	6	—	—	—	—	5	6	13
LADWP	4	—	—	1	1	10	—	—	3	—	—	—	—	—	2
NorthWestern	108	20	46	247	14	14	—	4	4	8	—	4	9	30	5
NV Energy	12	15	4	8	1	1	1	20	11	28	22	6	—	3	4
PacifiCorp East	1	—	4	—	2	1	1	1	—	4	4	3	5	4	—
PacifiCorp West	1	2	—	—	16	7	1	1	2	7	4	1	—	2	3
Portland GE	14	5	—	1	—	5	10	1	—	—	—	1	12	4	2
Powerex	15	—	—	7	5	8	7	1	—	4	—	—	—	10	3
PSC New Mexico	15	—	2	—	2	—	—	—	2	1	4	—	11	—	1
Puget Sound En	1	1	—	—	2	—	—	—	1	2	—	2	13	7	8
Salt River Proj.	57	49	24	5	36	1	5	—	19	14	5	13	19	34	17
Seattle City Light	1	—	4	—	—	—	—	—	2	—	—	—	6	1	7
Tacoma Power									—	—	4	3	1	2	4
Tucson Elec.											2	—	—	—	11
Turlock ID	—	—	2	5	—	—	—	—	—	—	—	—	—	—	3

Figure 5.4 Average shortfall of upward flexibility test failures (MW)

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	2021							2022							
Arizona PS	38	—	42	—	45	33	37	45	120	—	—	—	28	28	—
Avista									—	18	29	26	19	30	—
BANC	—	—	—	—	—	—	—	—	—	—	—	—	—	—	237
BPA											68	71	50	56	232
California ISO	585	400	735	—	540	—	—	—	—	—	—	—	—	684	671
Idaho Power	—	—	—	—	—	5	—	31	—	—	—	—	13	34	45
LADWP	70	—	—	10	11	97	—	—	106	—	—	—	—	—	36
NorthWestern	36	18	25	31	27	12	—	33	59	20	—	10	15	22	83
NV Energy	45	36	94	82	110	31	37	42	55	61	66	89	—	80	88
PacifiCorp East	44	—	21	—	57	10	124	59	—	83	77	9	34	43	—
PacifiCorp West	2	33	—	—	74	67	3	7	33	58	24	5	—	31	28
Portland GE	33	19	—	11	—	18	36	37	—	—	—	8	72	25	16
Powerex	111	—	—	50	88	41	202	26	—	366	—	—	—	318	101
PSC New Mexico	112	—	47	—	69	—	—	—	46	23	33	—	70	—	22
Puget Sound En	6	24	—	—	82	—	—	—	3	32	—	49	46	17	21
Salt River Proj.	61	53	50	32	65	10	43	—	45	36	43	89	45	156	72
Seattle City Light	7	—	14	—	—	—	—	—	8	—	—	—	17	2	8
Tacoma Power									—	—	206	6	3	5	3
Tucson Elec.											22	—	—	—	44
Turlock ID	—	—	2	18	—	—	—	—	—	—	—	—	—	—	3

Figure 5.5 Frequency of downward capacity test failures (number of intervals)

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	2021							2022							
Arizona PS	—	—	—	—	5	—	10	—	—	—	1	1	—	—	—
Avista									—	—	—	—	5	—	—
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	3	—	24	9	1	—	4	—	4	—	4	—	—	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
Seattle City Light	1	1	1	—	7	5	—	—	2	—	—	1	3	—	6
Tacoma Power									—	22	2	—	19	8	—
Tucson Elec.											—	1	—	—	—
Turlock ID	1	6	5	20	3	1	2	1	—	4	—	—	—	—	—

Figure 5.6 Average shortfall of downward capacity test failures (MW)

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	2021							2022							
Arizona PS	—	—	—	—	63	—	240	—	—	—	33	19	—	—	—
Avista									—	—	—	—	52	—	—
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	33	—	144	51	7	—	48	—	90	—	175	—	—	13	—
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
Seattle City Light	8	8	5	—	18	10	—	—	9	—	—	2	7	—	6
Tacoma Power									—	29	3	—	5	8	—
Tucson Elec.											—	6	—	—	—
Turlock ID	3	8	2	5	1	3	1	1	—	3	—	—	—	—	—

Figure 5.7 Frequency of downward flexibility test failures (number of intervals)

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Arizona PS	—	4	2	3	15	11	43	11	25	10	15	6	—	—	4
Avista									—	—	—	2	—	—	3
BANC	—	—	—	—	—	4	—	—	3	1	2	2	—	—	—
BPA											4	7	—	1	10
California ISO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Idaho Power	—	—	—	—	8	1	—	1	—	8	13	—	—	1	—
LADWP	—	—	—	2	—	—	4	—	—	—	—	—	—	—	—
NorthWestern	18	11	33	68	4	1	—	—	—	—	16	56	6	—	—
NV Energy	88	74	48	34	11	13	17	111	50	92	39	52	19	7	13
PacifiCorp East	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PacifiCorp West	—	—	—	—	1	—	—	—	1	1	3	11	16	—	—
Portland GE	—	—	—	—	—	—	—	—	—	—	—	7	—	—	—
Powerex	12	6	29	12	1	4	—	1	7	1	9	6	—	4	2
PSC New Mexico	—	—	4	11	20	4	9	1	36	10	53	19	1	1	6
Puget Sound En	—	—	—	—	1	—	—	—	—	—	6	66	2	—	—
Salt River Proj.	—	2	1	2	1	2	2	28	46	6	11	14	6	7	28
Seattle City Light	6	—	—	—	1	1	—	—	2	4	4	9	2	23	10
Tacoma Power									—	11	8	—	14	6	—
Tucson Elec.											—	—	—	—	—
Turlock ID	—	1	—	18	3	5	6	—	14	16	4	13	3	2	—
	2021							2022							

Figure 5.8 Average shortfall of downward flexibility test failures (MW)

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Arizona PS	—	50	27	36	81	51	69	32	42	54	58	33	—	—	81
Avista									—	—	—	20	—	—	11
BANC	—	—	—	—	—	71	—	—	18	7	5	15	—	—	—
BPA											212	55	—	4	149
California ISO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Idaho Power	—	—	—	—	31	40	—	43	—	18	55	—	—	13	—
LADWP	—	—	—	5	—	—	43	—	—	—	—	—	—	—	—
NorthWestern	14	29	17	25	21	7	—	—	—	—	12	27	14	—	—
NV Energy	141	70	83	39	34	24	44	92	55	86	49	98	151	59	58
PacifiCorp East	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PacifiCorp West	—	—	—	—	32	—	—	—	4	15	55	28	11	—	—
Portland GE	—	—	—	—	—	—	—	—	—	—	—	18	—	—	—
Powerex	83	44	121	101	16	163	—	15	184	3	257	244	—	87	62
PSC New Mexico	—	—	102	56	41	223	77	15	64	40	144	34	3	9	40
Puget Sound En	—	—	—	—	16	—	—	—	—	—	54	33	47	—	—
Salt River Proj.	—	25	100	22	4	11	45	35	49	74	62	34	54	155	42
Seattle City Light	2	—	—	—	2	3	—	—	10	6	7	11	10	21	10
Tacoma Power									—	5	14	—	5	4	—
Tucson Elec.											—	—	—	—	—
Turlock ID	—	4	—	16	3	94	9	—	5	20	5	6	3	2	—
	2021							2022							

Figure 5.9 Upward capacity/flexibility test failure intervals by concurrence (September 2022)

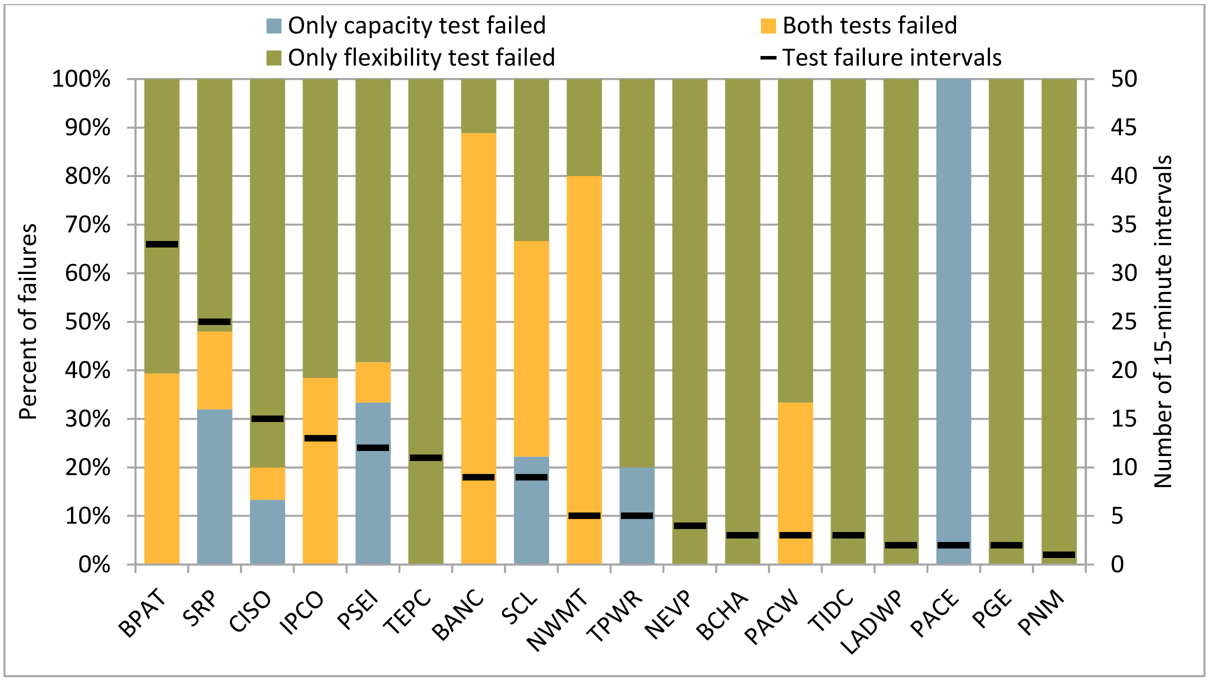
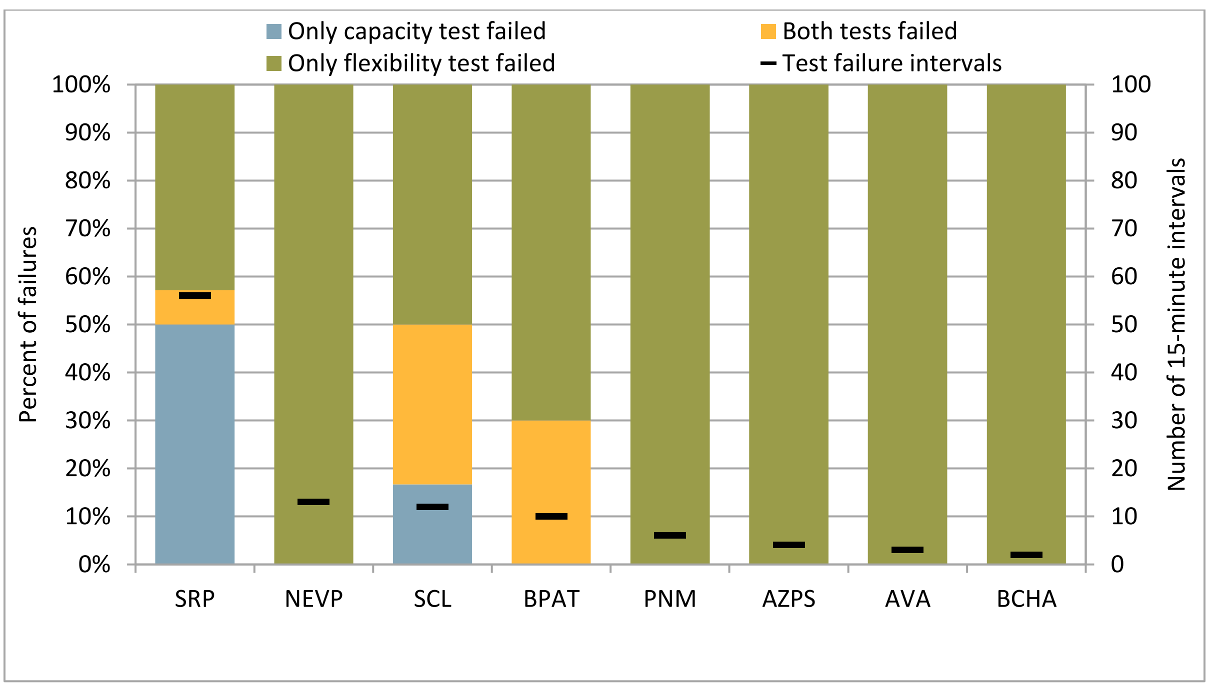


Figure 5.10 Downward capacity/flexibility test failure intervals by concurrence (September 2022)



6 Western Energy Imbalance Market 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 6.1 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. In some cases, the import limit after failing the test (i.e. the greater of the base transfer or last 15-minute interval transfer) is at or above the unconstrained total import capacity. In these cases, the import limit imposed after failing the test has no impact.

Figure 6.1 Upward capacity/flexibility test failure intervals by source of import limit (September 2022)

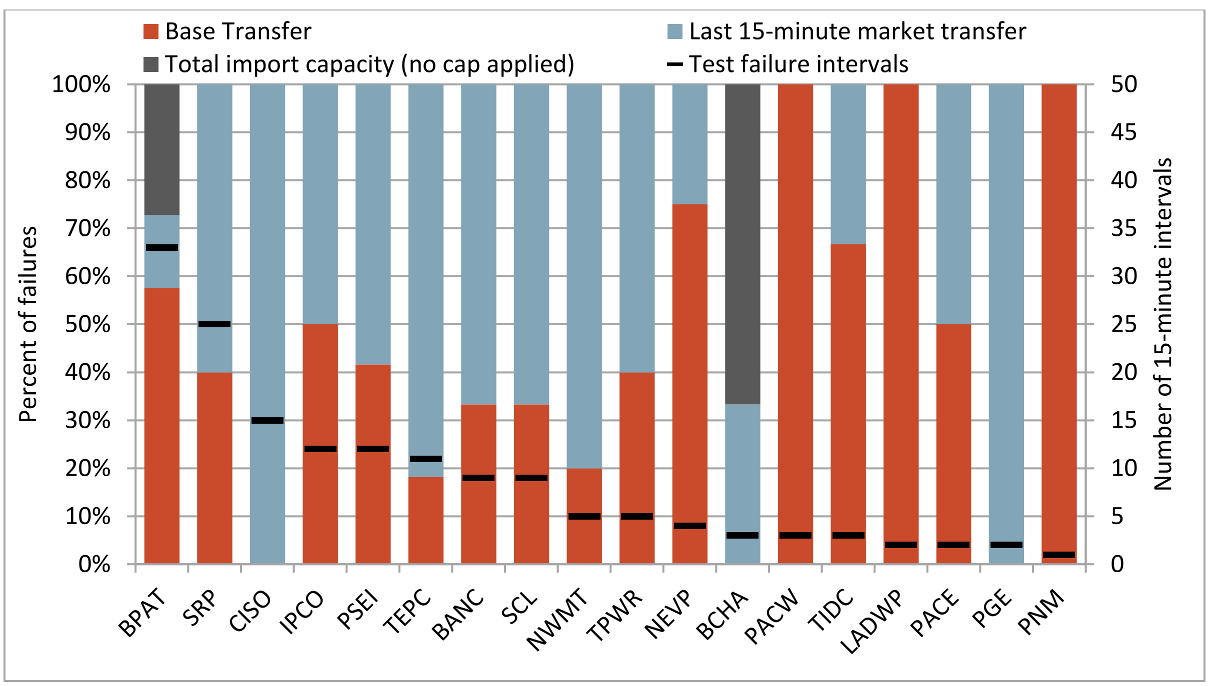


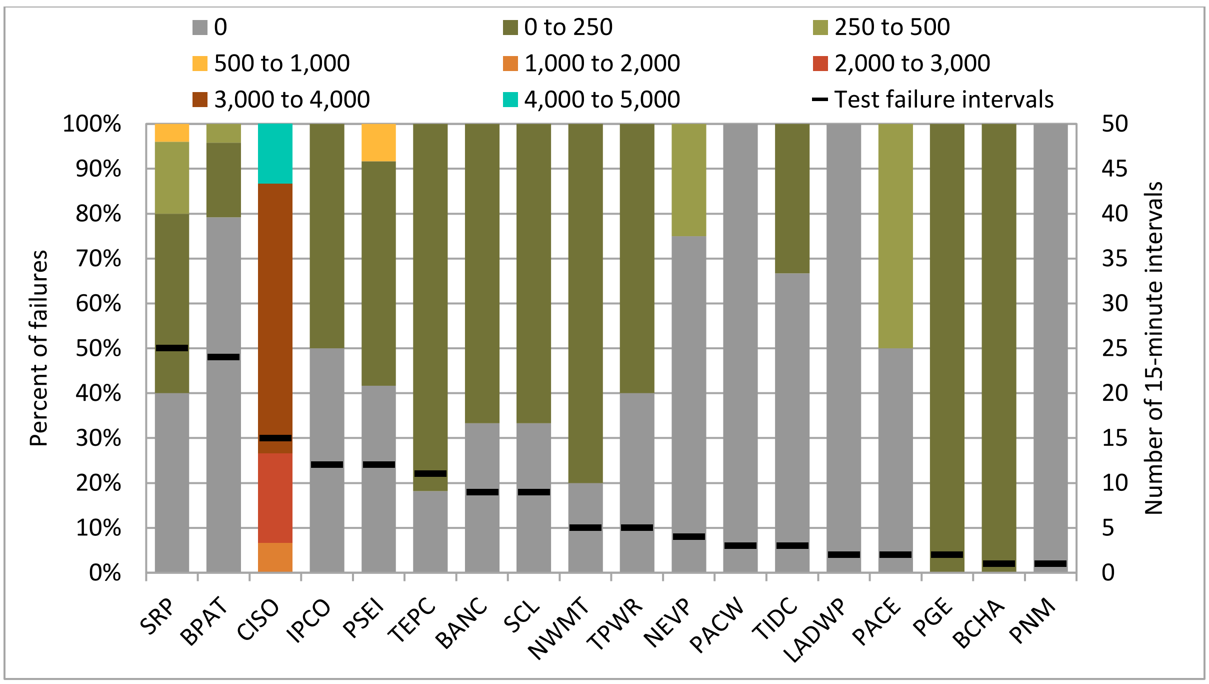
Figure 6.2 summarizes *dynamic* WEIM import limits above base transfers (fixed bilateral transactions between WEIM entities) after failing either test in the upward direction.[16] From this perspective, the incremental WEIM import limit after a test failure is set by the greater of (1) zero or (2) the transfer from the last 15-minute market interval minus the current base transfer. Therefore, the dynamic import limits

[16] 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.

show the incremental flexibility available through the Western Energy Imbalance Market 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.

The California ISO failed the resource sufficiency evaluation in 13 intervals during the month. The import limits here following the failure were between 1,700 and 4,200 MW (or around 3,260 MW on average). The CAISO does not have base transfers and often has a high volume of dynamic imports prior to any upward test failure, which will set the import limit during the failure interval. Substantial imbalance conformance adjustments entered by the CAISO operators can further contribute to this outcome. Here, the optimal transfer in the last 15-minute interval increases as the optimization solves for load plus imbalance conformance, potentially setting a higher import limit than would have existed otherwise.

Figure 6.2 Upward capacity/flexibility test failure intervals by dynamic import limit (September 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.

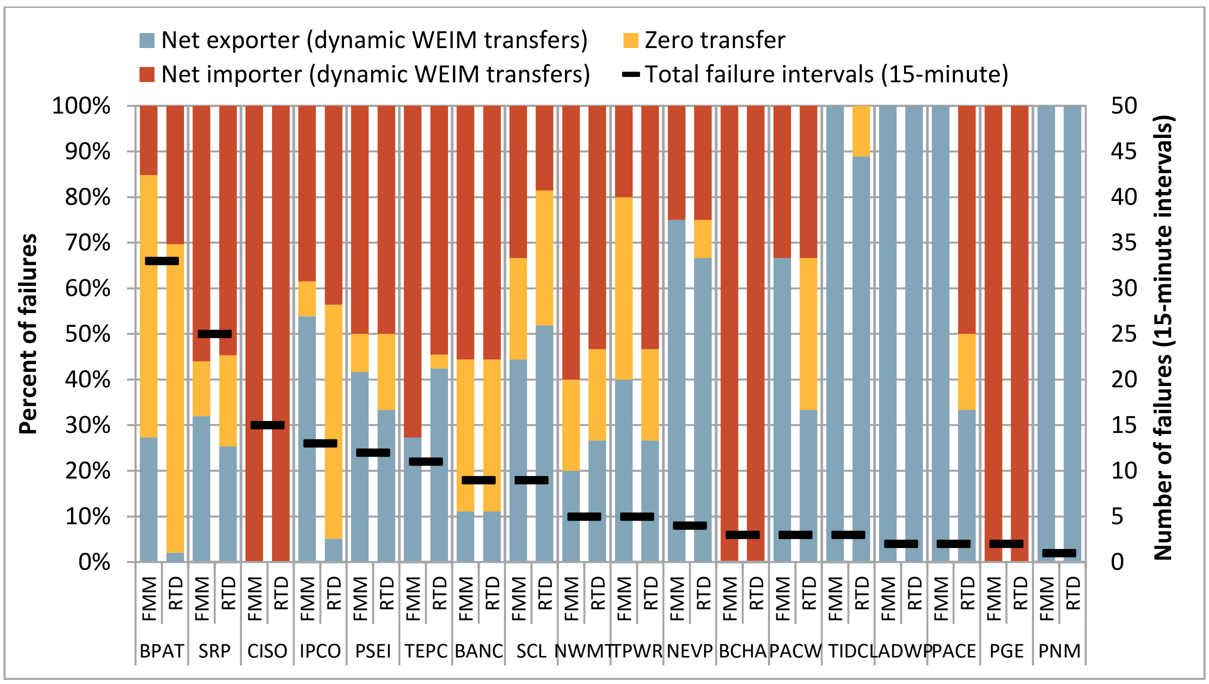
Figure 6.3 summarizes dynamic WEIM transfers (excluding any base transfer) on net for each area during an upward resource sufficiency evaluation failure in the month. Again, the black horizontal line (right axis) shows the number of 15-minute intervals with either a capacity or a flexibility test failure 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 6.4 summarizes the same information with the net transfer quantity categorized by various levels.

As shown by Figure 6.3, 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 6.5 summarizes whether the import limit that was imposed after failing either test in the upward direction ultimately impacted market transfers.[17] 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 6.3 Upward test failure by dynamic net WEIM transfer status (September 2022)



[17] 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 6.4 Upward test failure by dynamic net WEIM transfer amount (August 2022)

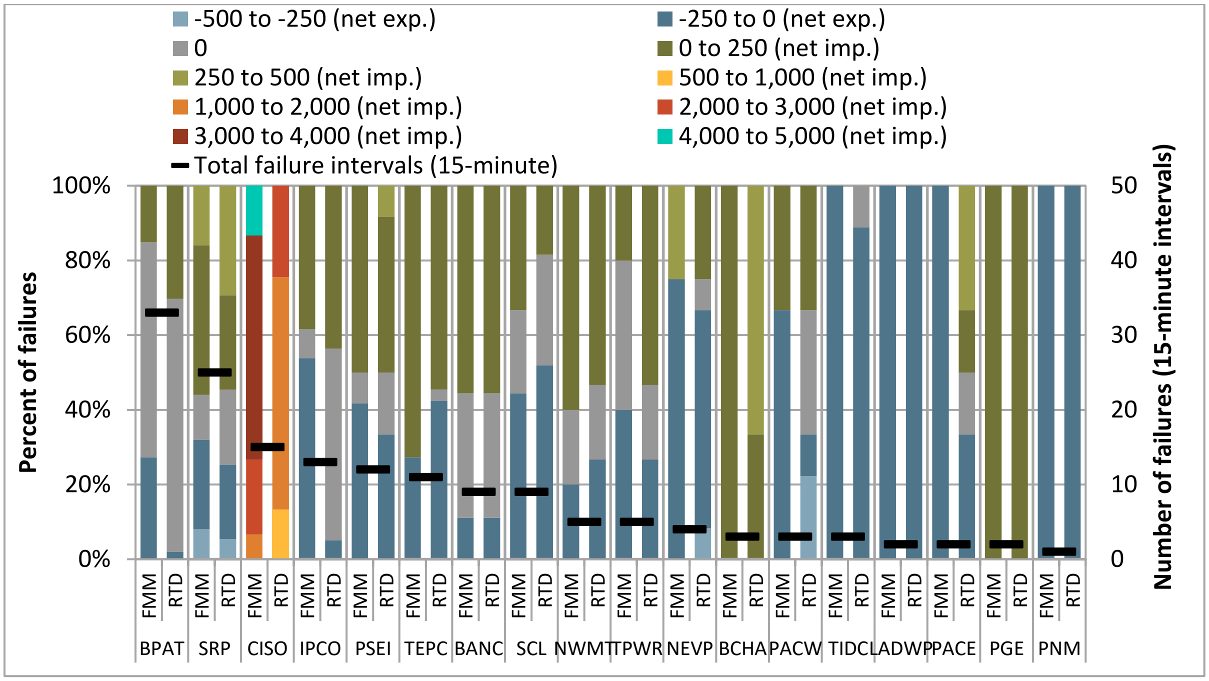
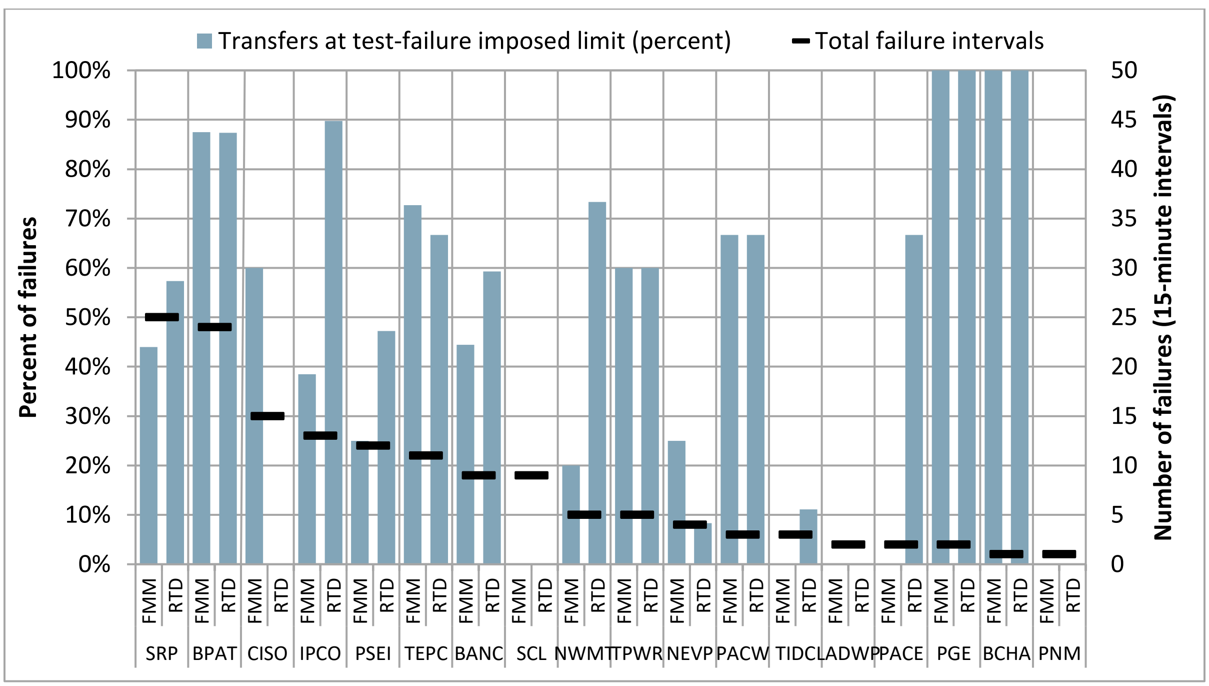


Figure 6.5 Percent of upward test failure intervals with market transfers at the imposed cap (September 2022)



7 Imbalance 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 imbalance conformance adjustments. These adjustments, sometimes referred to as *load bias,* 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.[18] 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.[19]

Figure 7.1 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 2,120 MW. Figure 7.2 shows the hourly distribution of 15-minute market imbalance conformance.

