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

May 11, 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 highlights existing metrics and analysis covering April 2022 and is organized as follows:

- Section 2 provides an overview of the flexible ramp sufficiency and bid-range capacity tests.
- Section 3 summarizes the frequency and size of resource sufficiency evaluation failures.
- Section 4 summarizes WEIM import limits and transfers following a resource sufficiency evaluation failure.
- Section 5 summarizes imbalance conformance adjustments and provides some context with how it interacts with the resource sufficiency evaluation.
- Section 6 provides analysis on the California ISO's proposed changes for counting offline capacity in the bid-range capacity test.
- Section 7 summarizes input differences between the resource sufficiency evaluation and latest 15-minute market run.
- Section 8 provides a discussion and metrics on net load uncertainty used in the tests.
- Section 9 summarizes resources sufficiency evaluation issues identified by DMM or the California ISO in 2021.

DMM is seeking 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] *EIM Resource Sufficiency Evaluation Enhancements Straw Proposal*, August 16, 2021. http://www.caiso.com/InitiativeDocuments/StrawProposal-ResourceSufficiencyEvaluationEnhancements.pdf

2 Overview of the flex 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.[2] 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.*

[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.

Equation 1. Flexible Ramp Sufficiency Test Formulation

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

$$Down\ Requirement = \underbrace{-\Delta Load}_{\text{Change in load forecast}} + \underbrace{Down\ uncertainty}_{\text{Net load uncertainty}} - \underbrace{\min\begin{bmatrix} Net\ export\ capability, \\ Diversity\ benefit + Down\ credit \end{bmatrix}}_{\text{Discounts: diversity benefit and credit reduction capped by transfer capability}}$$

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.

Finally, 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.

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.[3] The uncertainty component is expected to be enhanced in fall 2022 to scale and account for net load currently in the system.[4]

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*.

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[3] 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.

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

Equation 2. Bid Range Capacity Test Formulation

$$Requirement = \underbrace{Load}_{\text{Load forecast}} + \underbrace{Export_{base} - Import_{base} - Generation_{base}}_{\text{Intertie and generation base schedules}} + \underbrace{Intertie\ uncertainty}_{\text{Additional requirement to account for historical intertie deviation}}$$

As also shown in Equation 2, an additional component is added to the requirement in order to account for both historical intertie deviations.

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

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

Since the bid range capacity is calculated relative to the base schedules, the upward capacity test can generally be expressed as follows:[5]

$$\underbrace{Generation_{maximum} + Net\ Import_{maximum}}_{\text{Upward capacity}} \geq \underbrace{Load + Intertie\ Deviation + Uncertainty}_{\text{Requirement}}$$

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.

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[5] 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*: https://stakeholdercenter.caiso.com/Common/DownloadFile/25df1561-236b-4a47-9b1c-717b4a9cf9f0

3 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.[6]

Figure 3.1 through Figure 3.4 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 3.5 through Figure 3.8 provide the same information for the downward direction. The dash indicates that the area did not fail the test during the month.

The frequency of flexible ramp sufficiency test and bid-range capacity test failures reported in the figures is reported separately. As previously noted, if a balancing area fails either (or both) of these tests, then transfers between that and the rest of the WEIM areas are limited.

On June 16, 2021, the California ISO added net load uncertainty to the requirement of the bid range capacity test as part of a package of market enhancements for summer 2021 readiness. Subsequently, as part of the resource sufficiency evaluation enhancements stakeholder initiative, net load uncertainty was removed from the bid-range capacity test on February 15, 2022. Intertie uncertainty is expected to be removed at a future date. These adders would be expected to return once the calculations are improved as part of the next phase of the initiative.

Figure 3.9 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 3.10 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.

[6] 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.

Figure 3.1 Frequency of upward capacity test failures (number of intervals)

	2021											2022			
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Arizona PS	10	—	—	8	—	5	8	5	—	9	1	—	—	1	1
Avista														—	1
BANC	—	3	—	—	—	7	—	1	—	—	—	—	—	—	—
California ISO	—	—	—	—	4	6	1	5	—	—	—	—	—	—	—
Idaho Power	—	—	—	—	—	13	25	3	—	—	—	—	3	—	—
LADWP			—	—	2	—	—	—	8	5	2	—	—	—	—
NorthWestern					9	36	18	6	253	34	7	9	2	—	1
NV Energy	9	—	1	14	22	15	6	7	8	—	—	—	—	—	5
PacifiCorp East	—	—	—	—	10	9	4	6	4	—	—	—	—	—	—
PacifiCorp West	—	2	—	1	4	7	2	3	2	14	11	8	3	9	1
Portland GE	4	—	11	—	21	25	30	41	13	6	11	3	—	—	—
Powerex	1	—	—	—	1	1	—	2	15	6	6	6	—	—	4
PSC New Mexico			—	—	—	11	—	5	—	—	—	—	—	—	—
Puget Sound En	2	17	29	18	45	16	21	17	29	18	10	—	—	—	1
Salt River Proj.	215	—	2	4	19	90	76	56	3	20	—	—	—	6	42
Seattle City Light	—	—	—	—	—	—	1	14	4	—	4	—	—	2	—
Tacoma Power														—	17
Turlock ID		—	—	1	—	—	33	22	46	—	—	—	—	—	—

Figure 3.2 Average shortfall of upward capacity test failures (MW)

	2021											2022			
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Arizona PS	1443	—	—	48	—	92	45	97	—	80	20	—	—	64	3
Avista														—	1
BANC	—	13	—	—	—	53	—	6	—	—	—	—	—	—	—
California ISO	—	—	—	—	405	601	274	125	—	—	—	—	—	—	—
Idaho Power	—	—	—	—	—	17	34	6	—	—	—	—	3	—	—
LADWP			—	—	46	—	—	—	95	103	40	—	—	—	—
NorthWestern					25	24	61	9	38	31	14	39	3	—	1
NV Energy	26	—	15	27	82	55	25	42	57	—	—	—	—	—	37
PacifiCorp East	—	—	—	—	73	40	38	63	79	—	—	—	—	—	—
PacifiCorp West	—	12	—	4	10	26	16	36	2	15	85	33	41	77	3
Portland GE	268	—	42	—	34	46	36	38	31	32	15	32	—	—	—
Powerex	32	—	—	—	63	3	—	22	78	70	148	216	—	—	364
PSC New Mexico			—	—	—	129	—	57	—	—	—	—	—	—	—
Puget Sound En	21	68	28	49	50	58	74	46	33	54	39	—	—	—	13
Salt River Proj.	54	—	25	38	30	75	121	74	27	27	—	—	—	28	50
Seattle City Light	—	—	—	—	—	—	4	151	53	—	16	—	—	13	—
Tacoma Power														—	77
Turlock ID		—	—	1	—	—	7	7	8	—	—	—	—	—	—

Figure 3.3 