Figure 7.3 shows the same information for Bonneville Power Administration (BPA). 15-minute market imbalance conformance from BPA operators was on average 39 MW between hours 10 and 22. Figure 7.4 shows imbalance conformance adjustments for other WEIM entities with substantial imbalance conformance and Figure 7.5 shows adjustments as a percent of total load.[20]

Table 7.1 summarizes the average frequency and size of 15-minute and 5-minute market imbalance conformance for all balancing authority areas.

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

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

[20] 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 7.1 Average CAISO hour-ahead and 15-minute market imbalance conformance (September 2022)

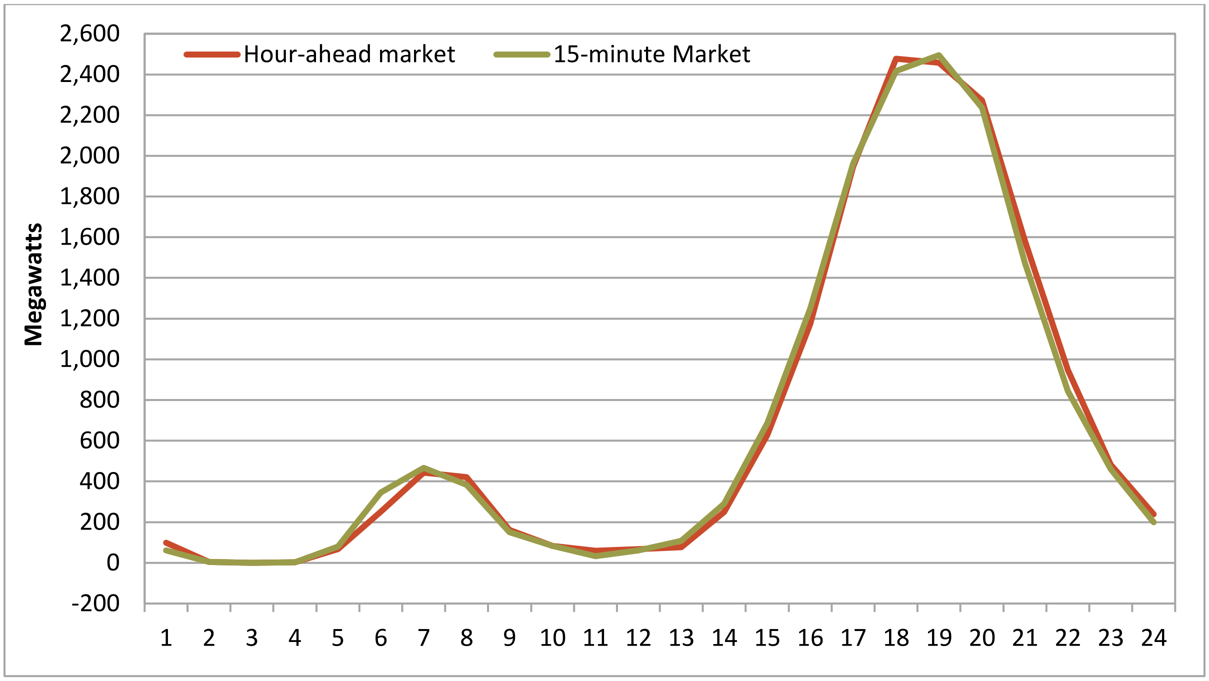


Figure 7.2 Distribution of CAISO 15-minute market imbalance conformance (September 2022)

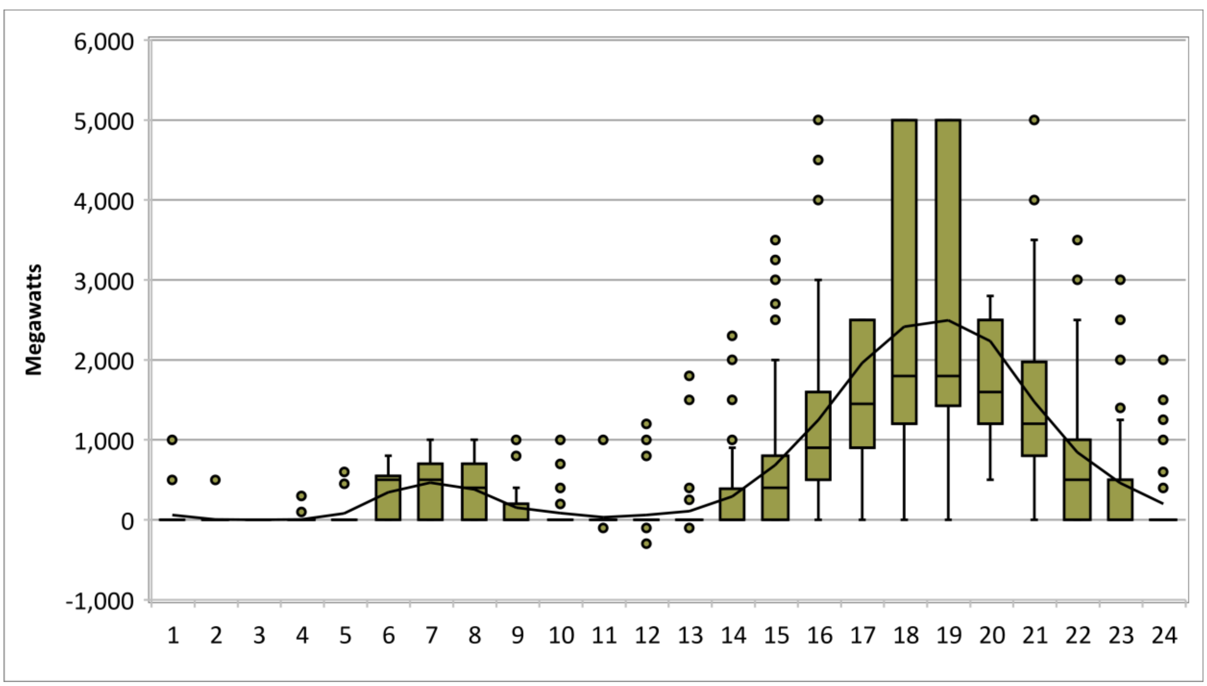


Figure 7.3 Average hourly BPA 15-minute market imbalance conformance (September 2022)

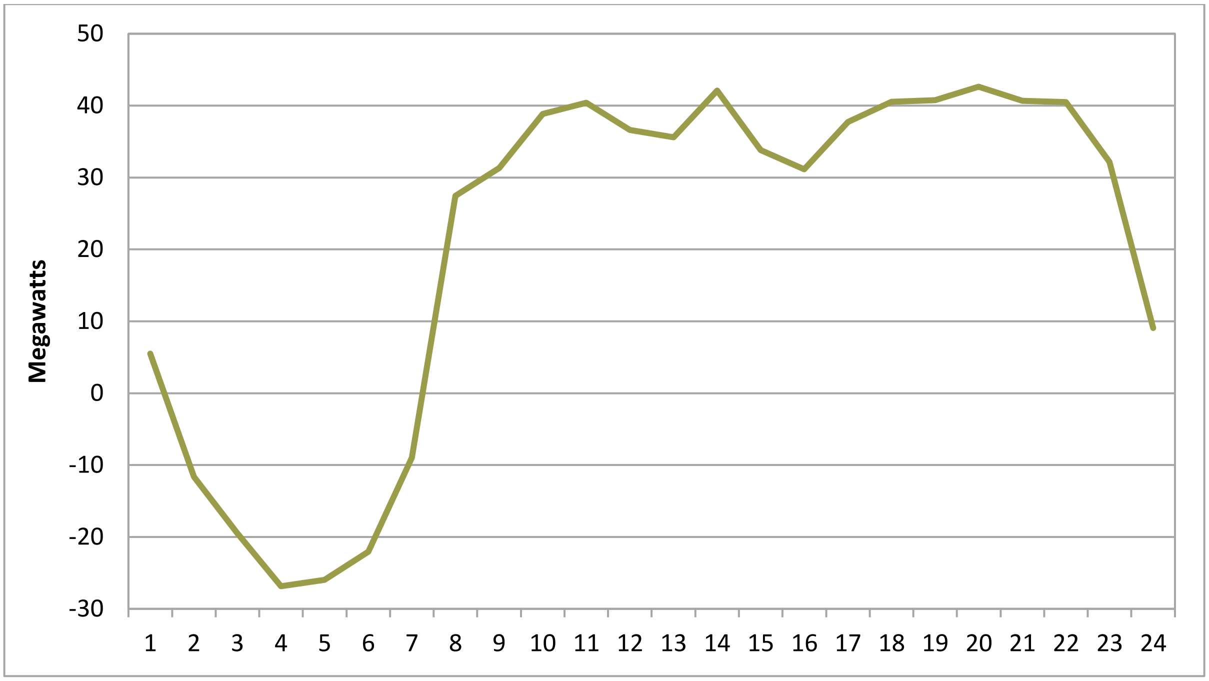


Figure 7.4 Average hourly 15-minute market imbalance conformance (September 2022)

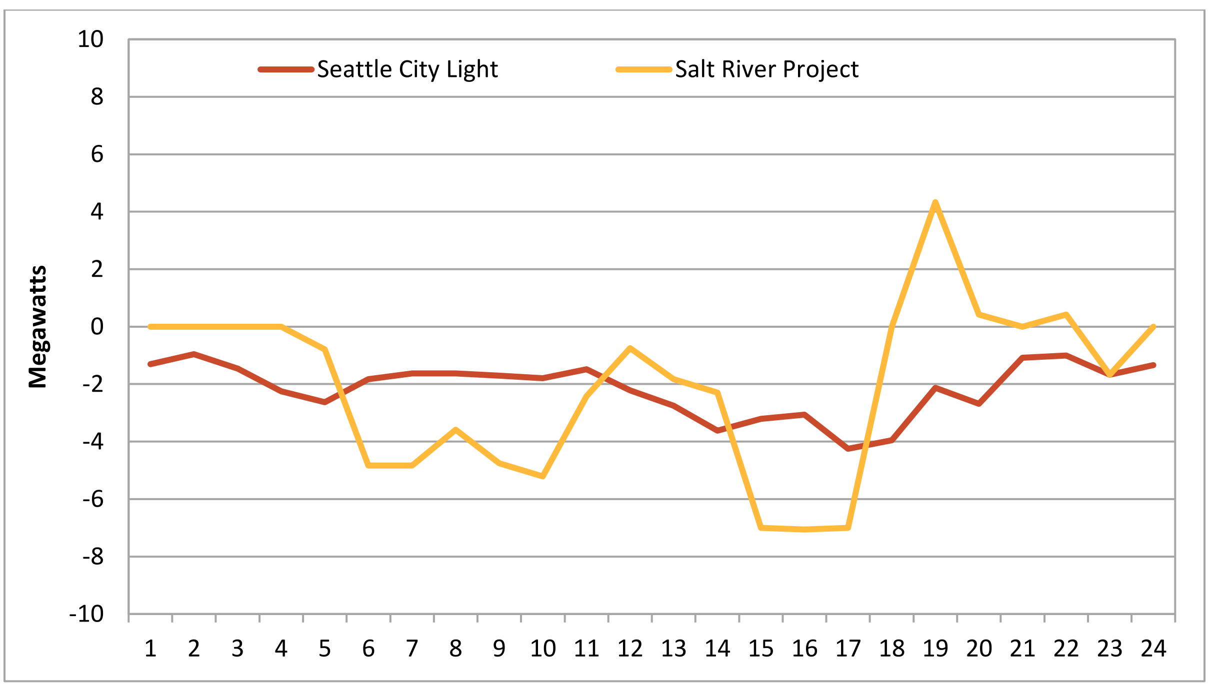


Figure 7.5 Average hourly 15-minute market imbalance conformance *as a percent of load* (August 2022)

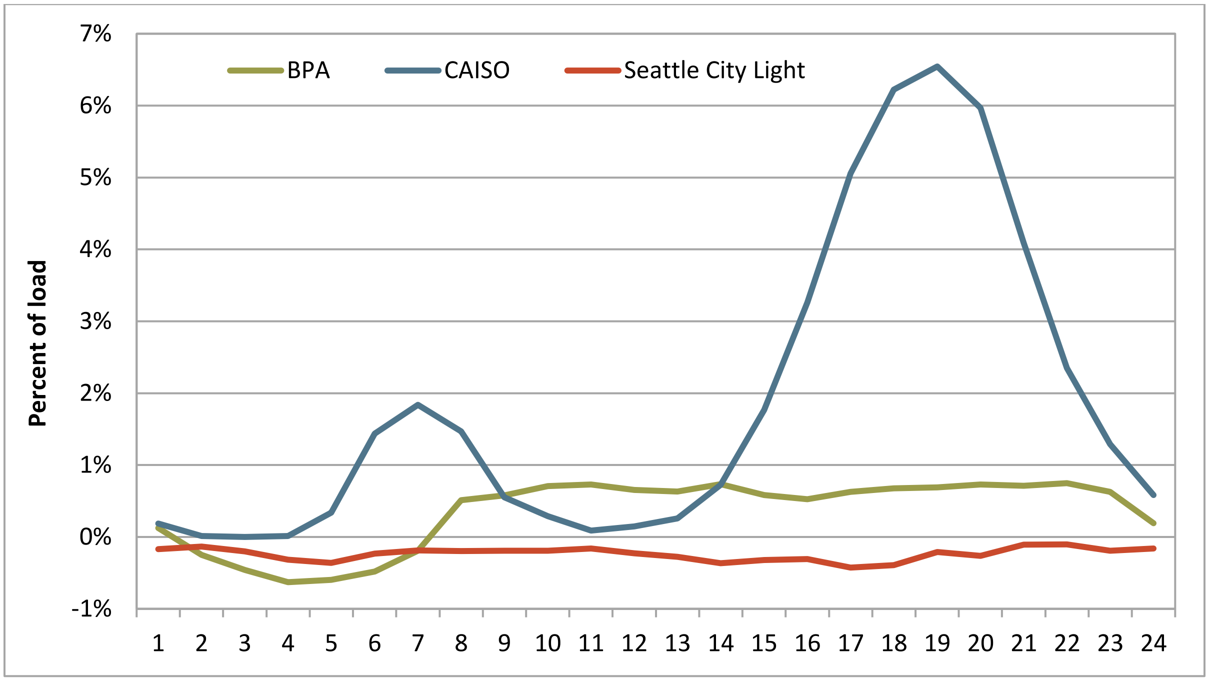


Table 7.1 Average frequency and size of imbalance conformance (September 2022)

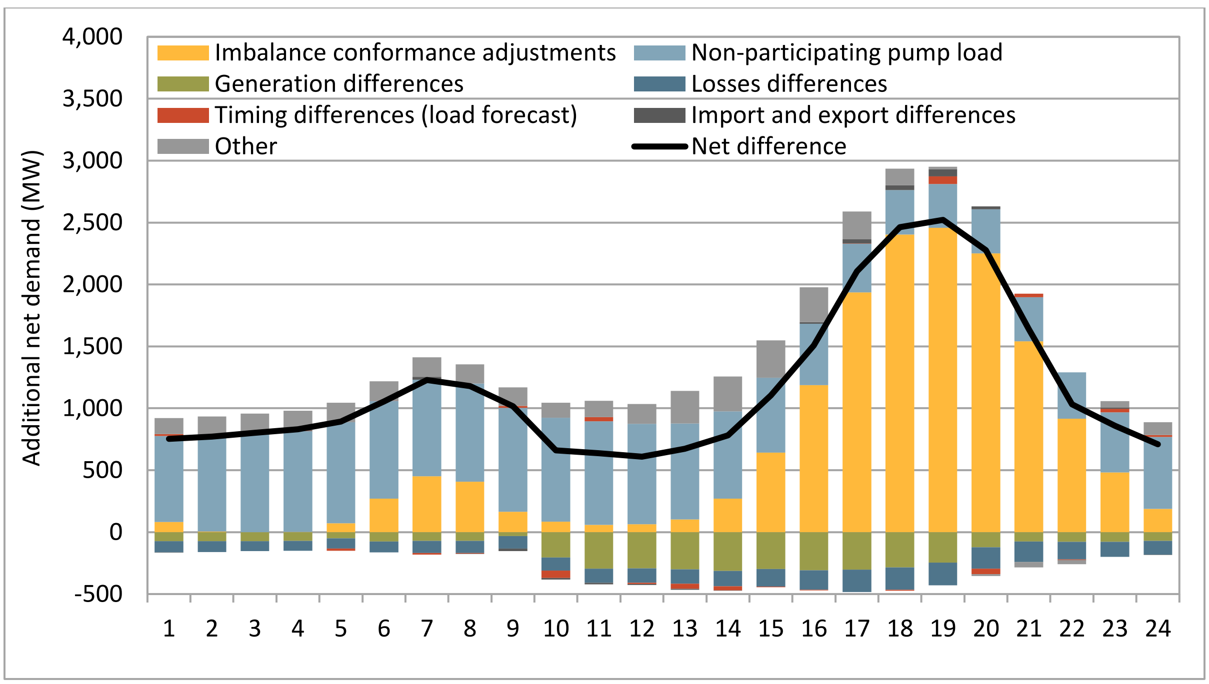
		Positive imbalance conformance			Negative imbalance conformance			Average hourly adjustment MW
Balancing area	**Market**	**Percent of intervals**	**Average MW**	**Percent of total load**	**Percent of intervals**	**Average MW**	**Percent of total load**	
Arizona Public Service	15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
	5-minute market	54%	68	1.5%	14%	-43	1.1%	30
Avista	15-minute market	0.2%	27	1.5%	1%	-40	3.3%	0
	5-minute market	2%	18	1.3%	32%	-22	2.0%	-7
Balancing Authority of Northern California	15-minute market	0%	N/A	N/A	0.2%	-103	3.0%	0
	5-minute market	0%	N/A	N/A	0.3%	-82	3.2%	0
Bonneville Power Administration	15-minute market	67%	43	0.8%	31%	-27	0.6%	20
	5-minute market	68%	43	0.8%	31%	-28	0.6%	21
California ISO	15-minute market	44%	1516	4.6%	0.3%	-122	0.5%	670
	5-minute market	46%	310	1.0%	19%	-263	0.9%	93
Idaho Power	15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
	5-minute market	31%	50	2.3%	7%	-40	2.0%	13
Los Angeles Department of Water and Power	15-minute market	2%	56	2.0%	0%	N/A	N/A	1
	5-minute market	16%	54	1.4%	13%	-60	2.0%	0
NorthWestern Energy	15-minute market	3%	11	1.1%	1%	-21	1.8%	0
	5-minute market	10%	16	1.4%	5%	-17	1.5%	1
NV Energy	15-minute market	0.03%	75	1.2%	0%	N/A	N/A	0
	5-minute market	40%	108	2.0%	1%	-110	2.2%	43
PacifiCorp East	15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
	5-minute market	20%	94	1.6%	30%	-110	2.0%	-15
PacifiCorp West	15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
	5-minute market	0.9%	46	2.1%	40%	-53	2.5%	-21
Portland General Electric	15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
	5-minute market	8%	31	1.2%	1%	-32	1.3%	2
Public Service Company of New Mexico	15-minute market	0.03%	80	3.8%	0%	N/A	N/A	0
	5-minute market	22%	57	3.8%	4%	-88	6.0%	10
Puget Sound Energy	15-minute market	0%	N/A	N/A	1%	-42	1.7%	0
	5-minute market	0.8%	34	1.4%	47%	-35	1.4%	-16
Salt River Project	15-minute market	0.7%	64	1.3%	2%	-118	2.5%	-2
	5-minute market	9%	59	1.1%	7%	-89	2.3%	-1
Seattle City Light	15-minute market	0.1%	20	2.3%	11%	-19	2.1%	-2
	5-minute market	1%	13	1.3%	81%	-24	2.6%	-19
Tacoma Power	15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
	5-minute market	4%	12	2.6%	6%	-15	3.7%	0
Tucson Electric Power	15-minute market	0%	N/A	N/A	0.2%	-48	3.0%	0
	5-minute market	26%	50	3.0%	9%	-55	3.7%	8
Turlock Irrigation District	15-minute market	3%	12	3.1%	0.1%	-25	7.2%	0
	5-minute market	4%	12	3.1%	0.1%	-25	7.2%	0

8 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 8.1 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 8.1 Additional CAISO net demand in the latest 15-minute market run not accounted for in the bid-range capacity test (September 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.

9 Net load uncertainty in the resource sufficiency evaluation

This section highlights where net load uncertainty currently used in the resource sufficiency evaluation comes from, and how it compares with error between load and variable energy resources (VER) amounts used in the tests and in the real-time market. The uncertainty component currently used in both the flexible ramp sufficiency test and the bid-range capacity test, is pulled from the 15-minute market flexible ramping product uncertainty calculations. As noted in this section, DMM recommends that any uncertainty calculation used in the resource sufficiency evaluation be developed separately from that of the flexible ramping product.

Current load uncertainty calculation

The uncertainty component, currently used in both the flexible ramp sufficiency test and the bid-range capacity test, is pulled from the 15-minute market flexible ramping product uncertainty calculations. These are calculated from historical net load error observations in the same hour based on the error between advisory 15-minute market net load and binding 5-minute market net load.[21] The 2.5 percentile of these observations is used for downward uncertainty and the 97.5 percentile is used for upward uncertainty.

The 95 percent confidence interval for the uncertainty requirement in the flexible ramping product was designed to capture the upper end of uncertainty needs, such that it could be optimally relaxed based on the trade-off between the cost of procuring additional flexible ramping capacity and the expected cost of a power balance violation costs. In the resource sufficiency evaluation, this trade-off is not considered, and the upper end of uncertainty is instead required in full to pass both tests. DMM has asked the CAISO and stakeholders to consider whether the 95 percent confidence interval, or another, is most appropriate for the tests.[22]

Further, the resource sufficiency evaluation occurs in a different timeframe than the 15-minute market. Figure 9.1 illustrates the current uncertainty calculation — based on net load error between an advisory 15-minute market interval and corresponding binding 5-minute market intervals — as well as how it compares with the timeframe of the resource sufficiency evaluation. The current uncertainty calculation captures 45 to 55 minutes of potential uncertainty from the 15-minute market run to three corresponding 5-minute market runs. In contrast, when comparing the VER and load forecast values used in each interval of the resource sufficiency evaluation to corresponding 5-minute intervals, there exist a larger gap for uncertainty to materialize.[23]

In comparing the first 15-minute test interval to corresponding 5-minute market intervals, the timeframe and potential for net load uncertainty is similar to the timeframe of the 15-minute market

[21] Weekdays use data for the same hour from the last 40 weekdays. For weekends, the last 20 weekend days are used. In comparing the 15-minute observation to the three corresponding 5-minute observations, the minimum and maximum net load errors are used as a separate observation in the distribution.

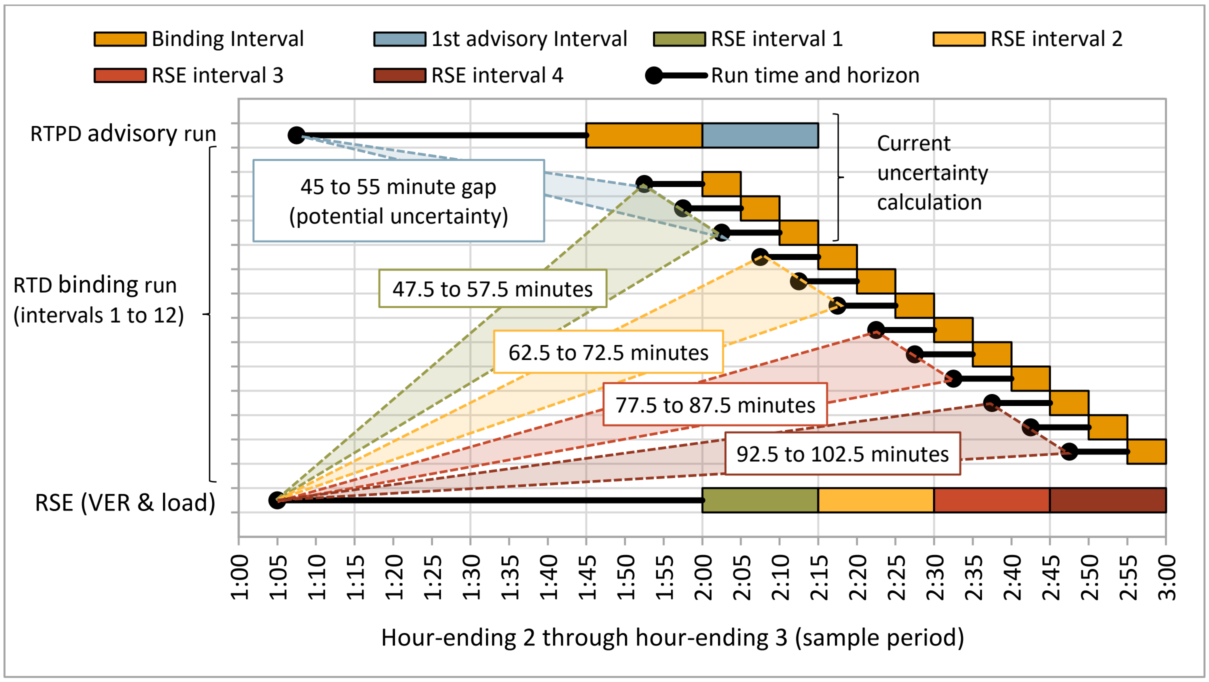
[22] Department of Market Monitoring, *Comments on EIM Resource Sufficiency Evaluation Enhancements Issue Paper*, September 8, 2021. http://www.caiso.com/Documents/DMM-Comments-on-EIM-Resource-Sufficiency-Evaluation-Enhancements-Issue-Paper-Sep-8-2021.pdf

[23] The figure shows the resource sufficiency evaluation run time at 55 minutes prior to the hour. While the financially binding test is run at 40 minutes prior to the hour, the VER and load forecasts used in the final test are pulled from the advisory test performed at T-55.

flexible ramping product uncertainty calculation. In the later test intervals, the gap between the predicted forecasts at the time of the resource sufficiency evaluation and the real-time forecasts widens, reaching above 100 minutes.

As part of the flexible ramping product refinements stakeholder initiative, the uncertainty component is expected to be enhanced to better account for net load uncertainty currently in the system. DMM recommends that any uncertainty used in the resource sufficiency evaluation be developed separately from that of the flexible ramping product.

Figure 9.1 Comparison of current uncertainty calculation to the timeframe of the RSE



Metrics on the uncertainty component and actual real-time net load error

This section provides metrics covering where uncertainty currently used in the tests comes from, and how that compares to error between load and VER amounts used in the tests and in the real-time market.

Figure 9.2 summarizes the current source of net load error from either load, wind, or solar error during the month for the CAISO. The figure shows the average weekday uncertainty during the month (from the 97.5 percentile of net load error observations for upward uncertainty and 2.5 percentile of net load error observations for downward uncertainty) and what contributed to that uncertainty.

Again, uncertainty is derived from the error between predicted 15-minute market net load and actual 5-minute market net load; this metric summarizes each component's contribution to net load error. Here, positive load error reflects an increase in net load in the 5-minute market because of an increase in load while positive VER error reflects an increase in net load in the 5-minute market because of a decrease in wind or solar. In some cases, DMM was not able to replicate the net load error from its components such that the full net load error was marked as 'unknown error' and factored into the average.

In the metric, *measured* uncertainty is from exactly the 2.5 percentile and 97.5 percentile of net load errors, from the same hour of the last 40 weekdays. In the resource sufficiency evaluation (and flexible ramping product), measured uncertainty can be capped by thresholds. The thresholds are based on a higher percentile of historical uncertainty and are designed to help prevent extreme outlier or erroneous net load errors from impacting the uncertainty and associated market outcomes. *RSE uncertainty* summarizes the values that were actually used in the tests, including any threshold caps and rounding.

Figure 9.3 summarizes the difference between net load forecasts used in the bid range capacity test and those used in the 5-minute market for the CAISO during the month. The hourly distributions were created from the difference between 5-minute market net load and net load in the corresponding test interval. Here, a higher net load error reflects higher load (or lower renewables) in real-time, relative to the tests. In comparison, the red lines show the average upward and downward uncertainty used in the tests during the same period. This metric therefore highlights test-horizon net load error and how well it fits within the current construct of uncertainty.

Figure 9.4 provides similar information, splitting out and showing how load and VER forecasts used in the resource sufficiency evaluation each compare to those in the 5-minute market. Again, positive load error reflects higher load in the 5-mintue market, while positive VER error reflects lower wind and solar in the 5-minute market (higher net load).

Figures covering the same information for all WEIM entities are shown below.

Figure 9.2 CAISO average uncertainty by component (weekdays, September 2022)

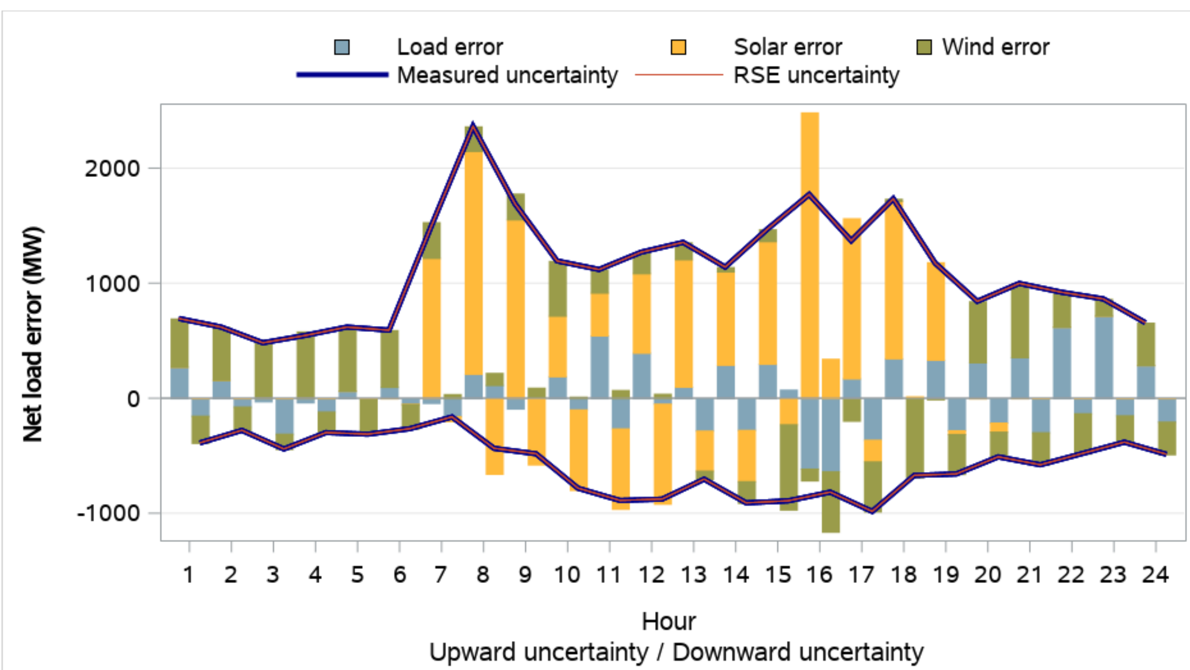


Figure 9.3 CAISO distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, September 2022)

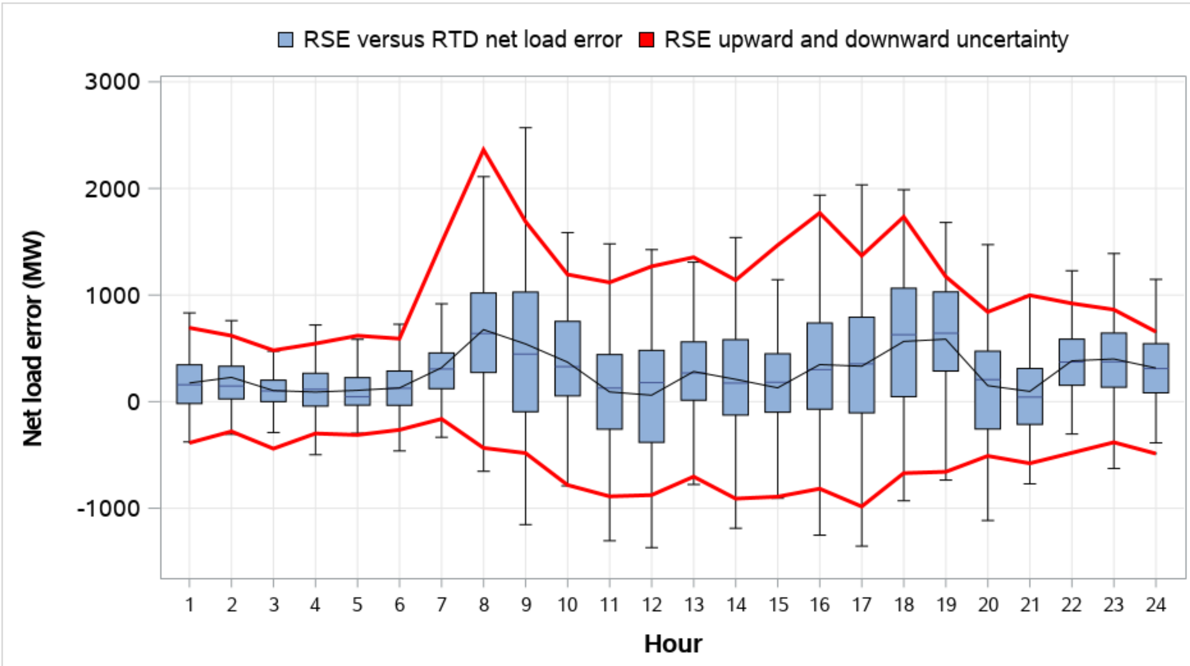


Figure 9.4 CAISO distribution of RSE and RTD load and VER error (weekdays, September 2022)

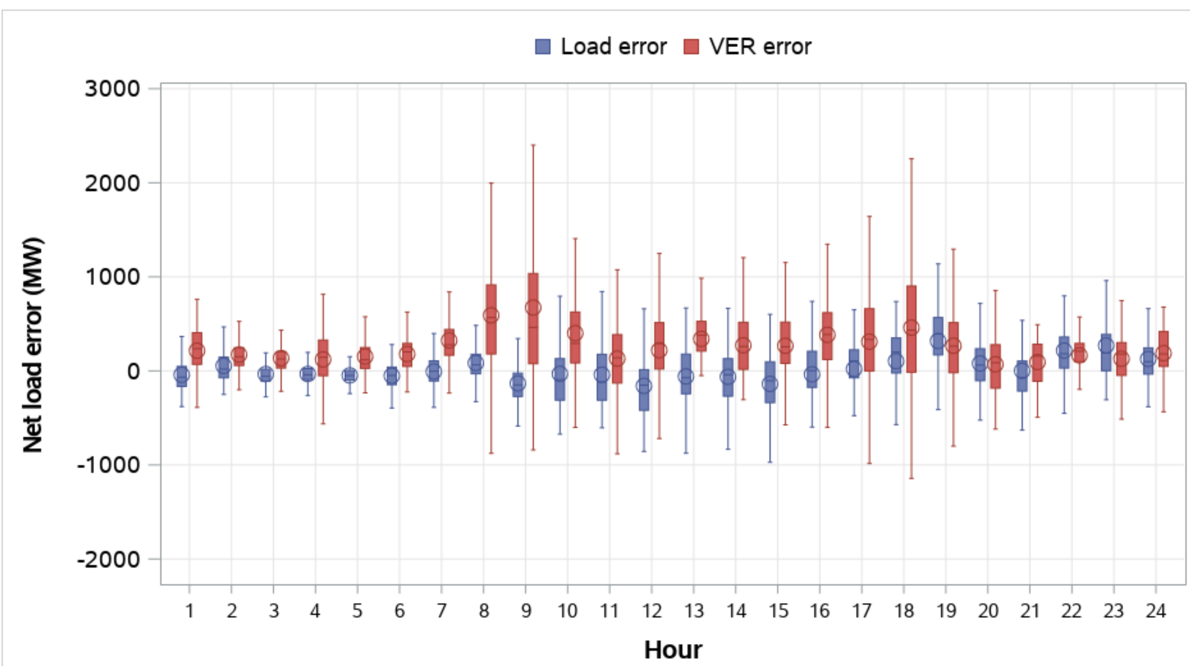


Figure 9.5 Arizona Public Service average uncertainty by component (weekdays, September 2022)

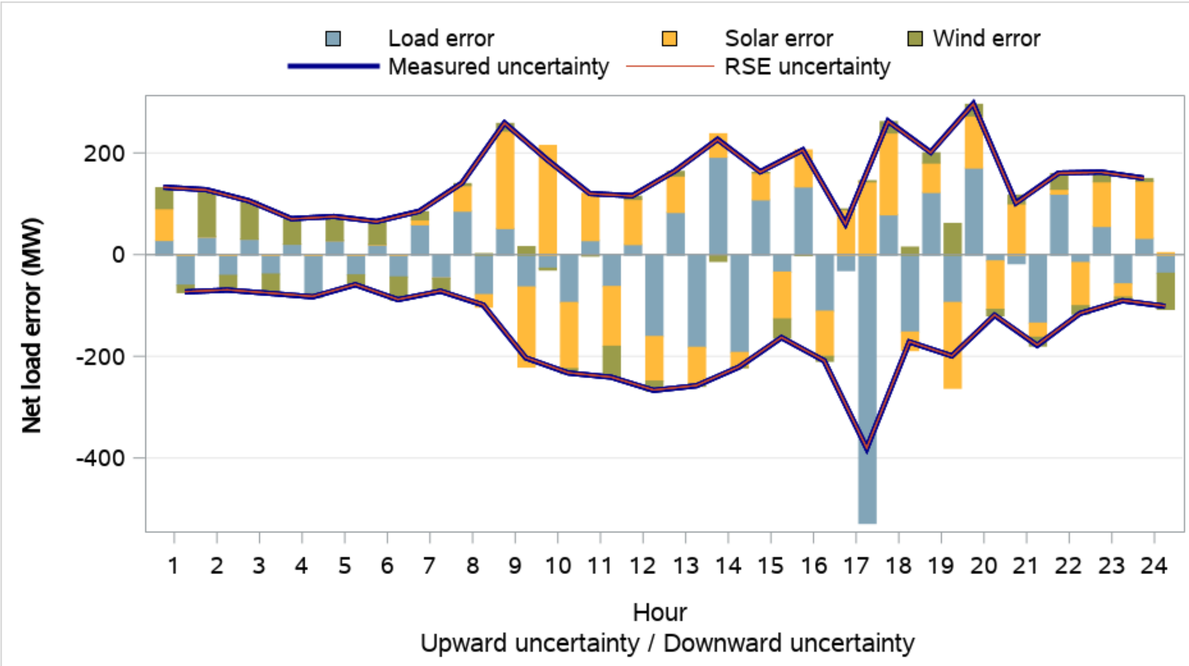


Figure 9.6 Arizona Public Service distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, September 2022)

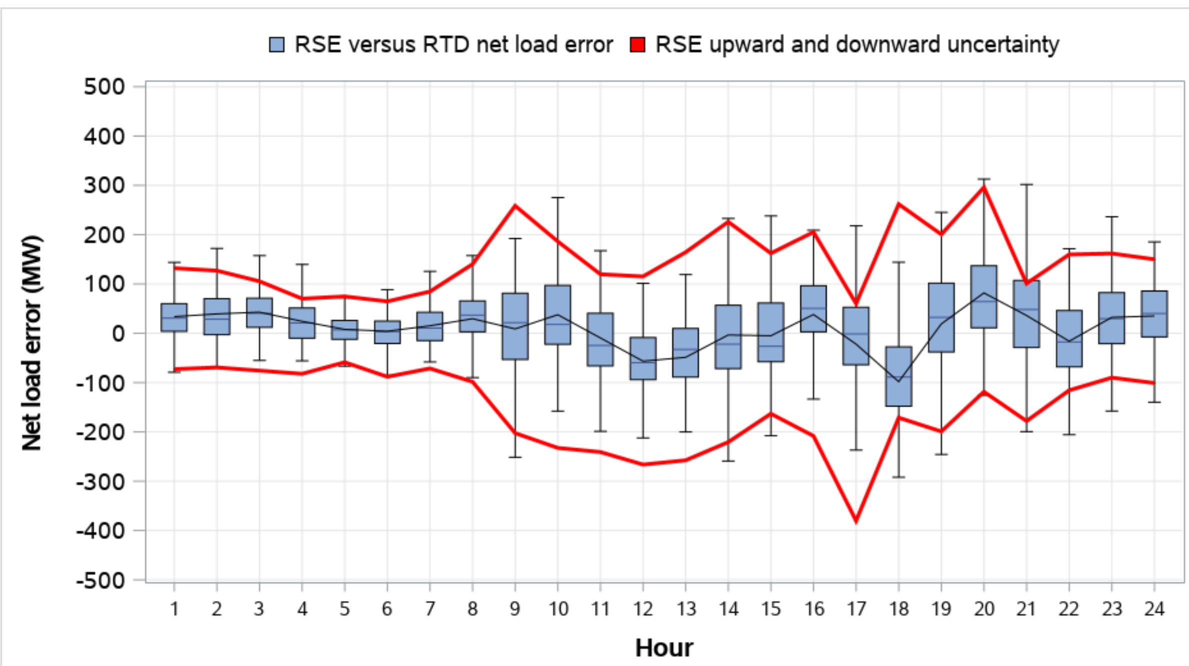


Figure 9.7 Arizona Public Service distribution of RSE and RTD load and VER error (weekdays, September 2022)

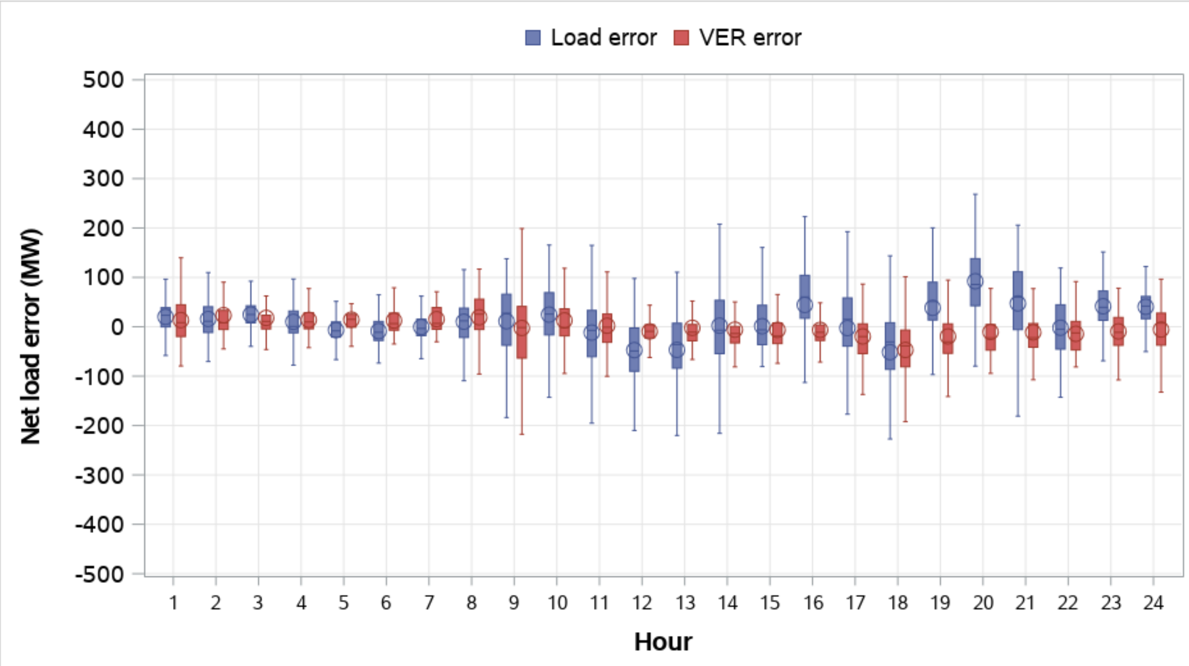


Figure 9.8 Avista average uncertainty by component (weekdays, September 2022)

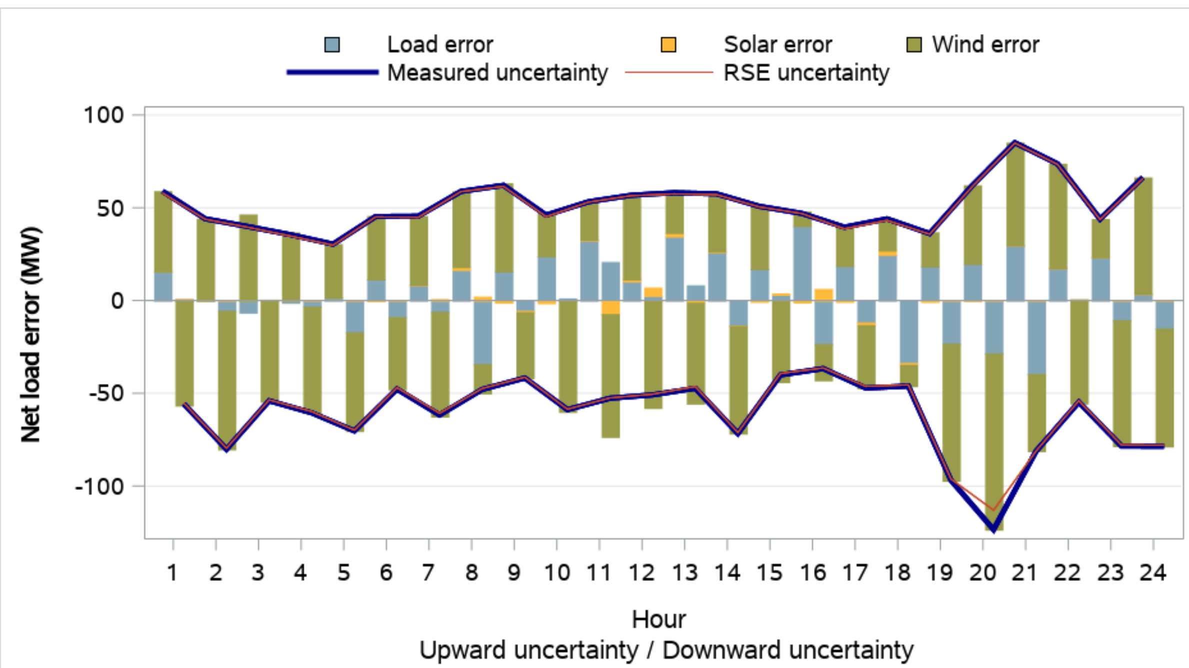


Figure 9.9 Avista distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, September 2022)

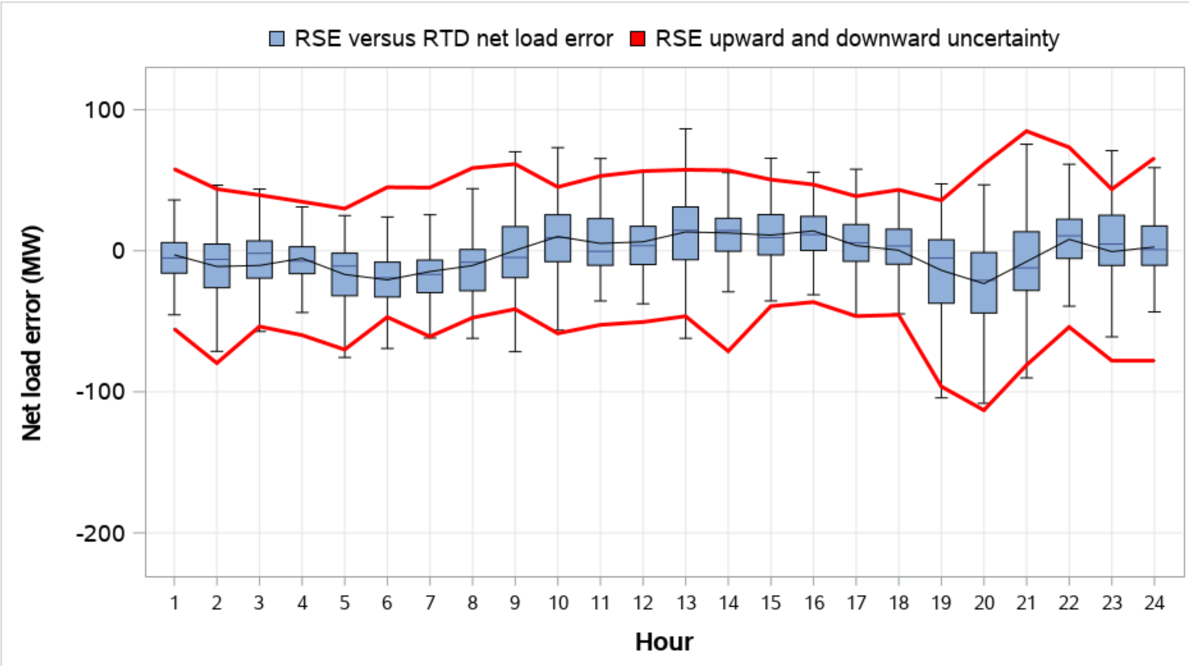


Figure 9.10 Avista distribution of RSE and RTD load and VER error (weekdays, September 2022)

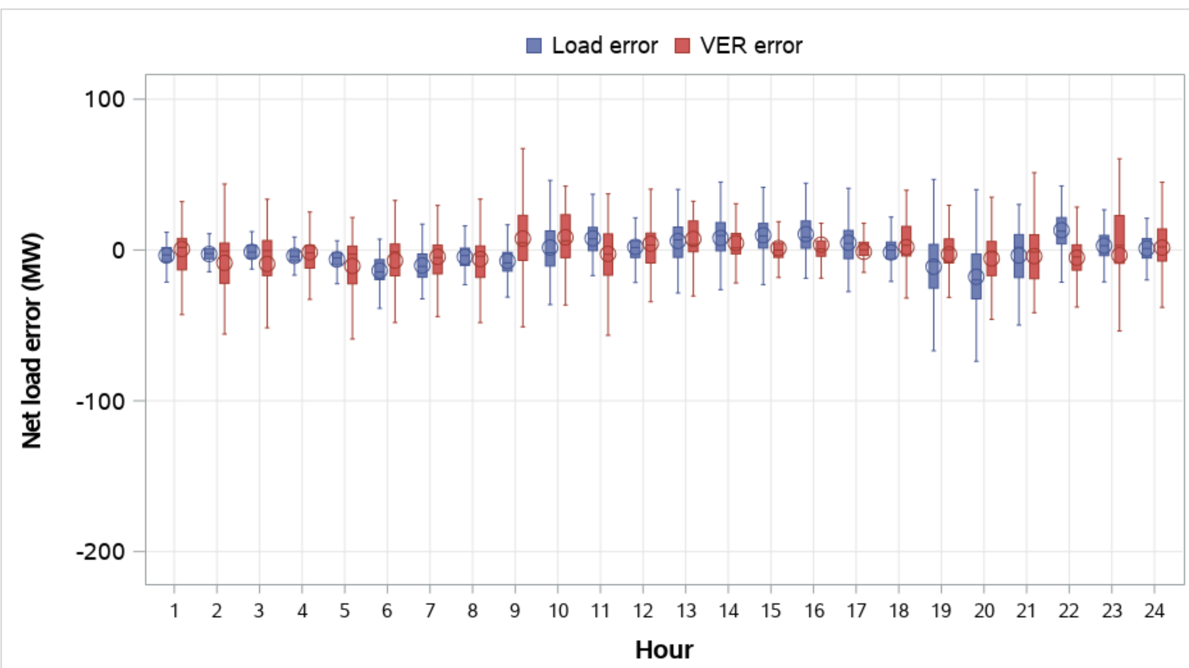


Figure 9.11 BANC average uncertainty by component (weekdays, September 2022)

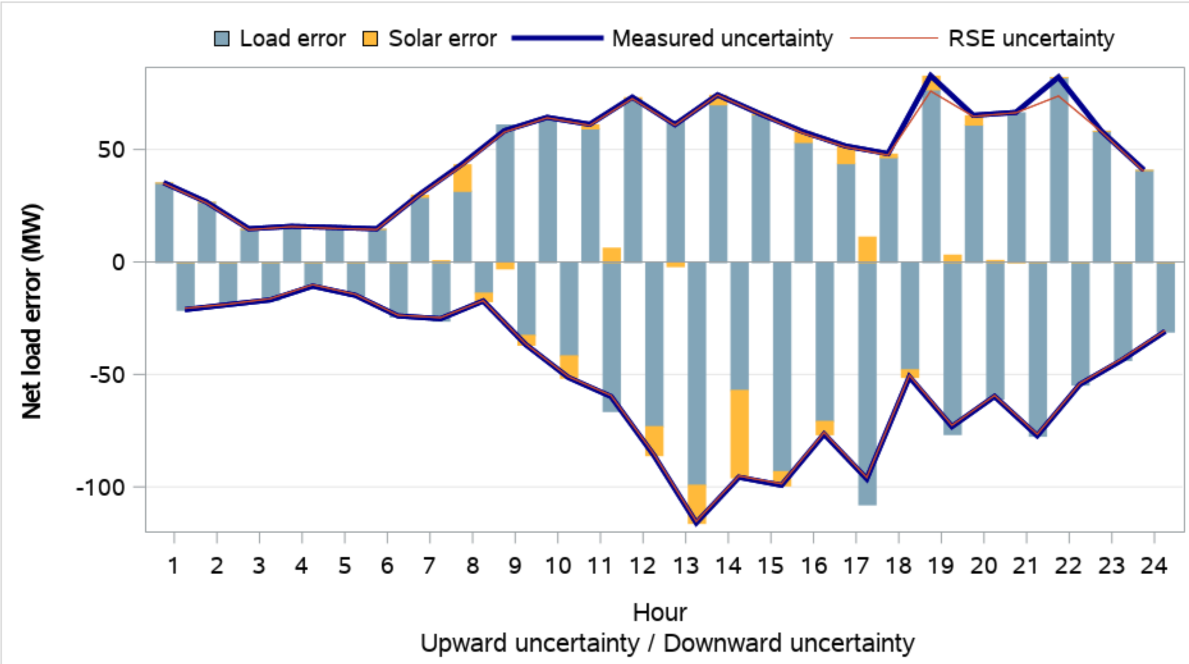


Figure 9.12 BANC distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, September 2022)

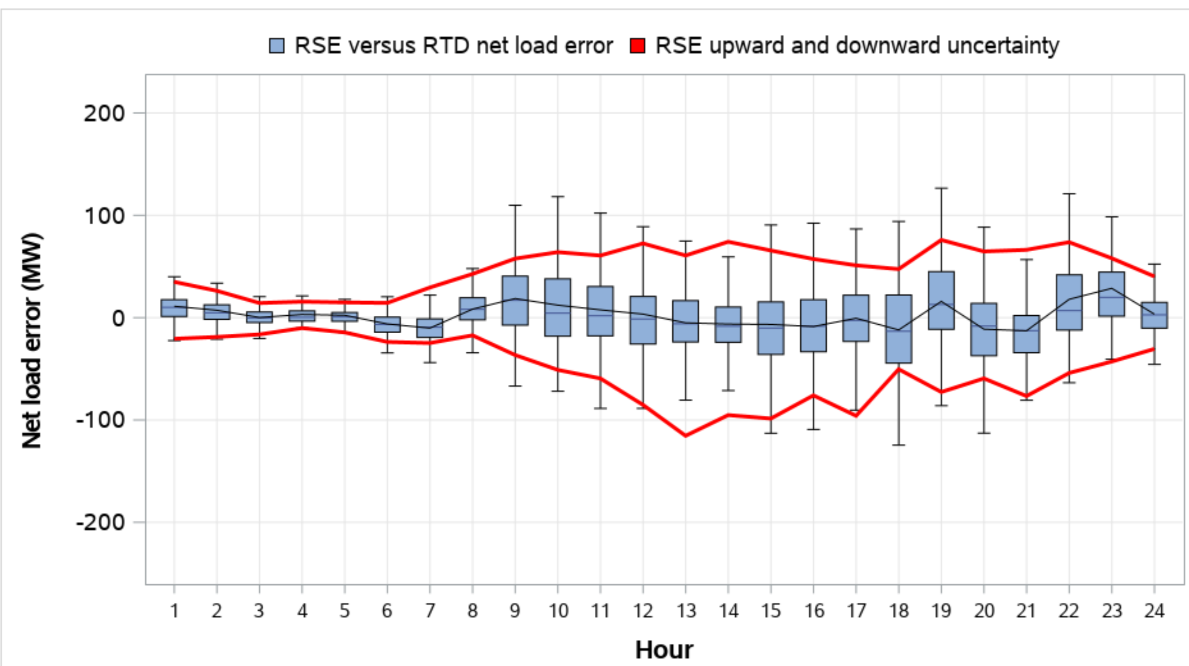


Figure 9.13 BANC distribution of RSE and RTD load and VER error (weekdays, September 2022)

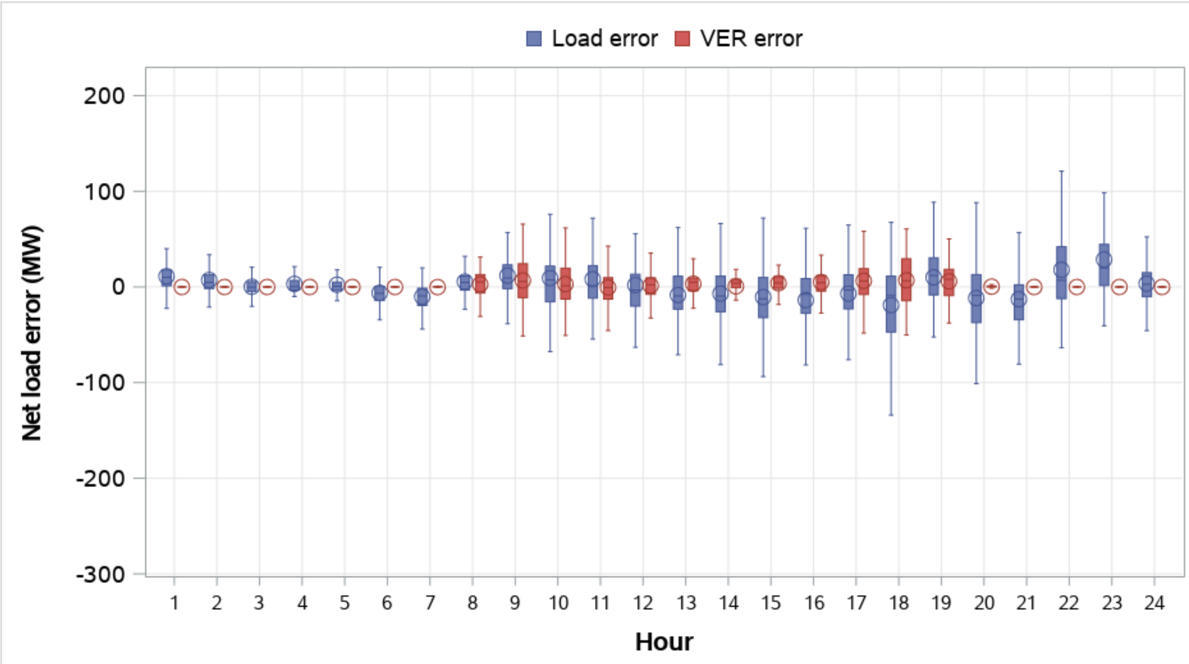


Figure 9.14 BPA average uncertainty by component (weekdays, September 2022)

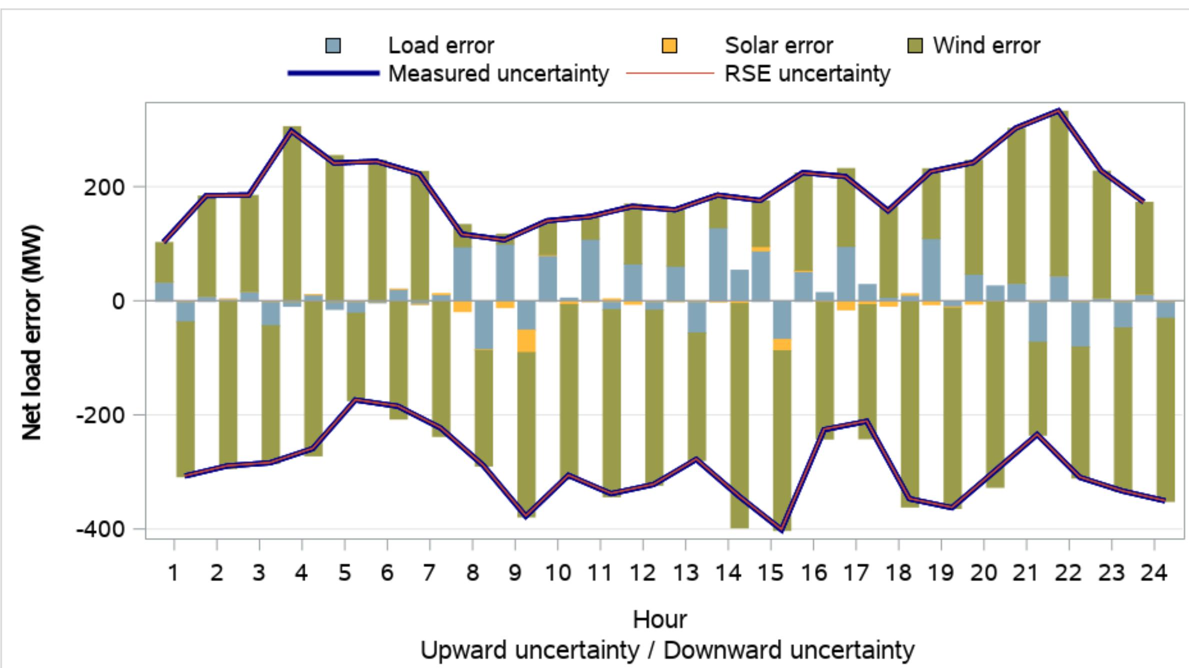


Figure 9.15 BPA distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, September 2022)

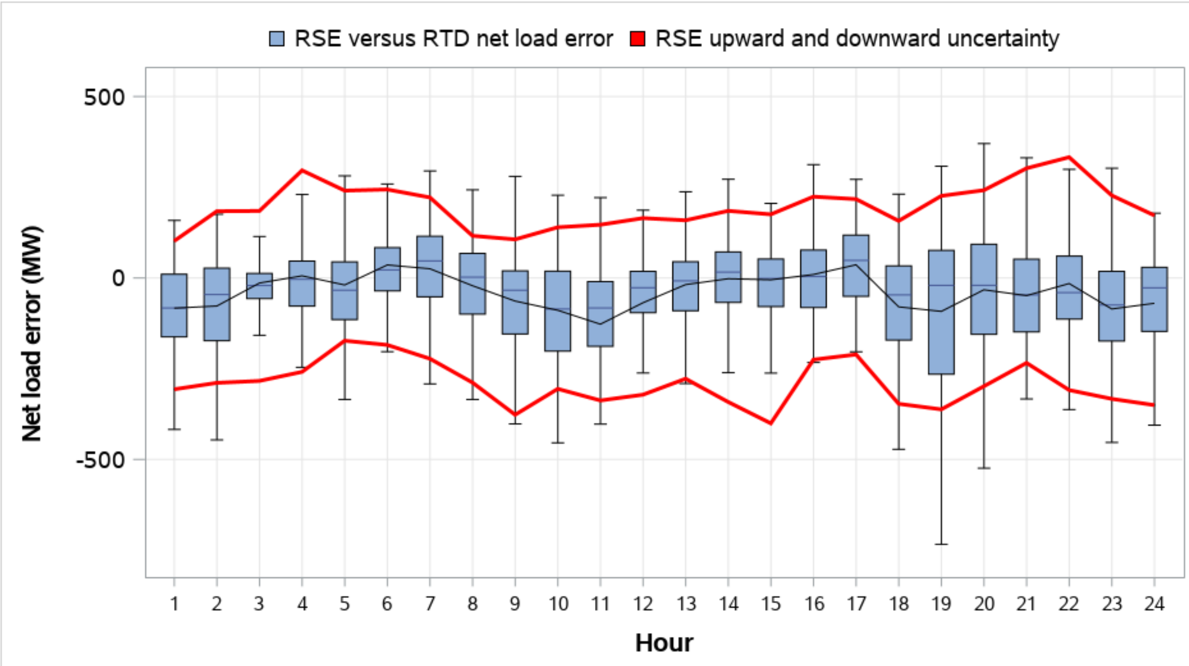


Figure 9.16 BPA distribution of RSE and RTD load and VER error (weekdays, September 2022)

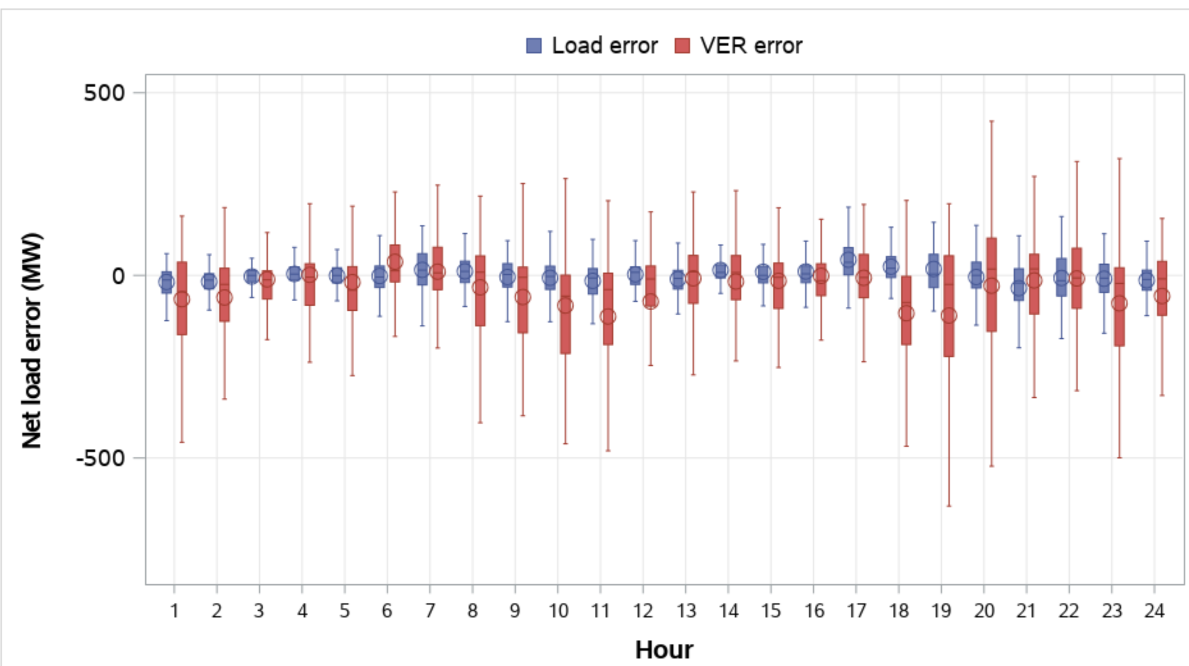


Figure 9.17 Idaho Power average uncertainty by component (weekdays, September 2022)

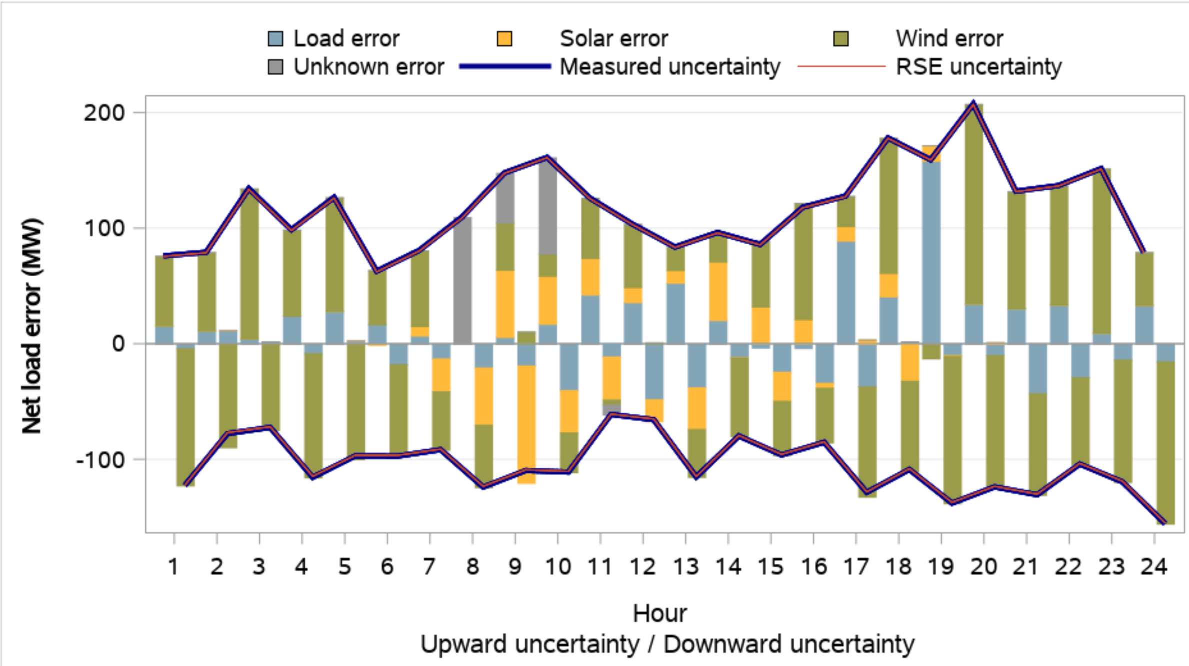


Figure 9.18 Idaho Power distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, September 2022)

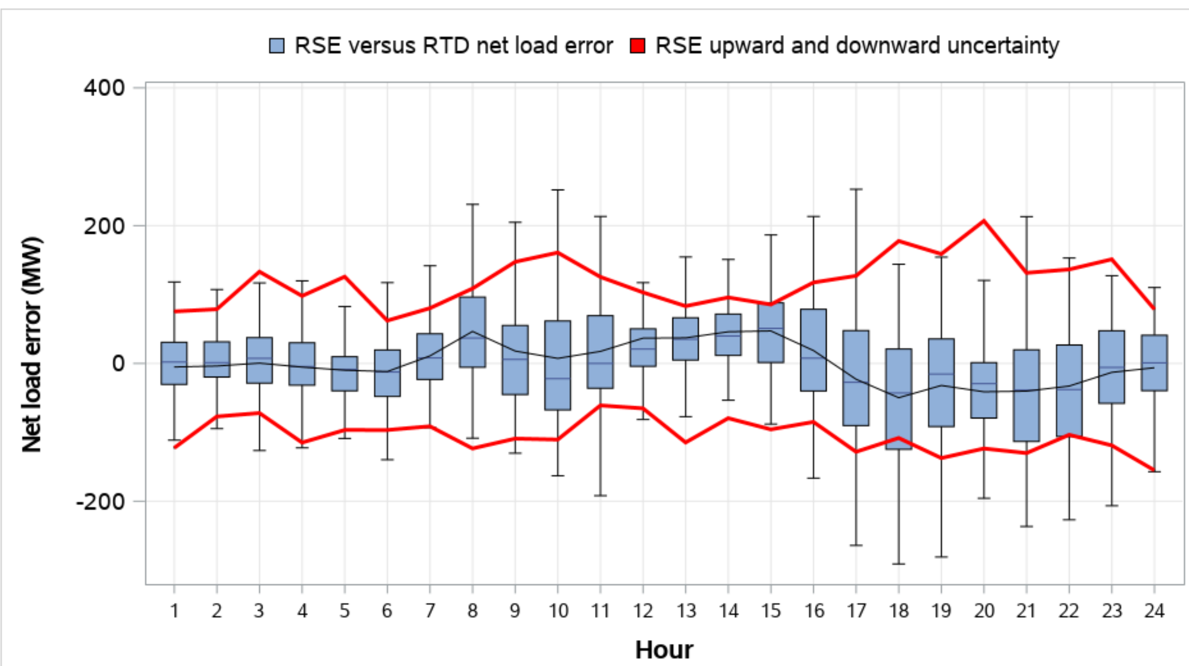


Figure 9.19 Idaho Power distribution of RSE and RTD load and VER error (weekdays, September 2022)

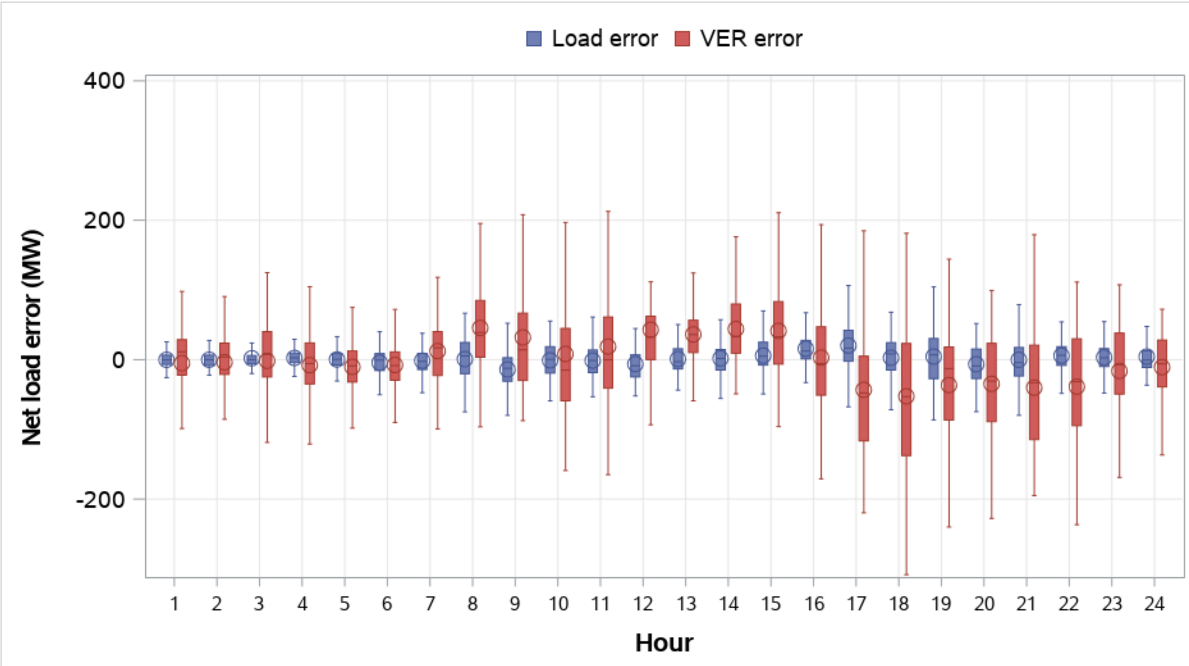


Figure 9.20 LADWP average uncertainty by component (weekdays, September 2022)

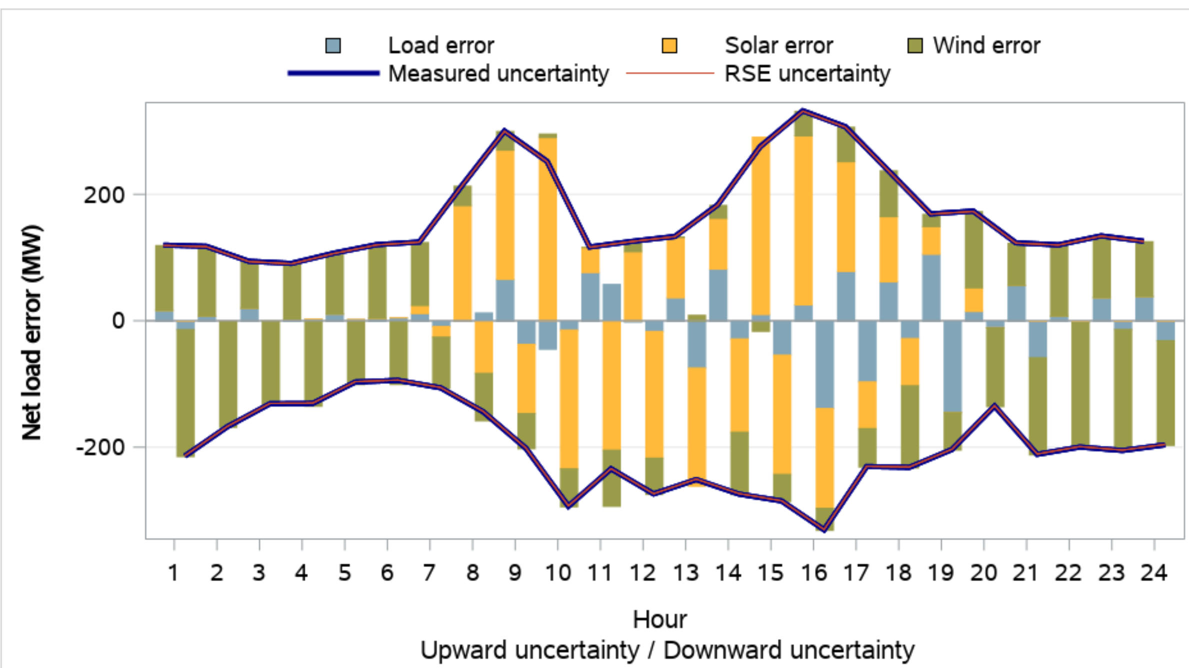


Figure 9.21 LADWP distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, September 2022)

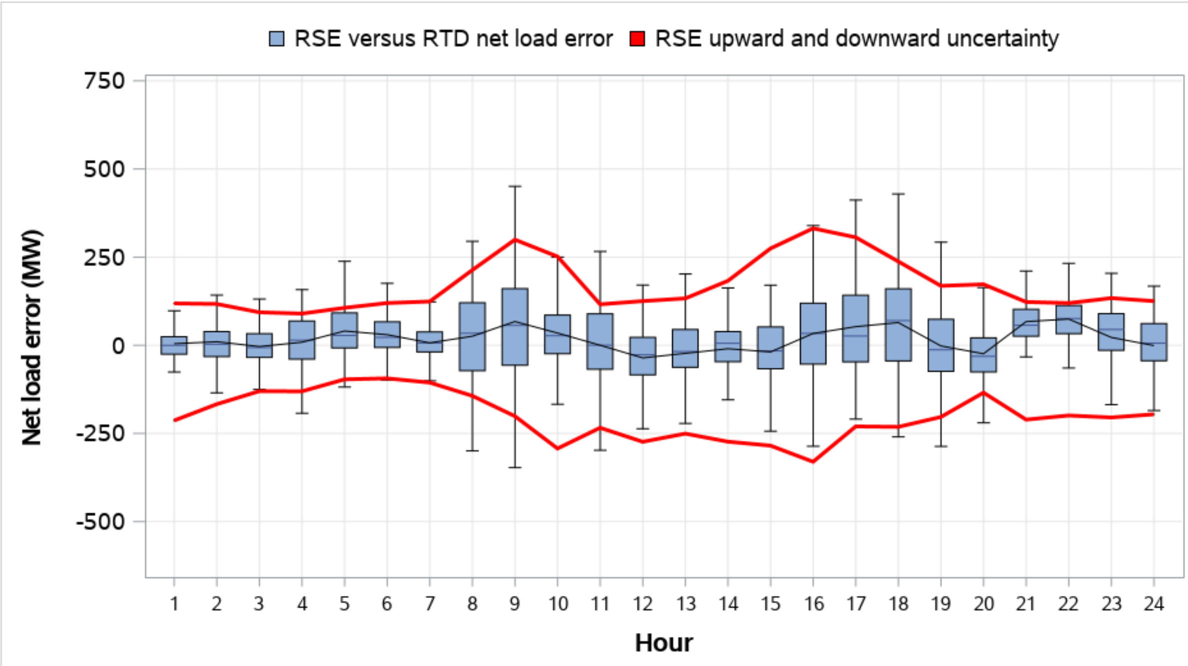


Figure 9.22 LADWP distribution of RSE and RTD load and VER error (weekdays, September 2022)

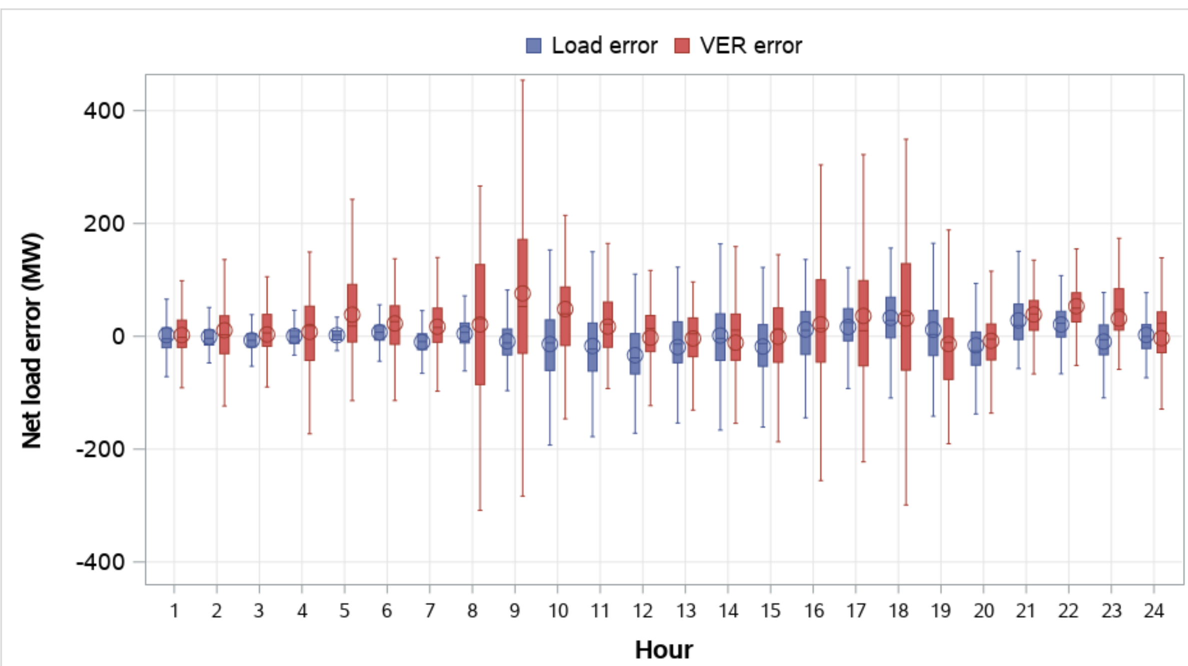


Figure 9.23 NorthWestern Energy average uncertainty by component (weekdays, September 2022)

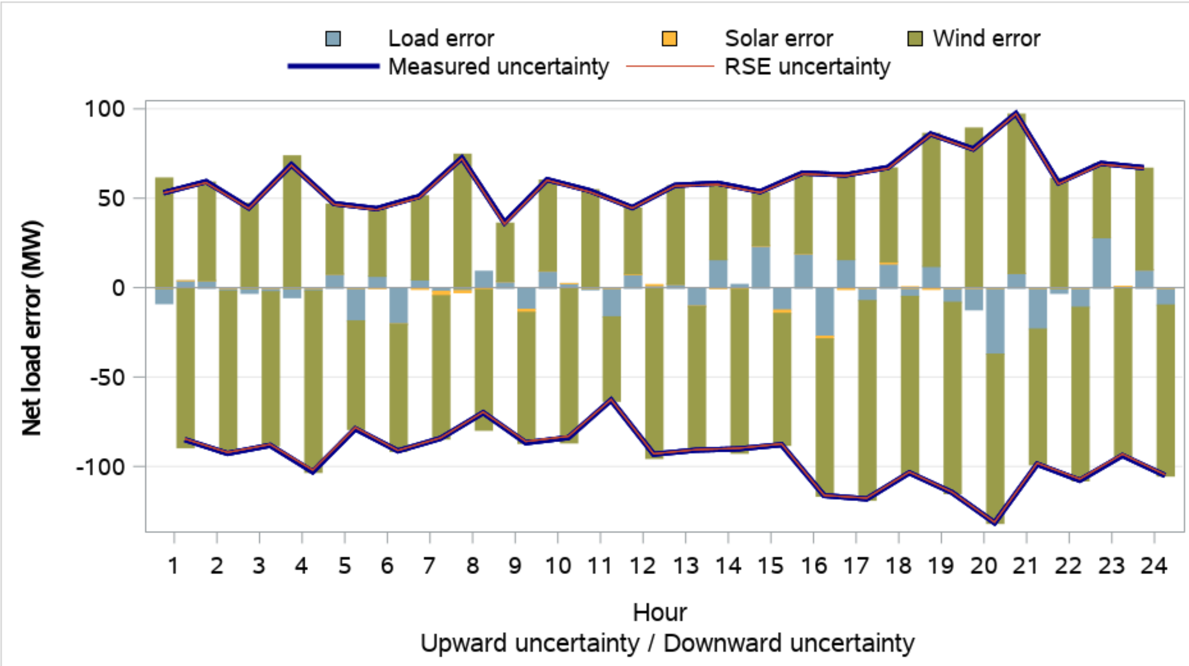


Figure 9.24 NorthWestern Energy distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, September 2022)

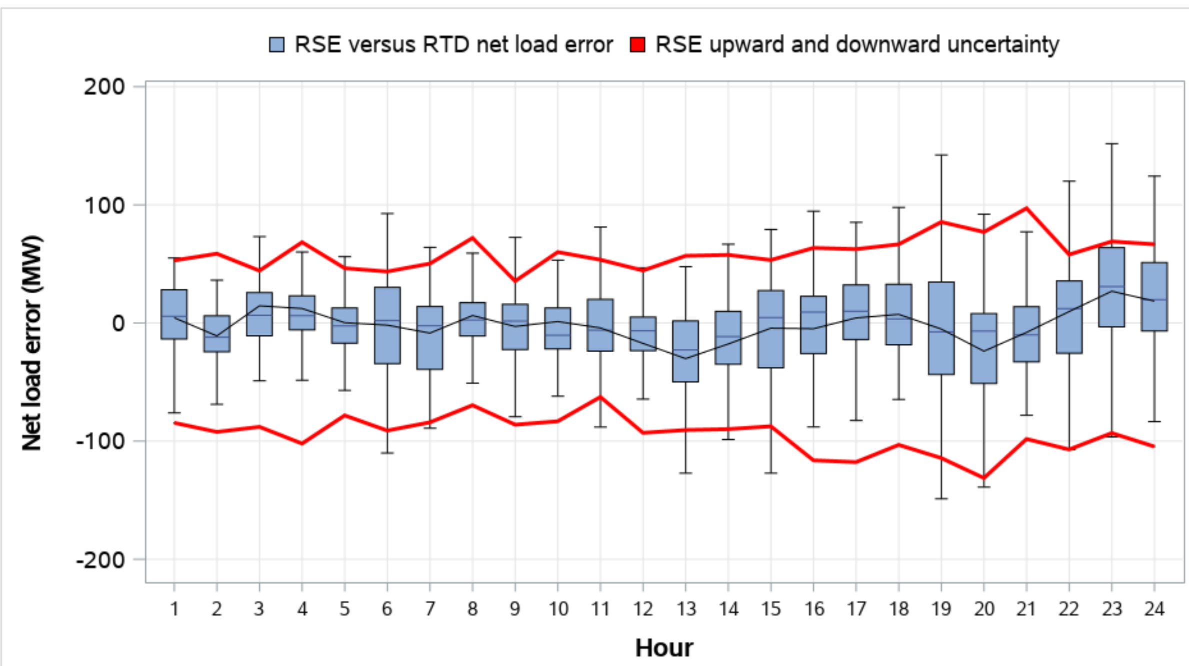


Figure 9.25 NorthWestern Energy distribution of RSE and RTD load and VER error (weekdays, September 2022)

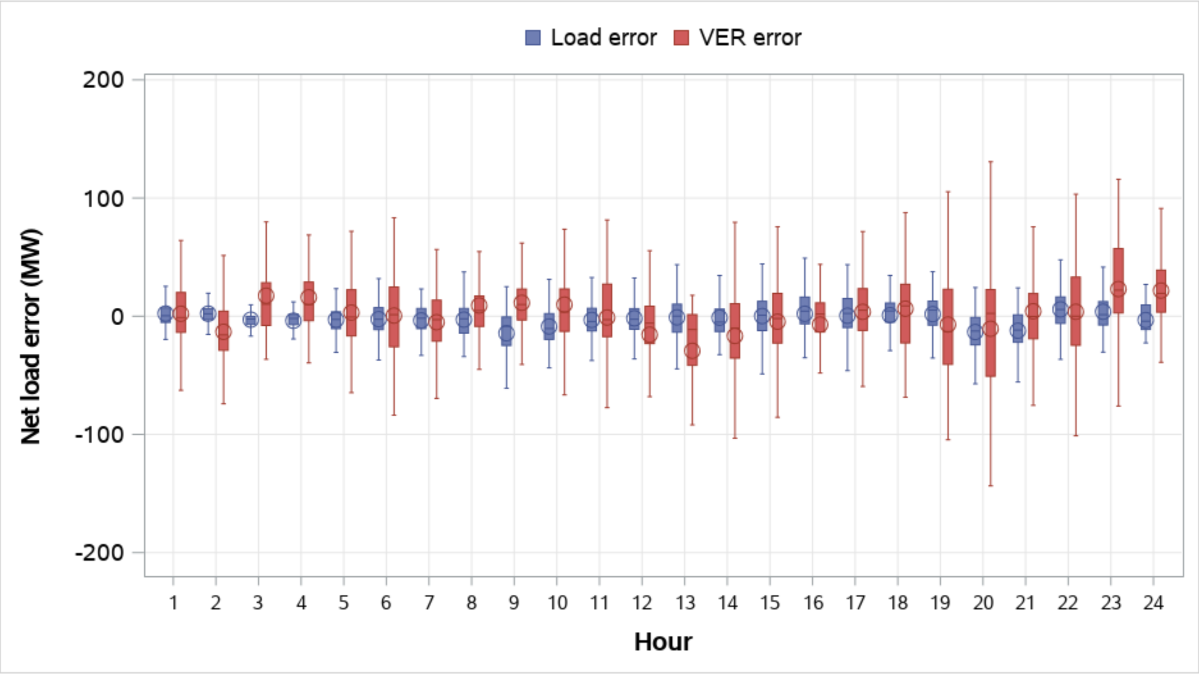


Figure 9.26 NV Energy average uncertainty by component (weekdays, September 2022)

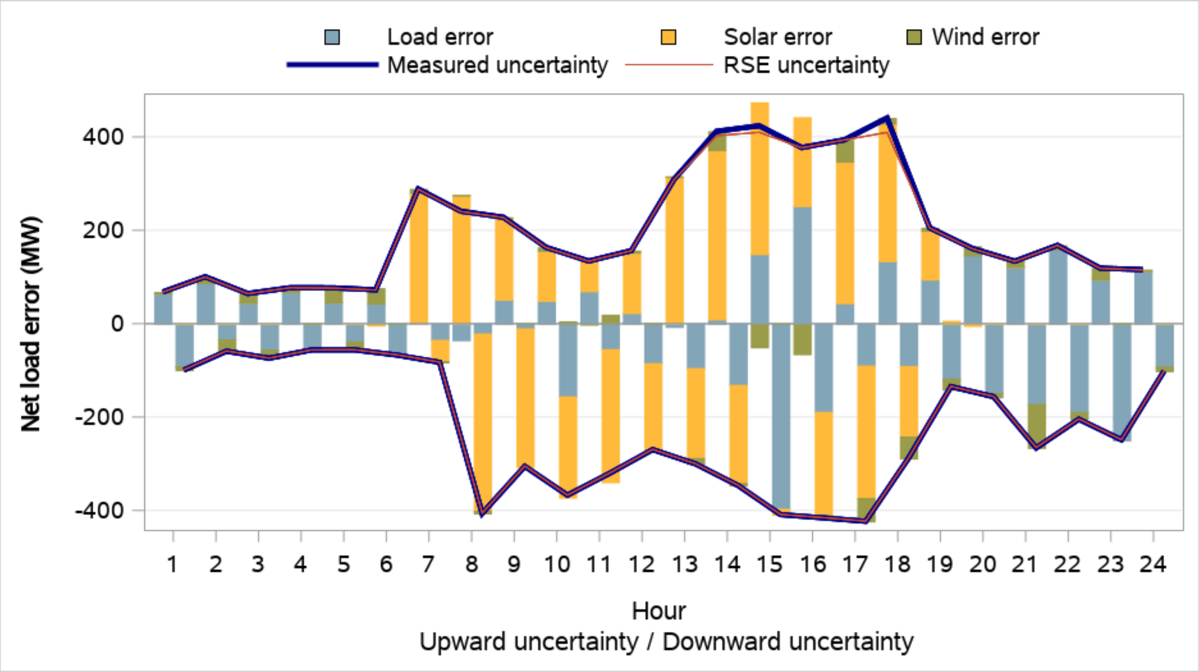


Figure 9.27 NV Energy distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, September 2022)

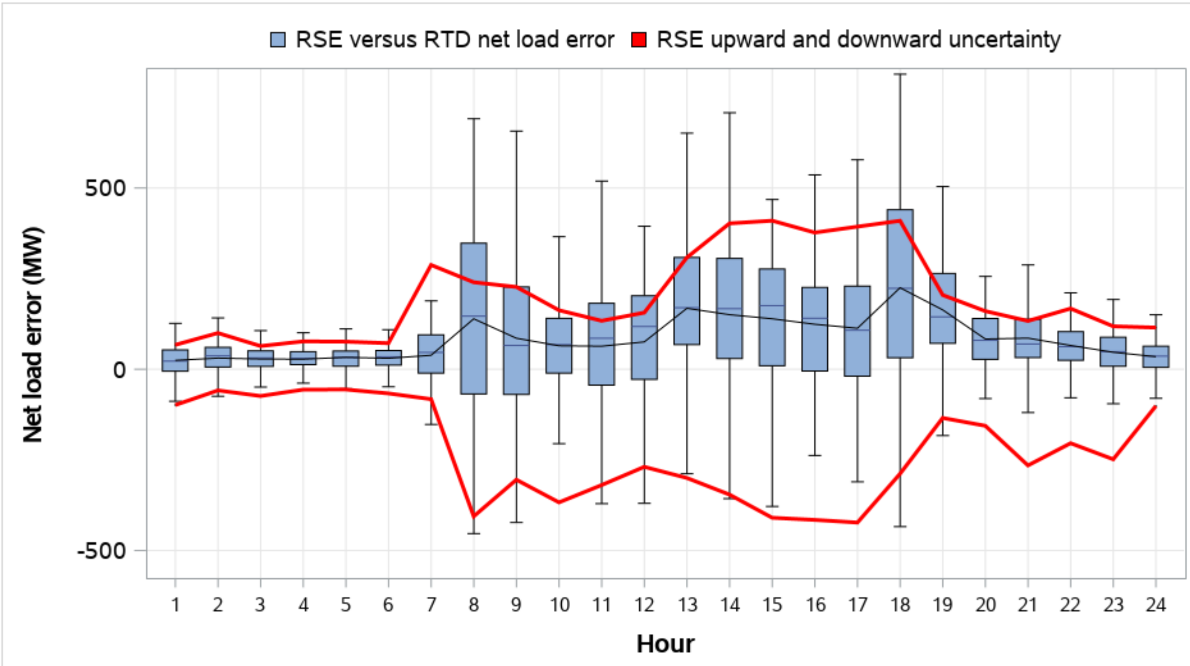


Figure 9.28 NV Energy distribution of RSE and RTD load and VER error (weekdays, September 2022)

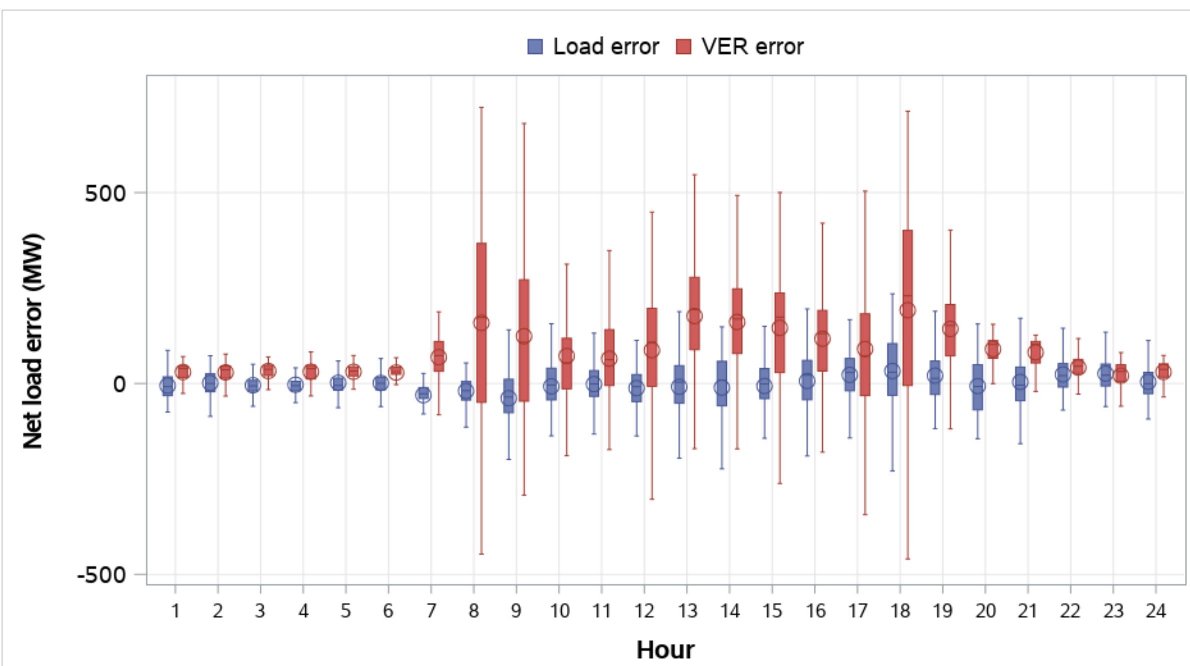


Figure 9.29 PacifiCorp East average uncertainty by component (weekdays, September 2022)

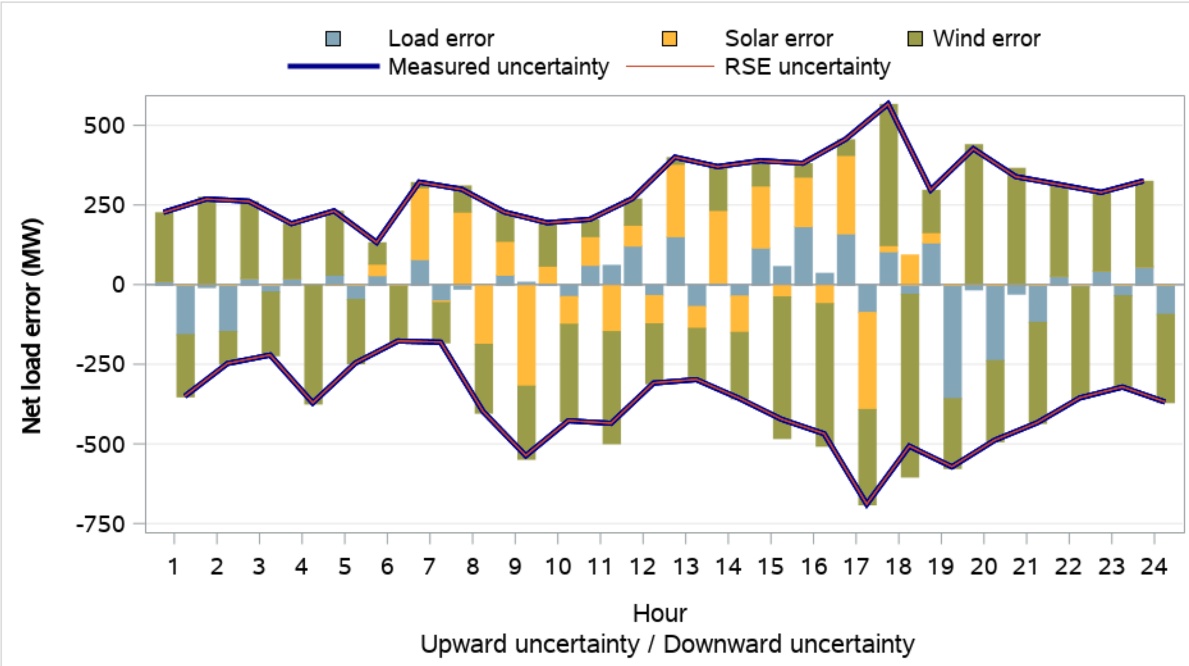


Figure 9.30 PacifiCorp East distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, September 2022)

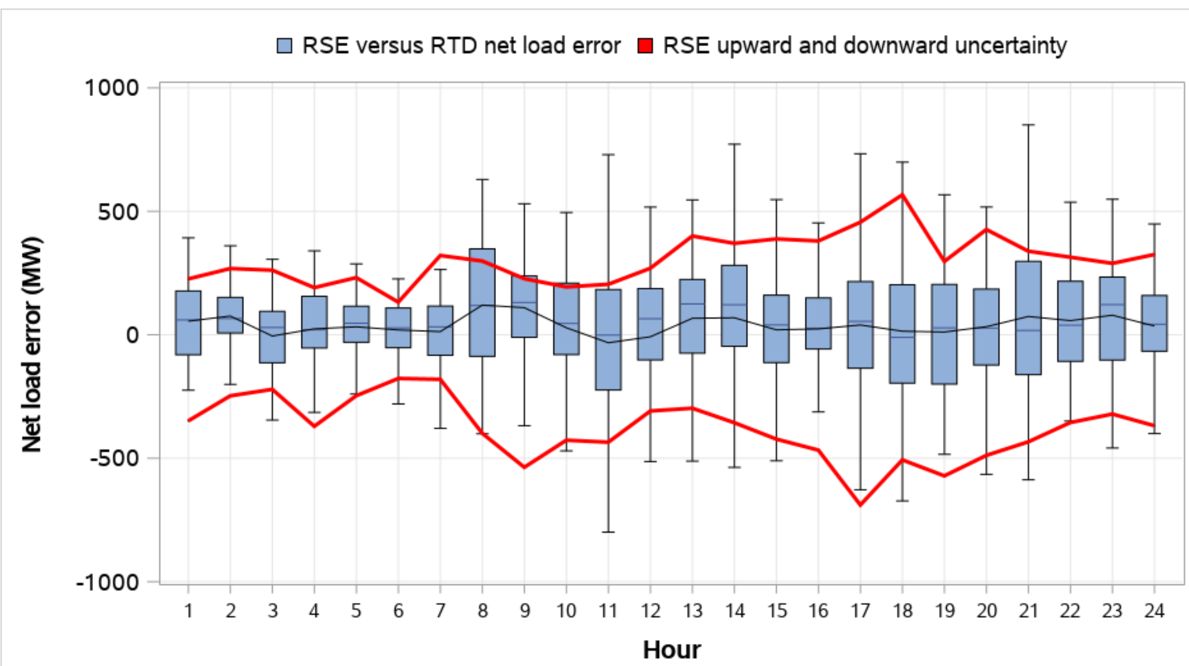


Figure 9.31 PacifiCorp East distribution of RSE and RTD load and VER error (weekdays, September 2022)

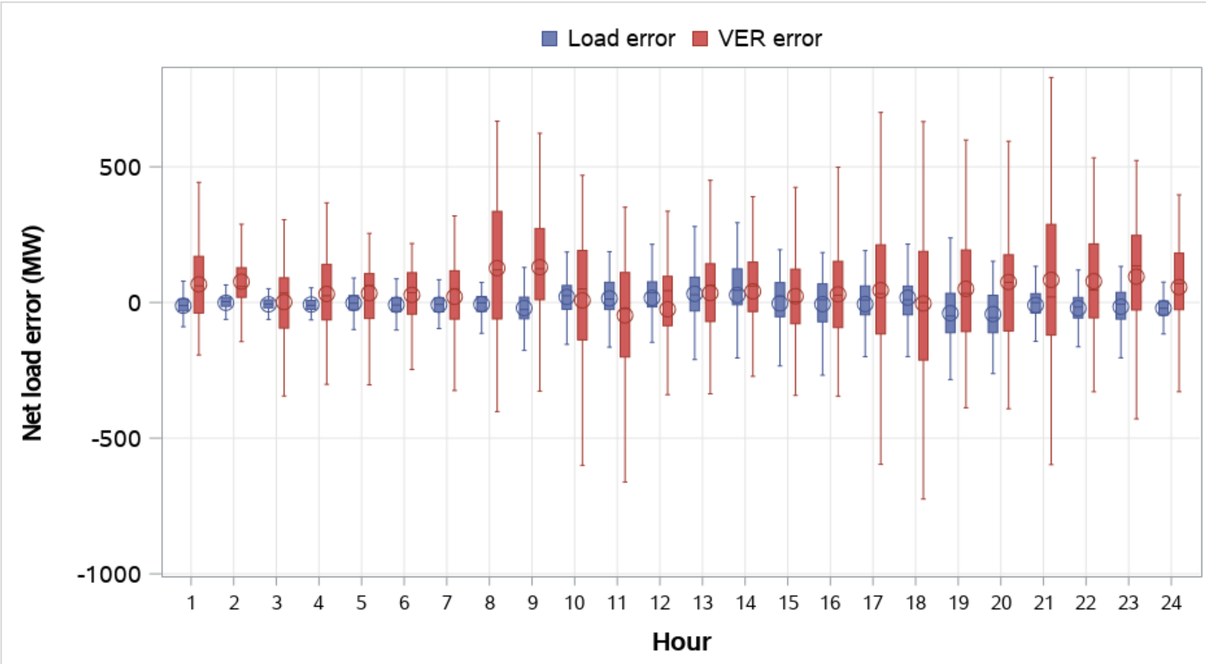


Figure 9.32 PacifiCorp West average uncertainty by component (weekdays, September 2022)

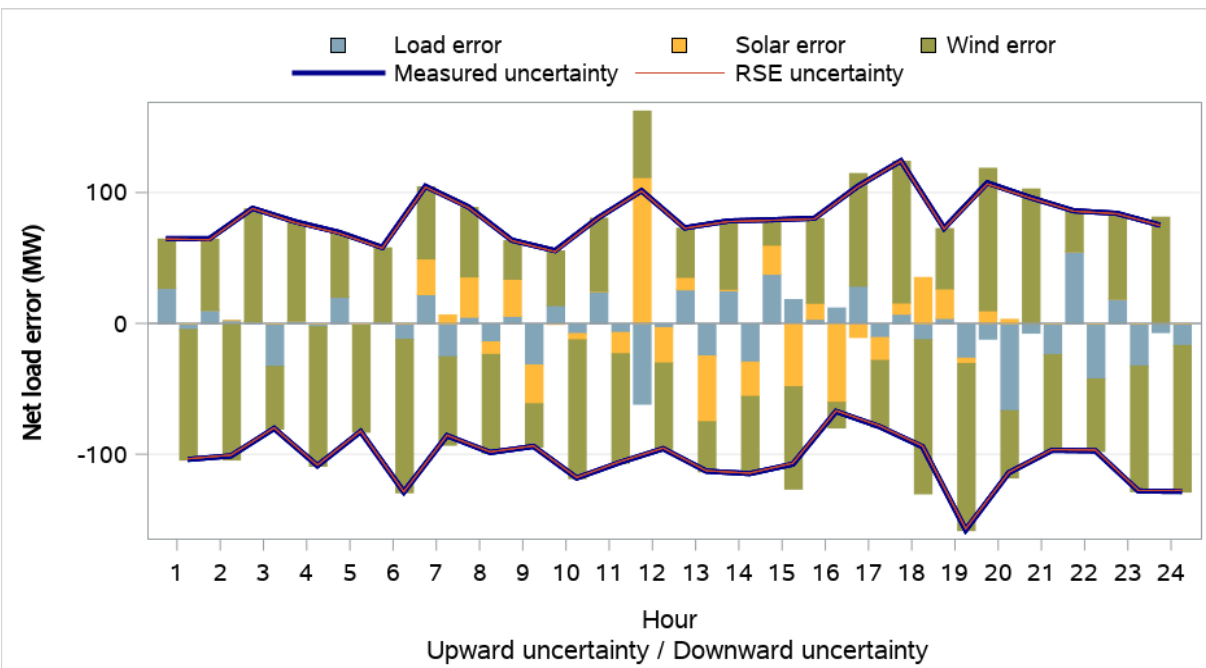


Figure 9.33 PacifiCorp West distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, September 2022)

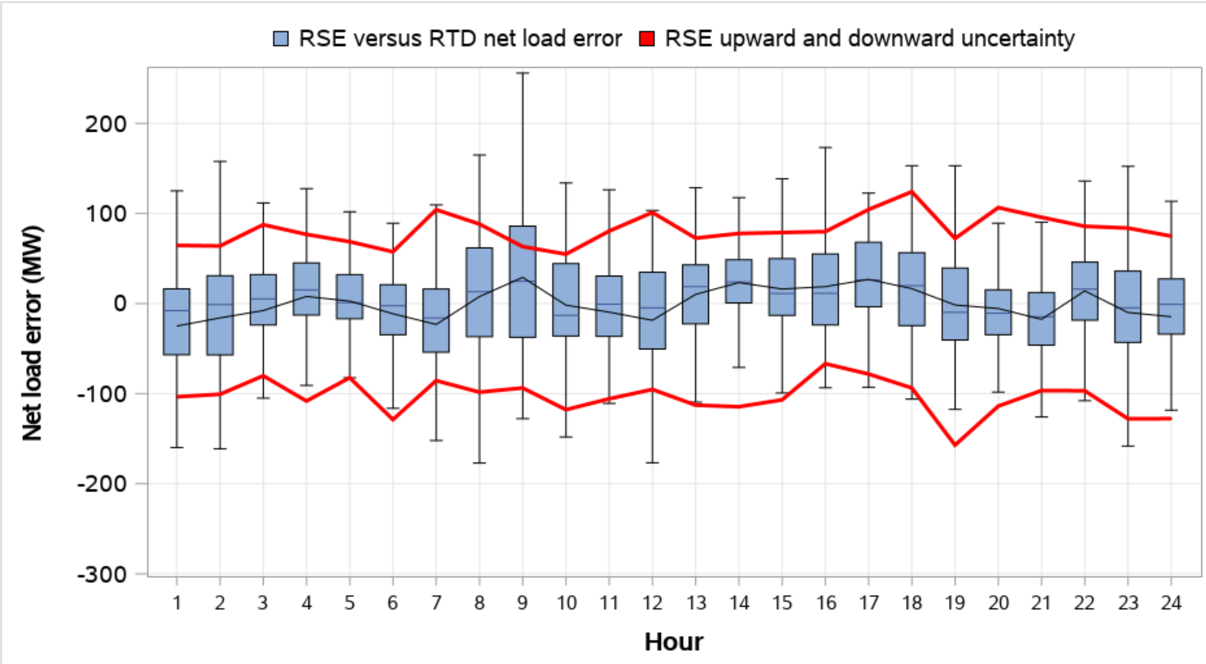


Figure 9.34 PacifiCorp West distribution of RSE and RTD load and VER error (weekdays, September 2022)

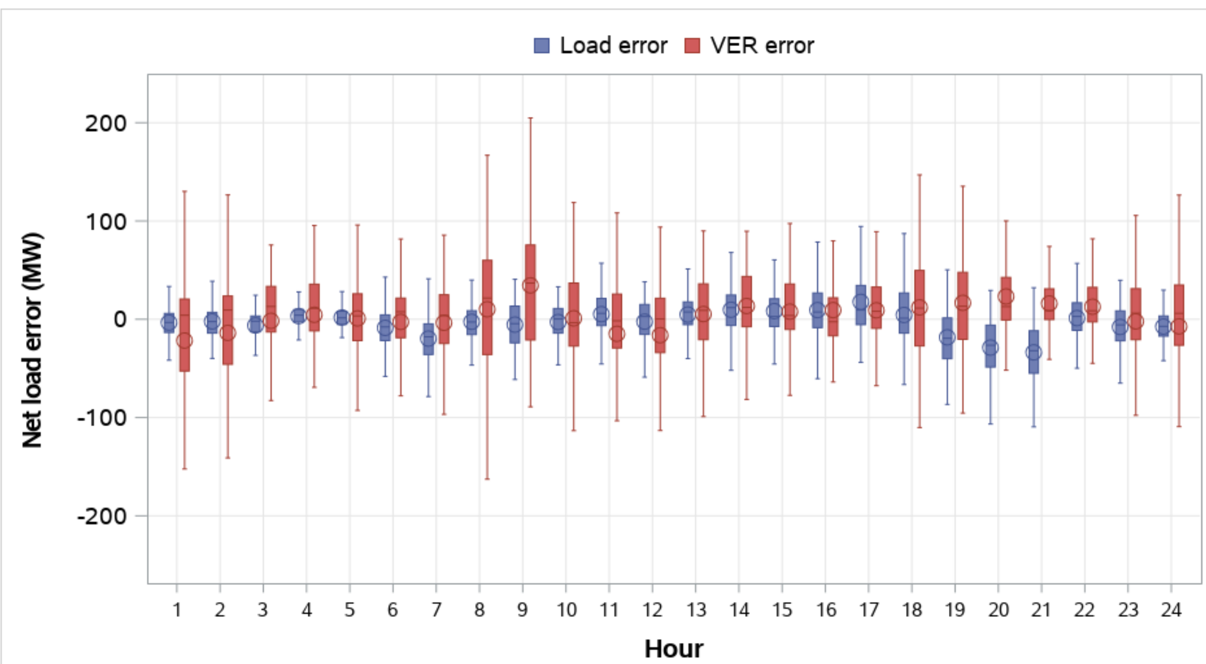


Figure 9.35 Portland General Electric average uncertainty by component (weekdays, September 2022)

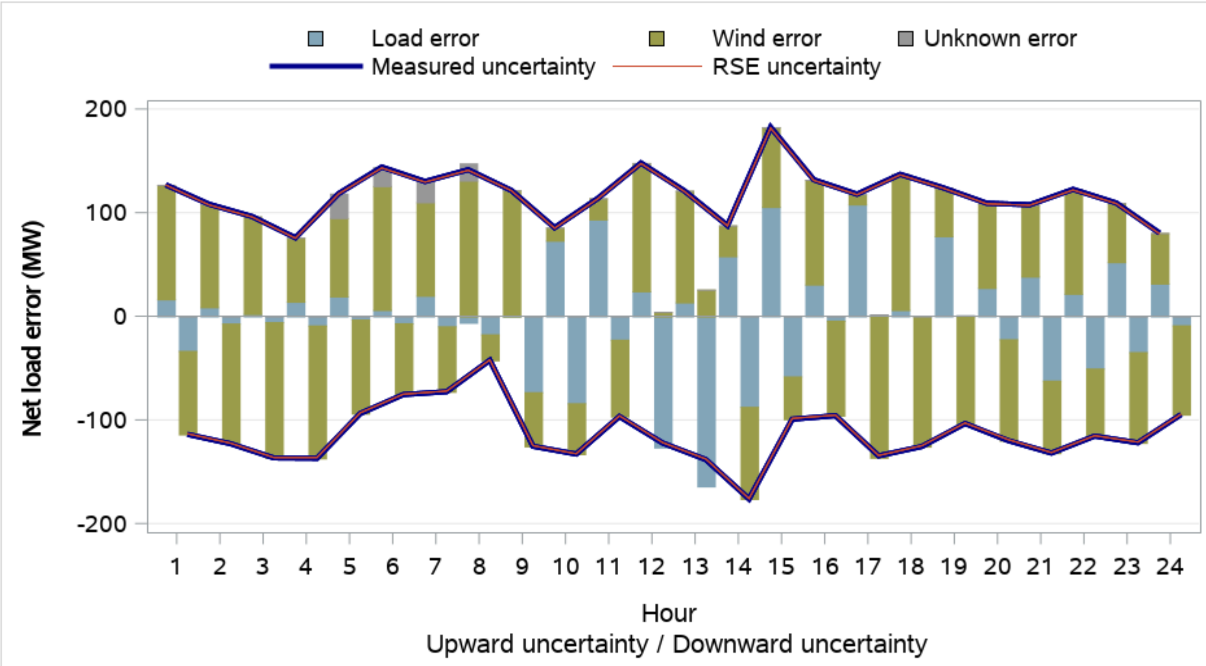


Figure 9.36 Portland General Electric distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, September 2022)

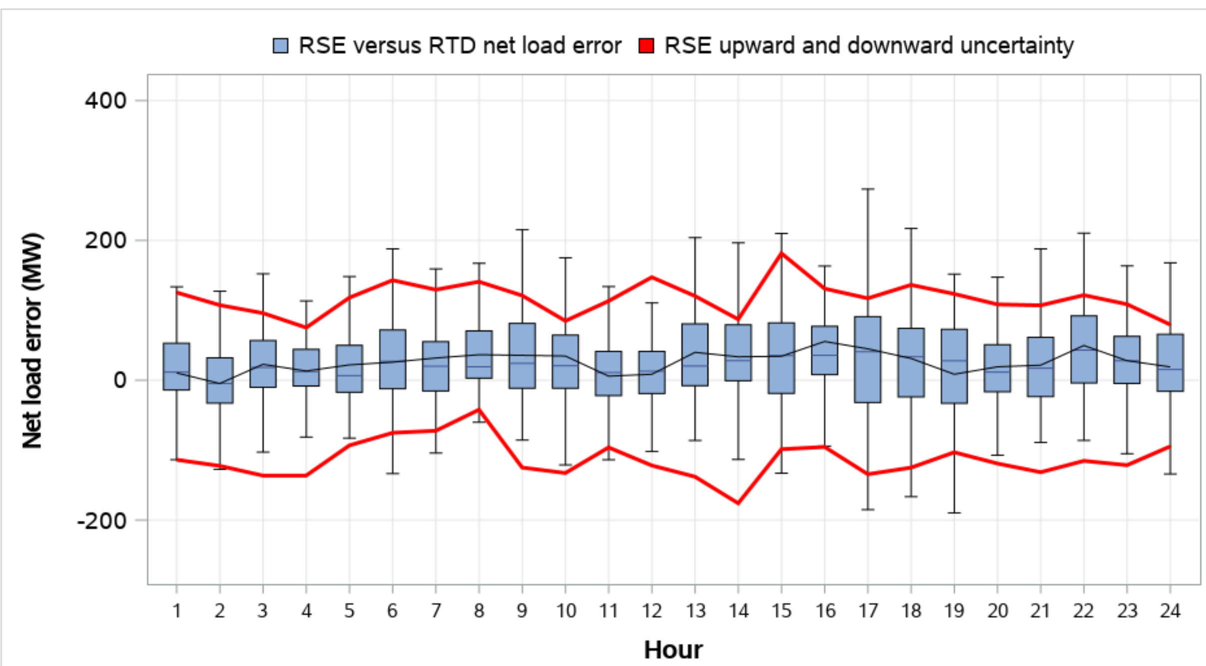


Figure 9.37 Portland General Electric distribution of RSE and RTD load and VER error (weekdays, September 2022)

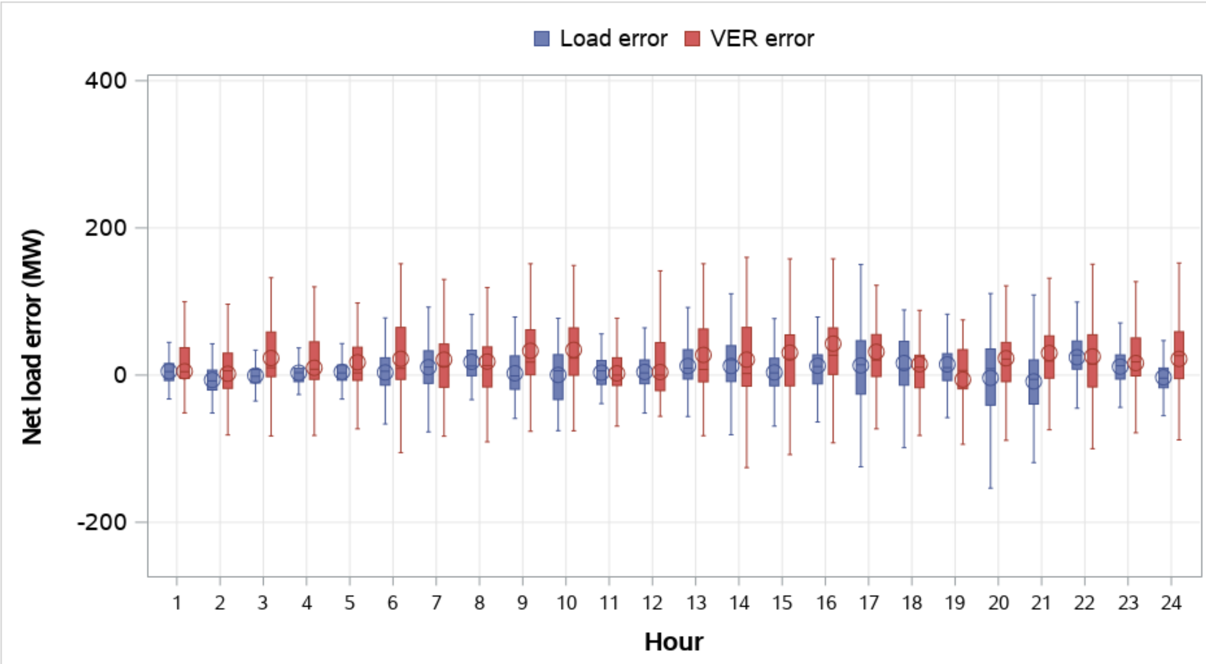


Figure 9.38 Powerex average uncertainty by component (weekdays, September 2022)

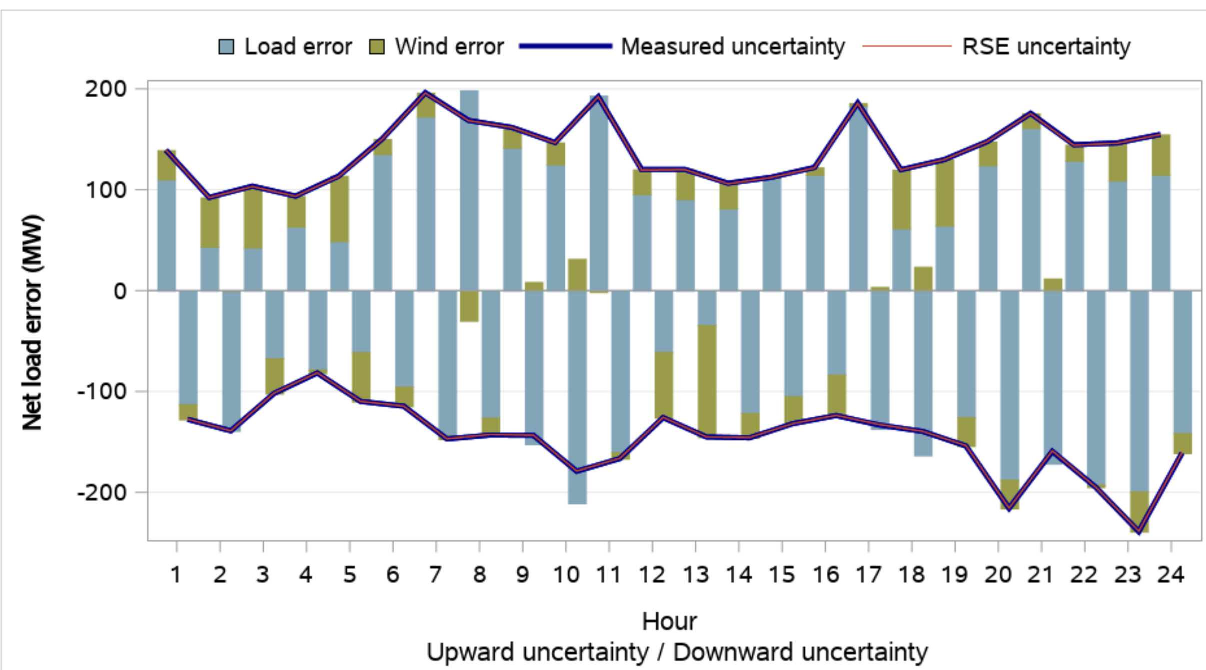


Figure 9.39 Powerex distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, September 2022)

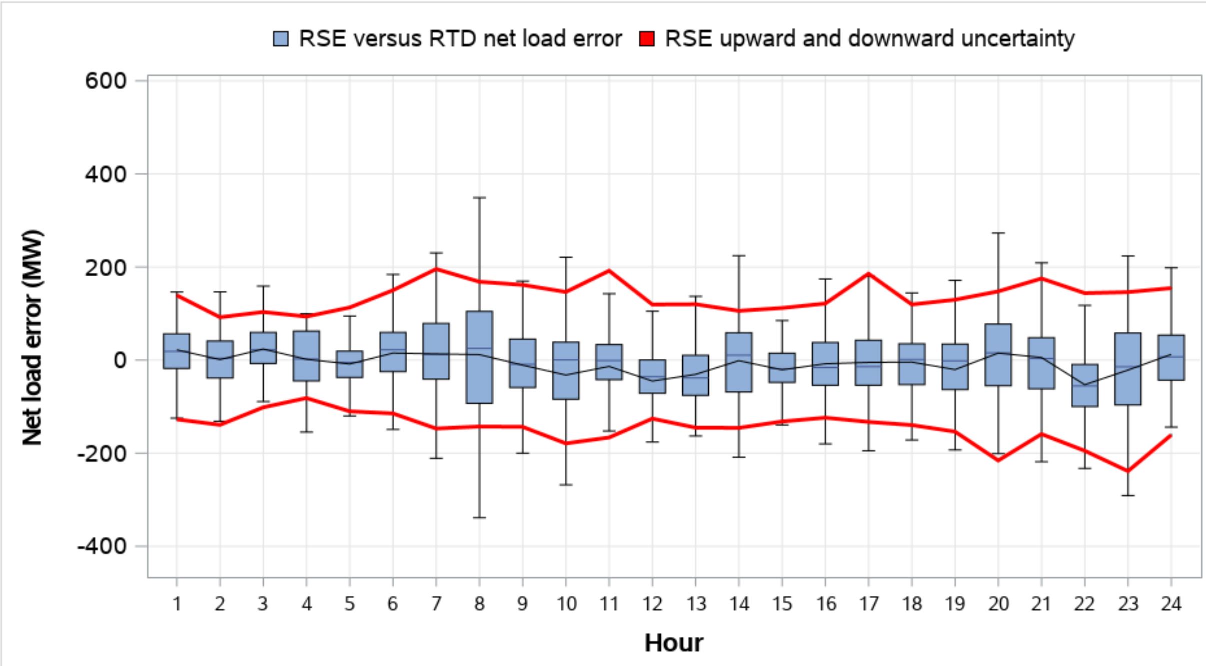


Figure 9.40 Powerex distribution of RSE and RTD load and VER error (weekdays, September 2022)

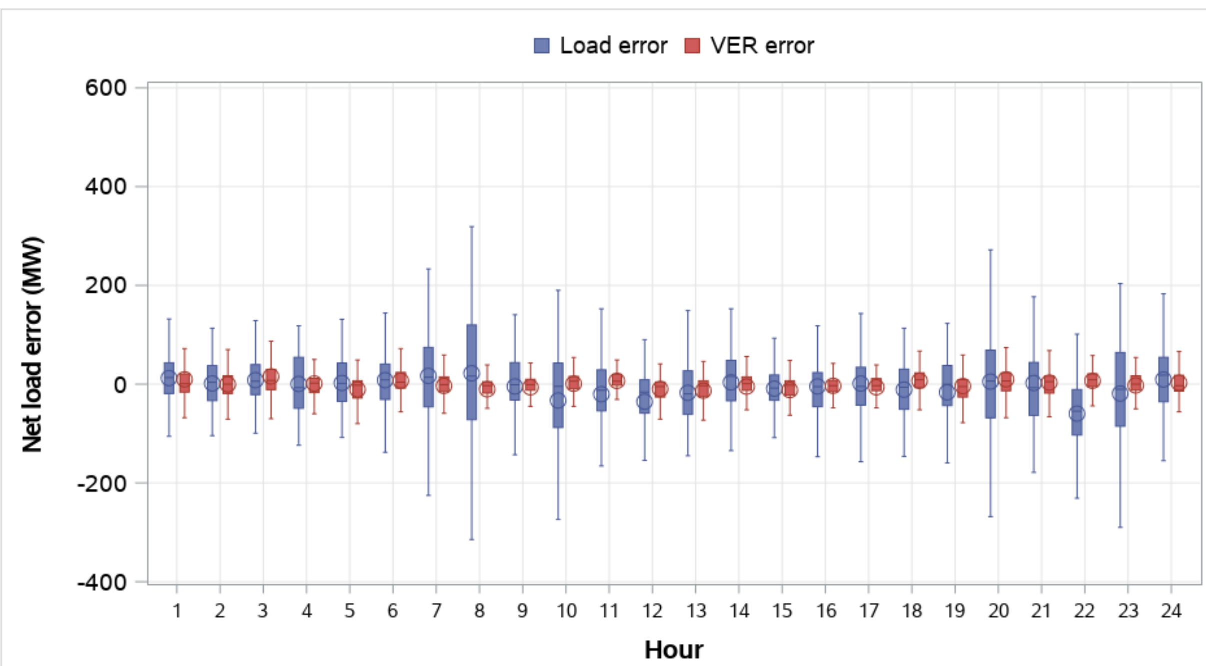


Figure 9.41 PNM average uncertainty by component (weekdays, September 2022)

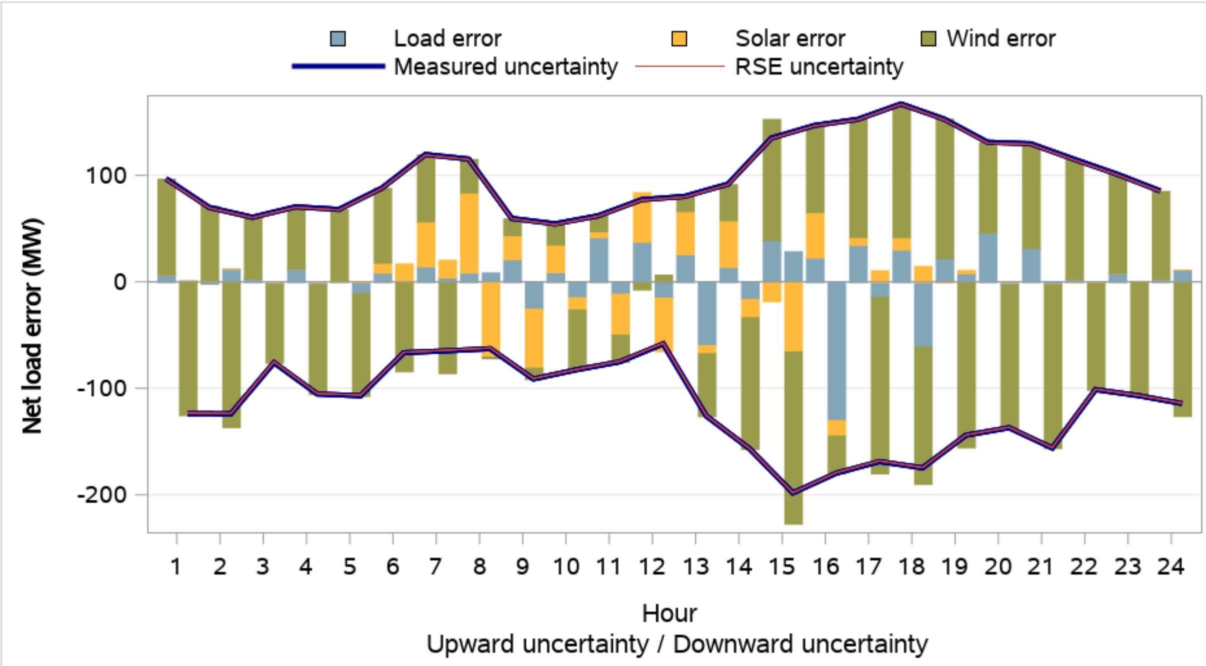


Figure 9.42 PNM distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, September 2022)

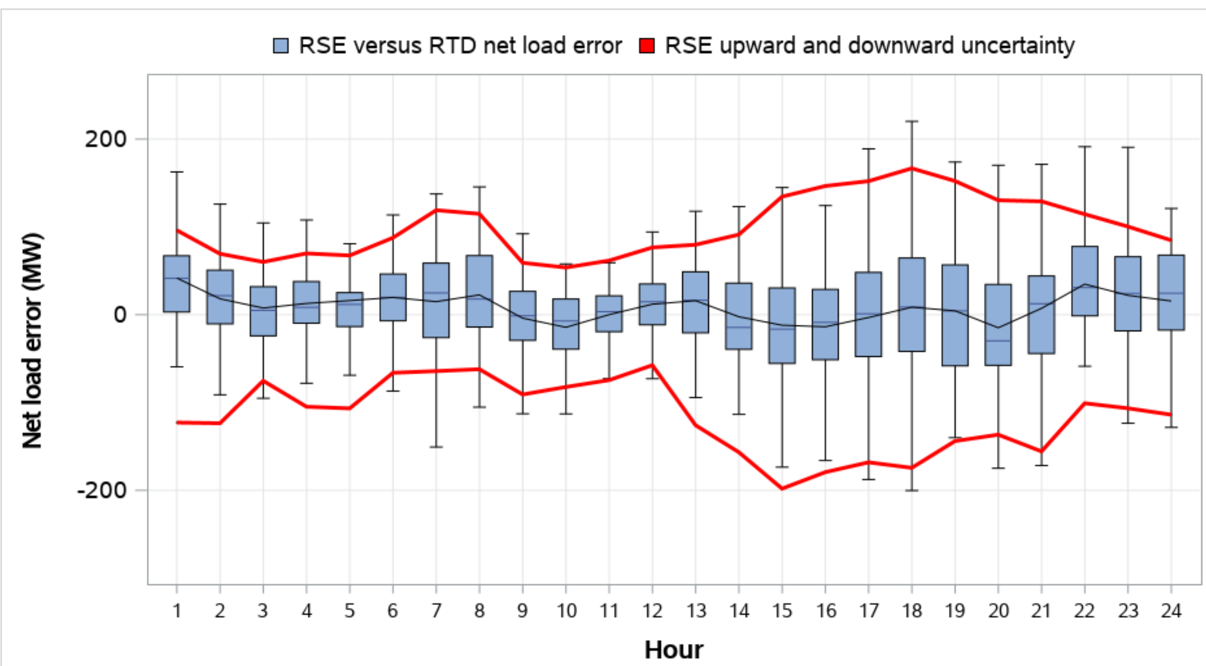


Figure 9.43 PNM distribution of RSE and RTD load and VER error (weekdays, September 2022)

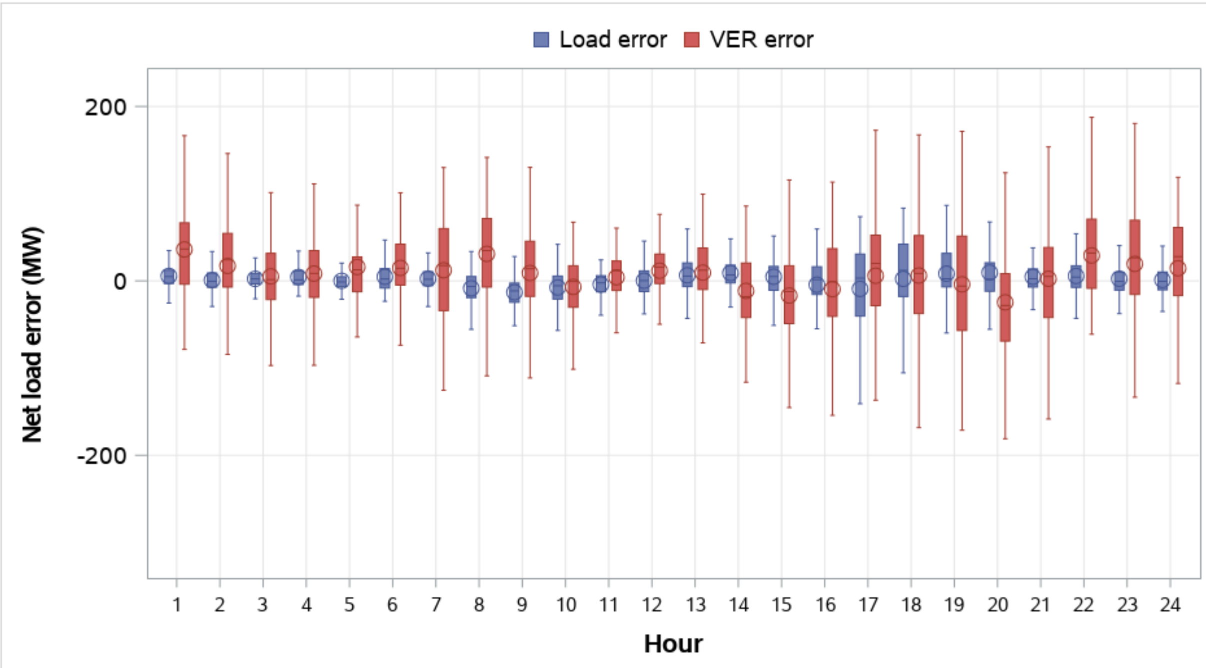


Figure 9.44 Puget Sound Energy average uncertainty by component (weekdays, September 2022)

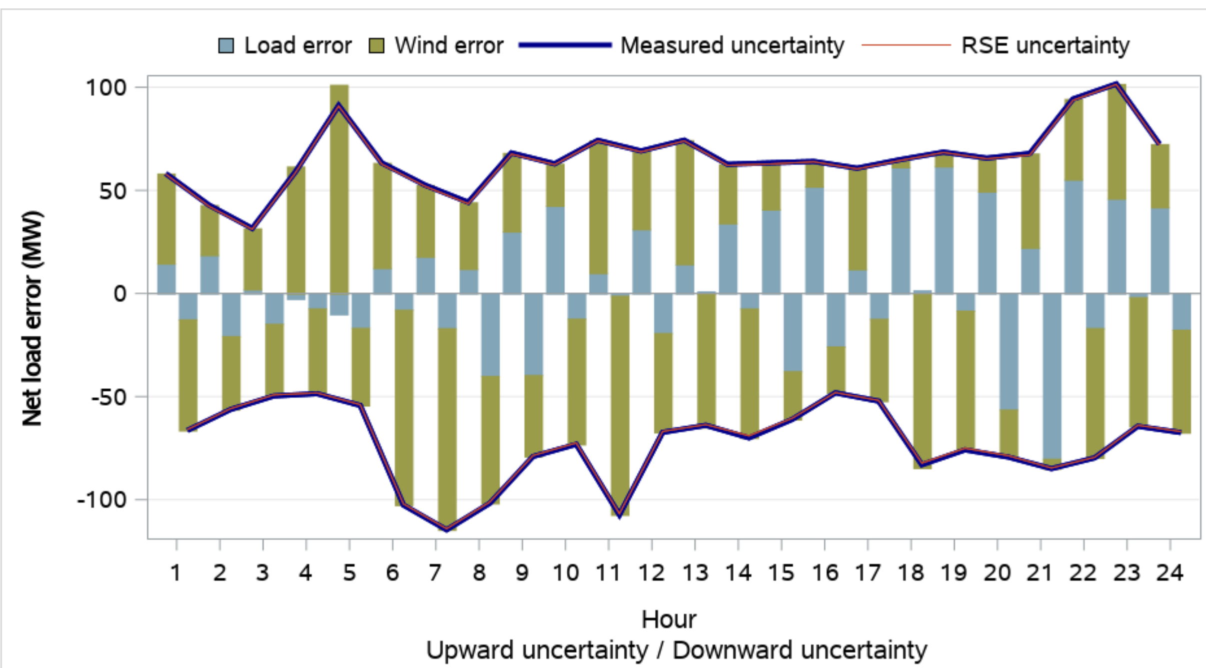


Figure 9.45 Puget Sound Energy distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, September 2022)

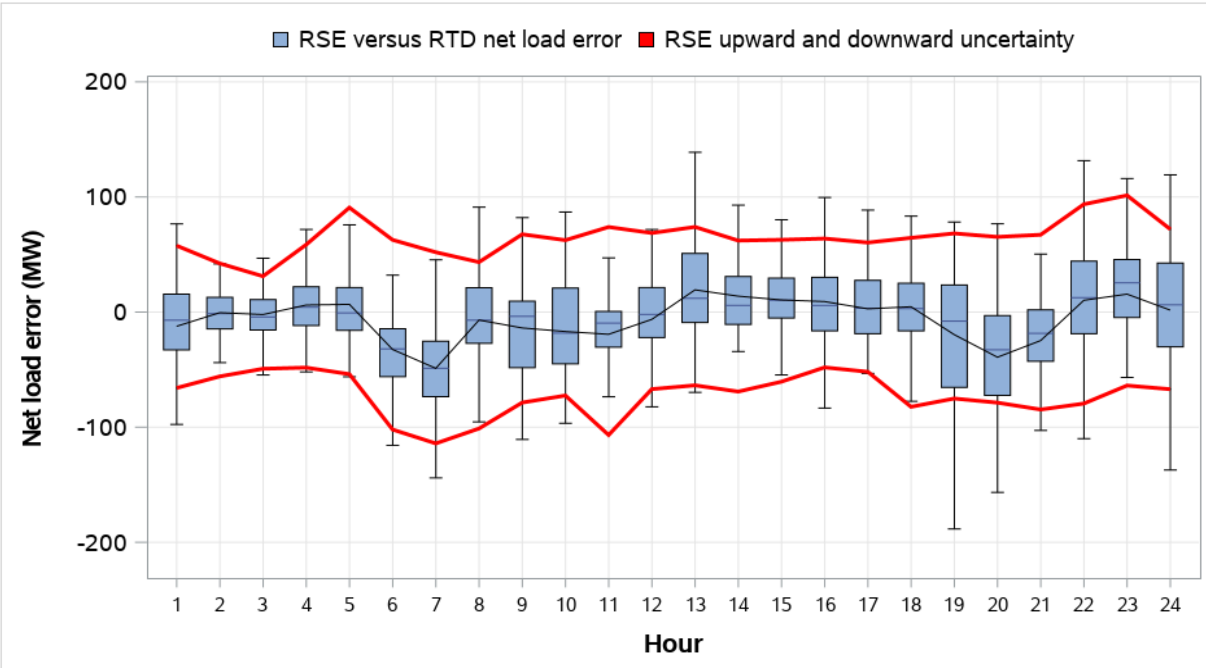


Figure 9.46 Puget Sound Energy distribution of RSE and RTD load and VER error (weekdays, September 2022)

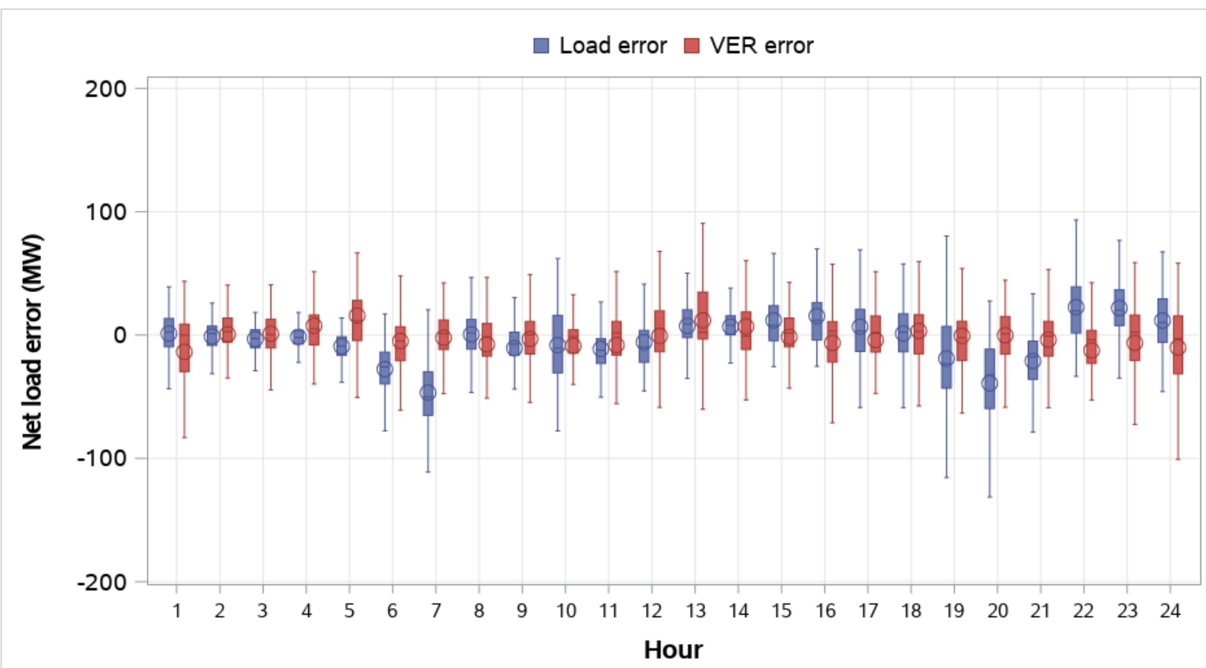


Figure 9.47 Salt River Project average uncertainty by component (weekdays, September 2022)

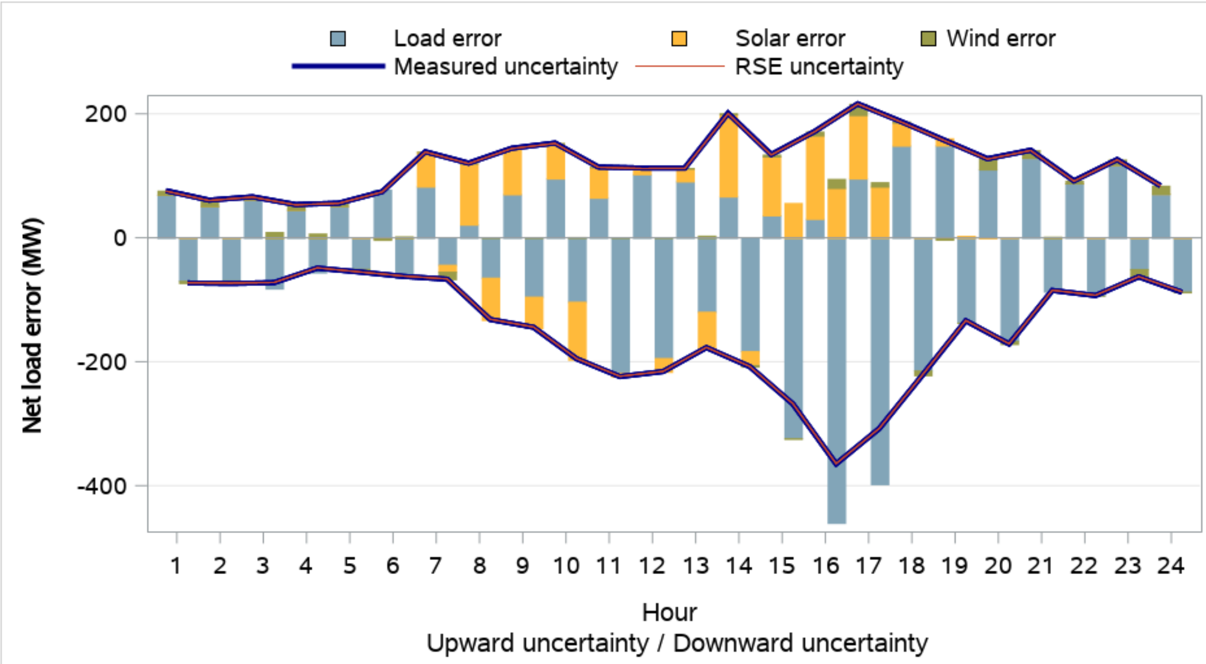


Figure 9.48 Salt River Project distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, September 2022)

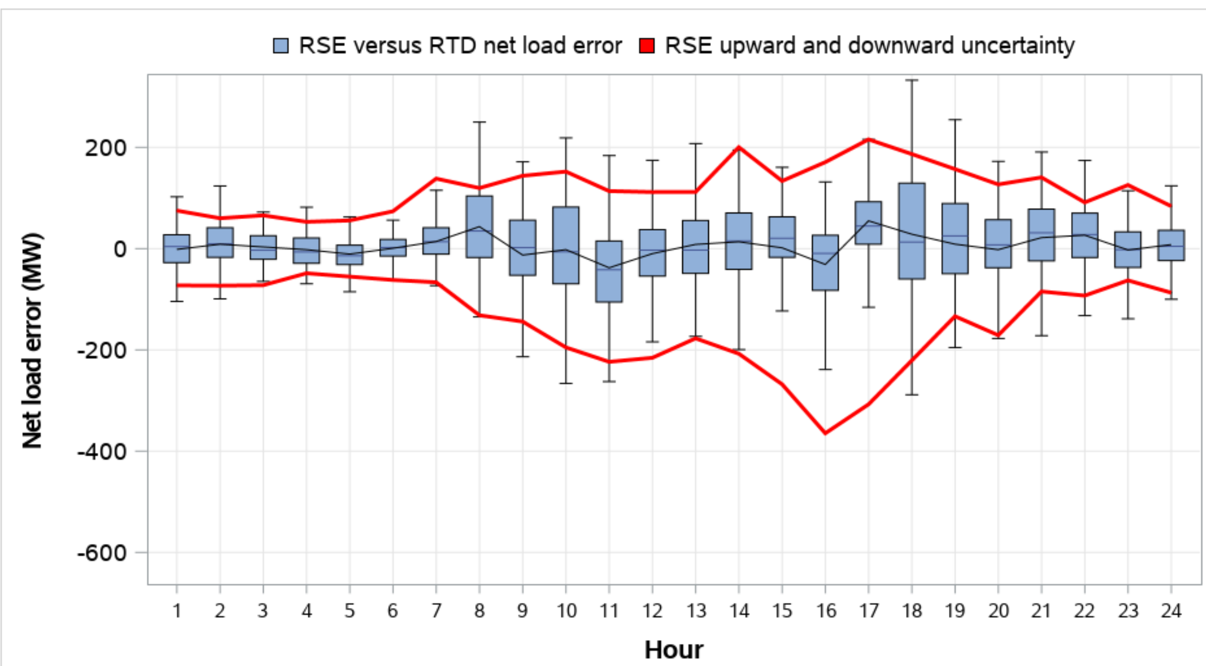


Figure 9.49 Salt River Project distribution of RSE and RTD load and VER error (weekdays, September 2022)

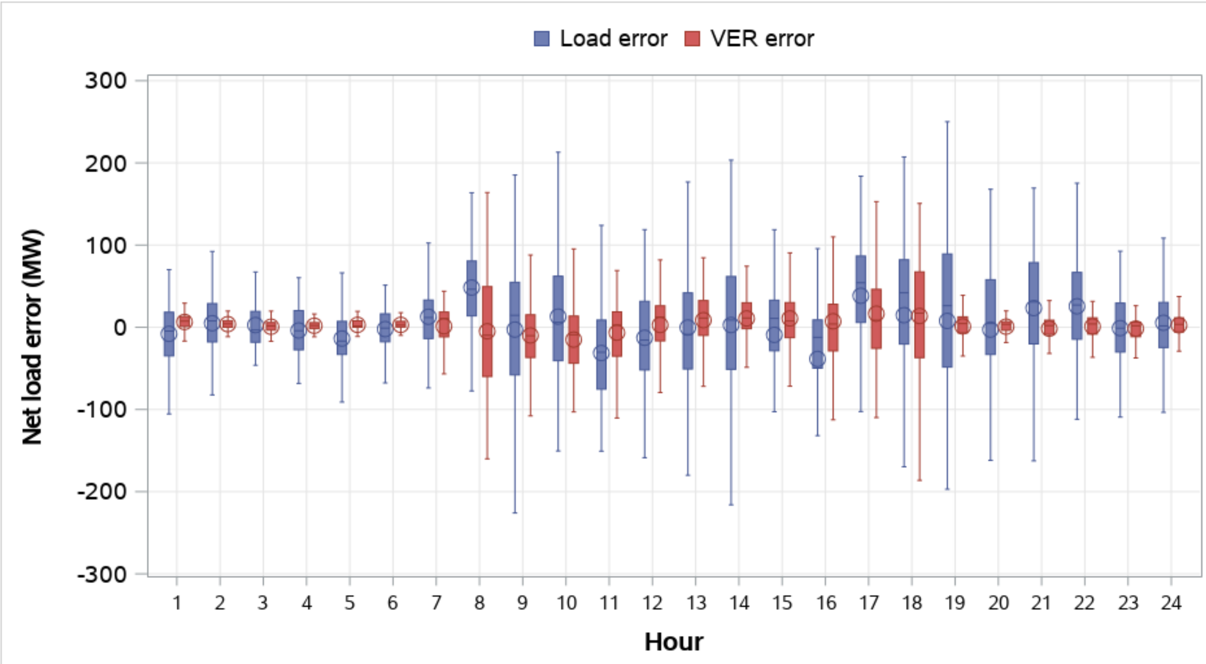


Figure 9.50 Seattle City Light average uncertainty by component (weekdays, September 2022)

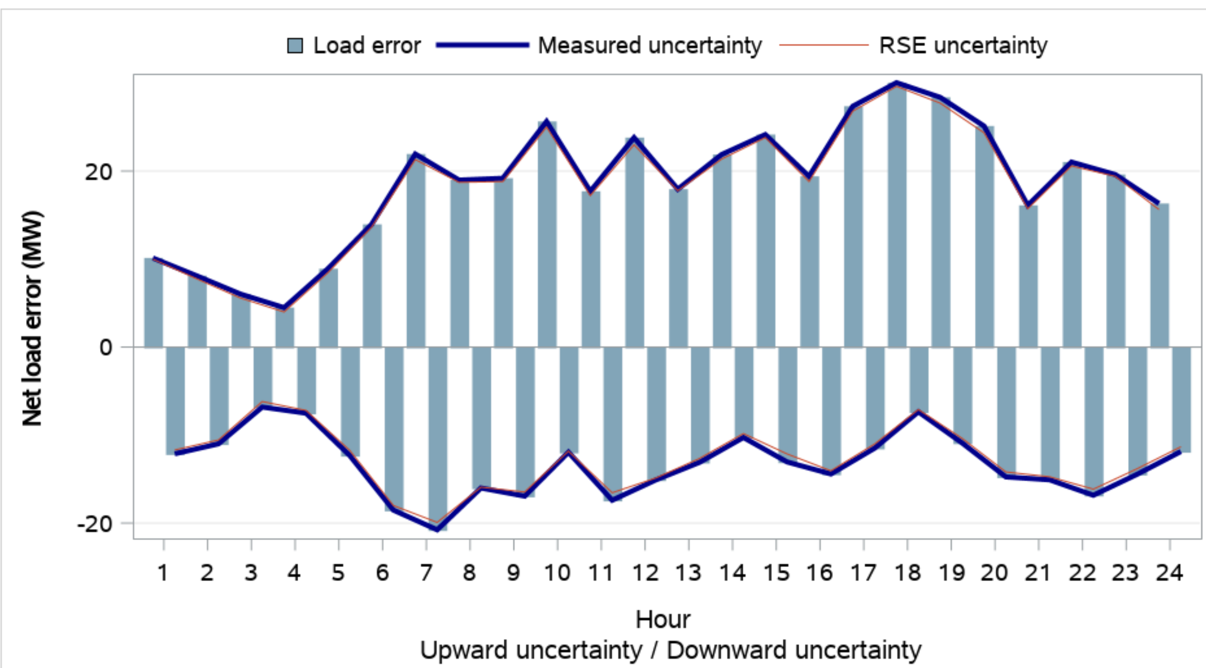


Figure 9.51 Seattle City Light distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, September 2022)

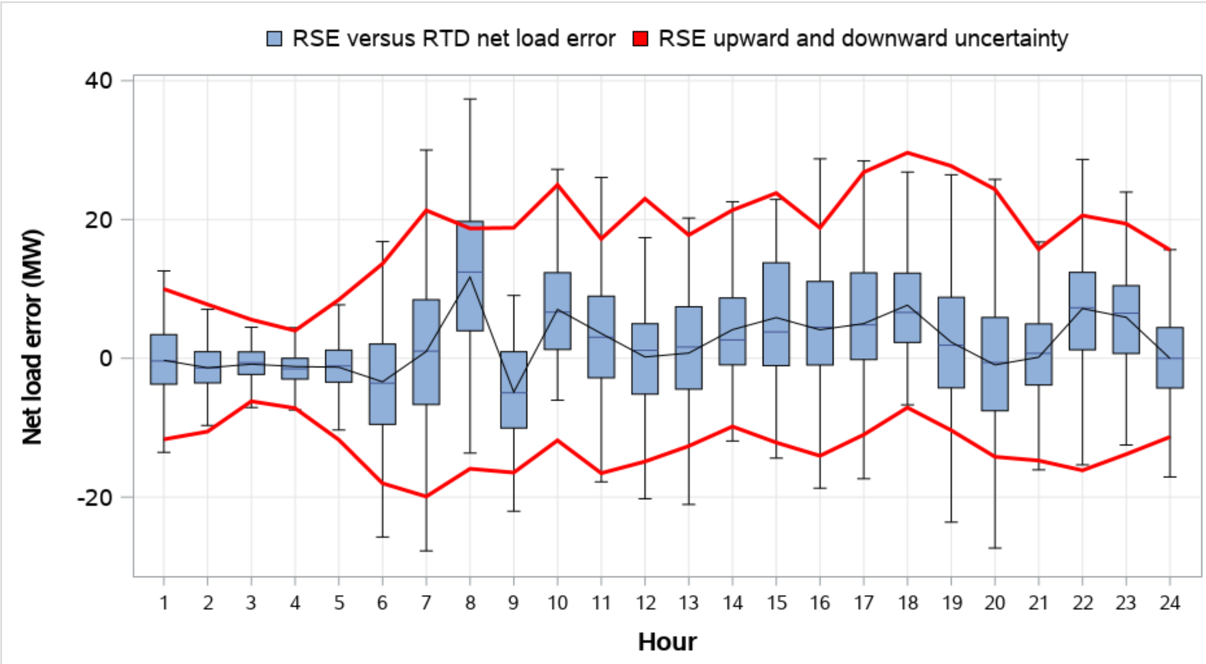


Figure 9.52 Seattle City Light distribution of RSE and RTD load and VER error (weekdays, September 2022)

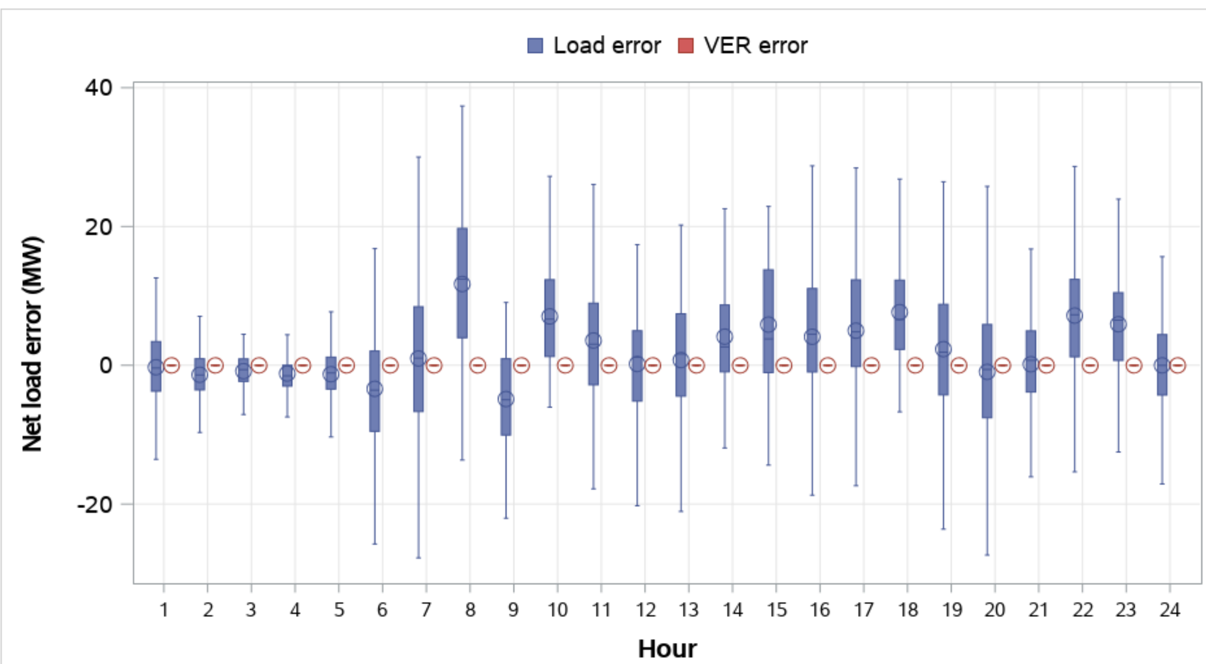


Figure 9.53 Tacoma Power average uncertainty by component (weekdays, September 2022)

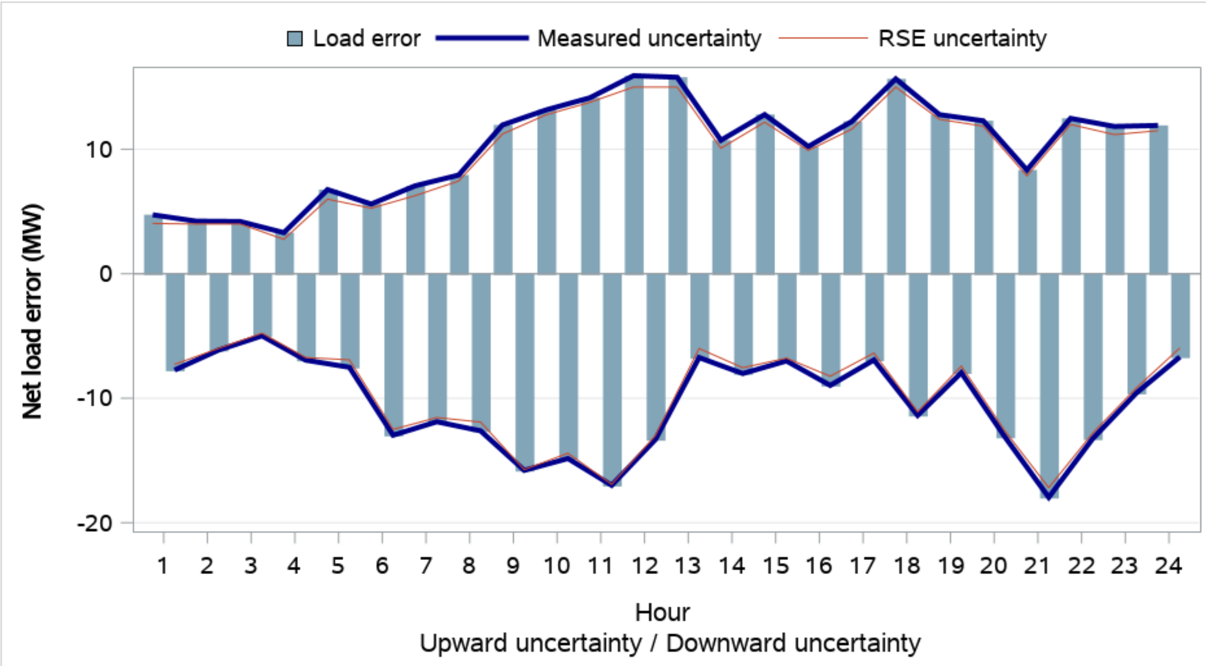


Figure 9.54 Tacoma Power distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, September 2022)

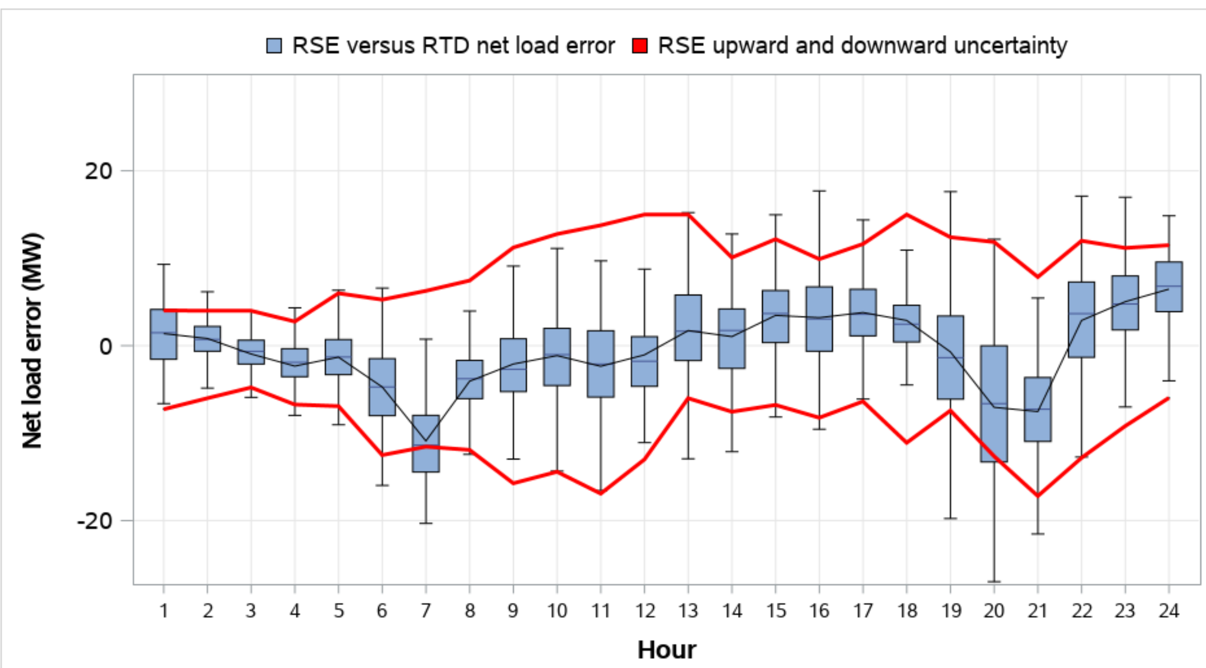


Figure 9.55 Tacoma Power distribution of RSE and RTD load and VER error (weekdays, September 2022)

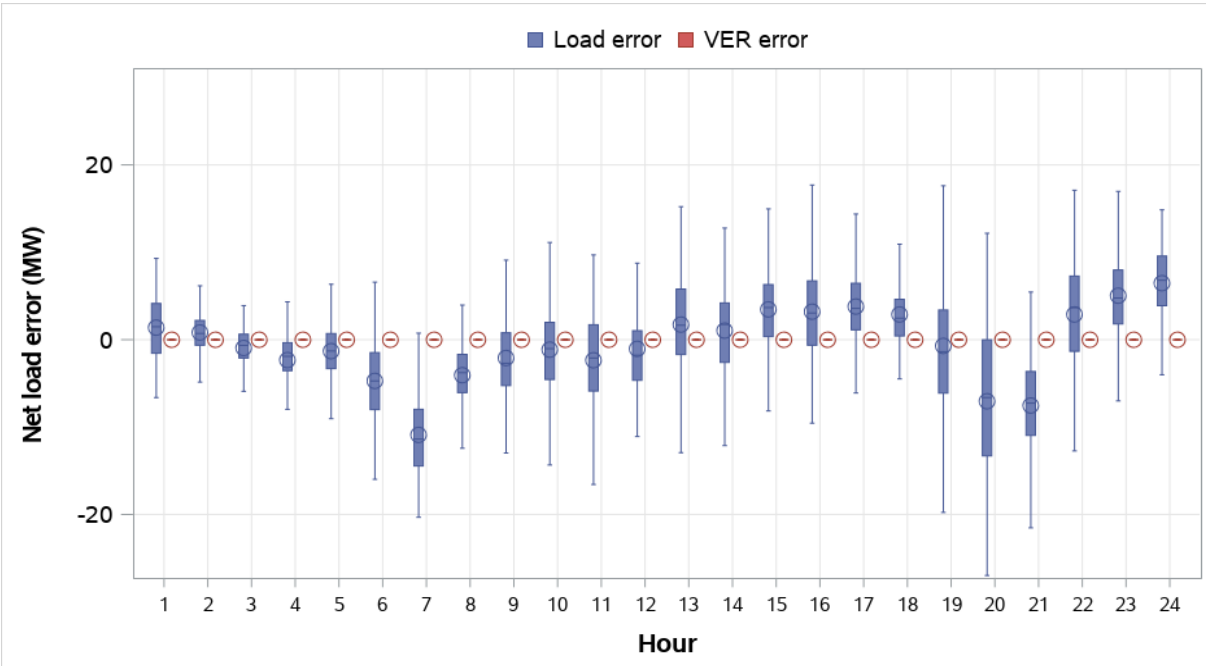


Figure 9.56 Tucson Electric Power average uncertainty by component (weekdays, September 2022)

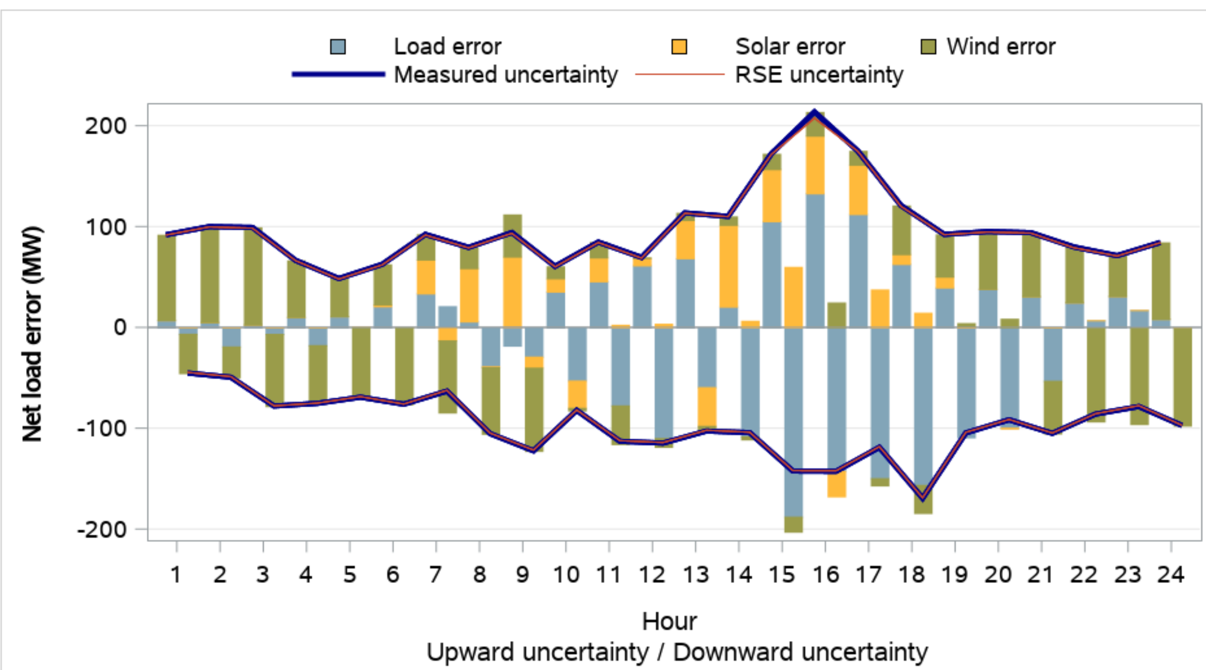


Figure 9.57 Tucson Electric Power distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, September 2022)

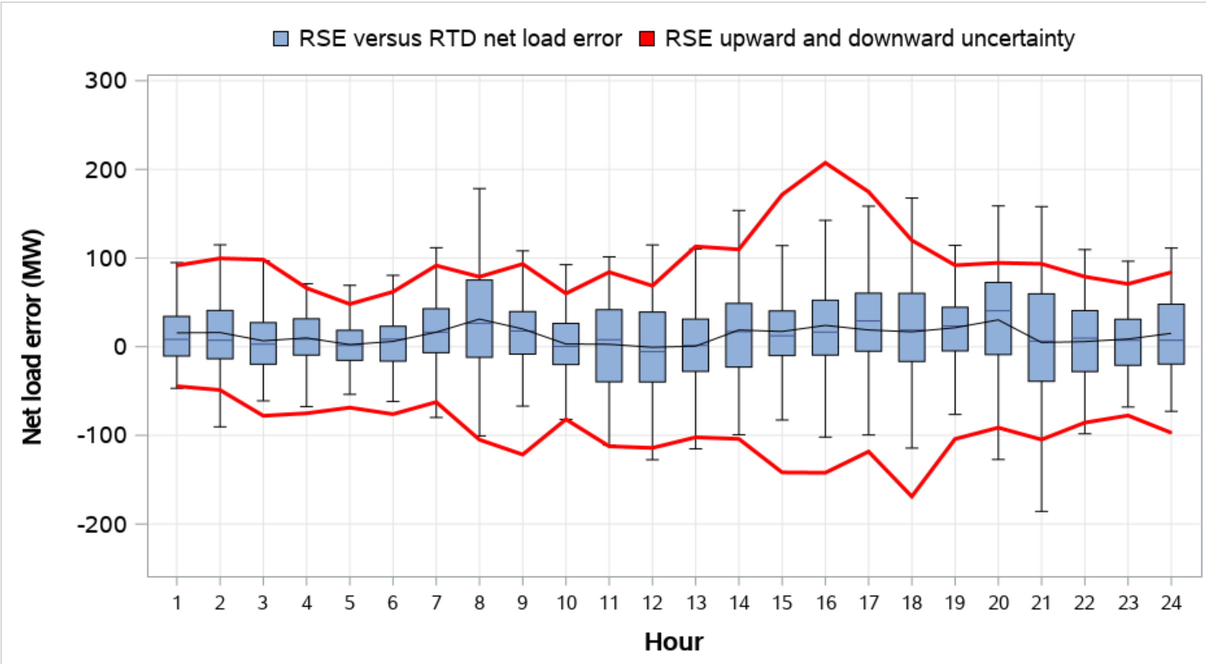


Figure 9.58 Tucson Electric Power distribution of RSE and RTD load and VER error (weekdays, September 2022)

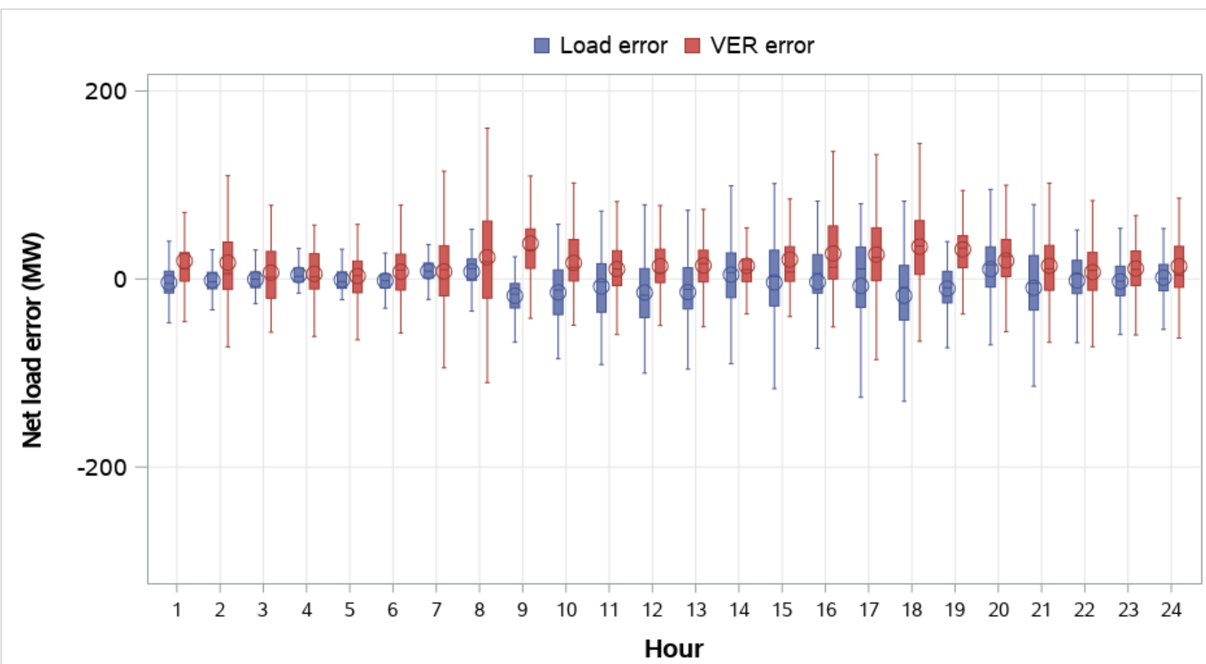


Figure 9.59 Turlock Irrigation District average uncertainty by component (weekdays, September 2022)

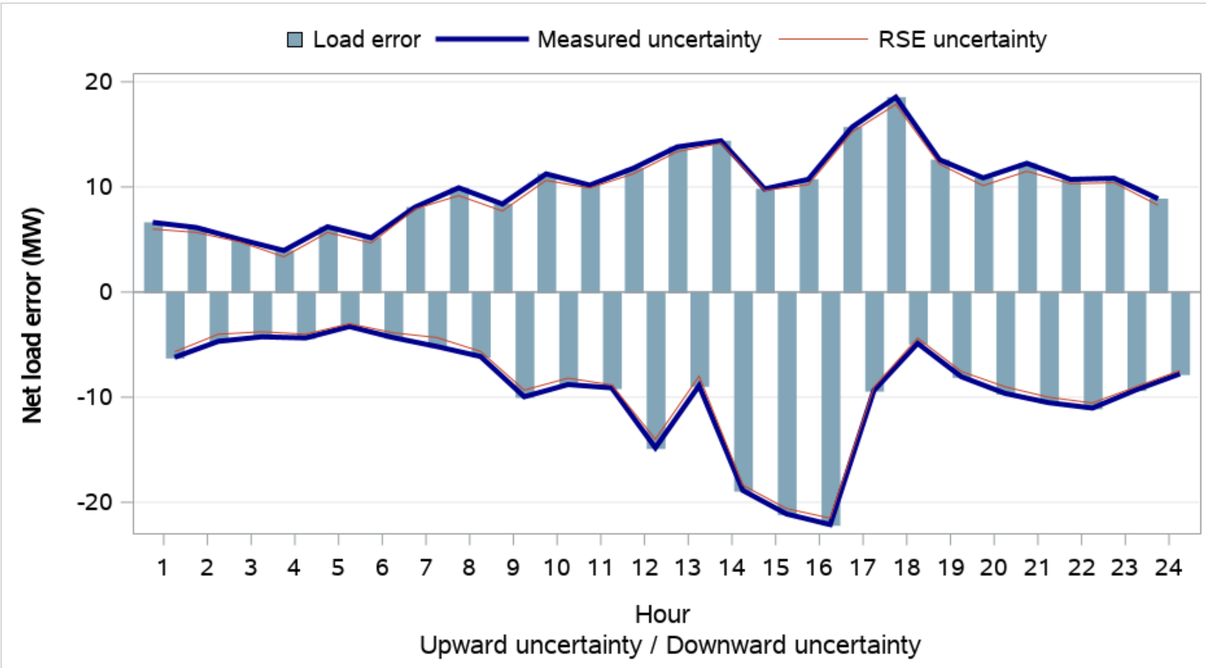


Figure 9.60 Turlock Irrigation District distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, September 2022)

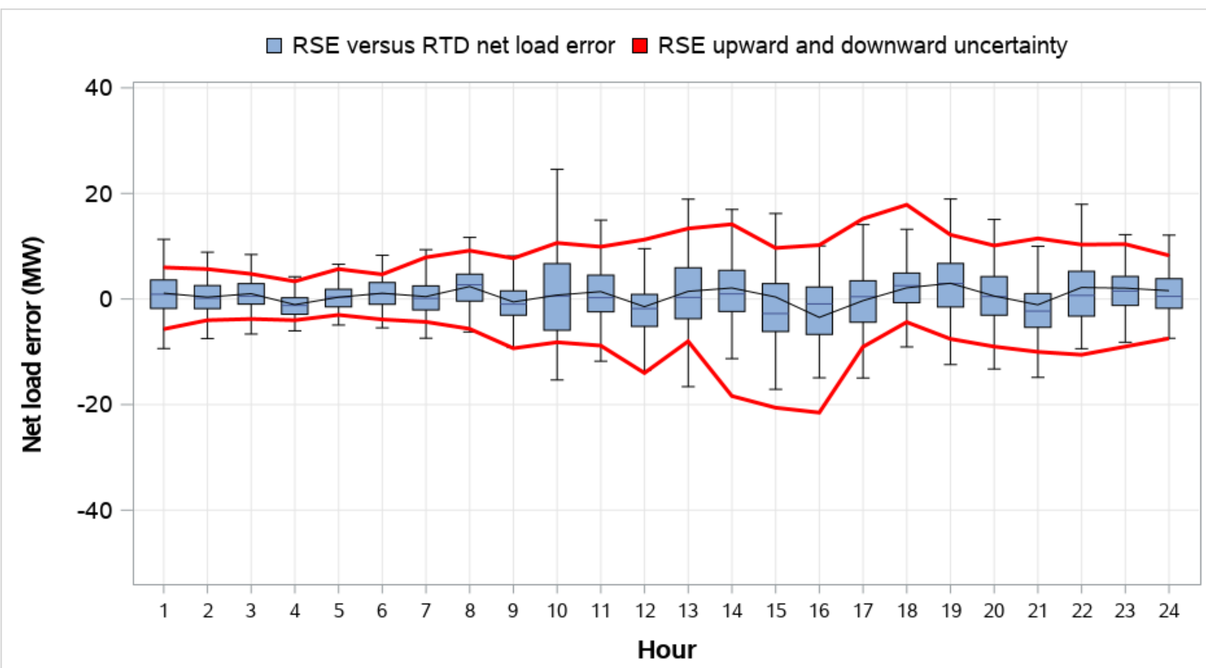


Figure 9.61 Turlock Irrigation District distribution of RSE and RTD load and VER error (weekdays, September 2022)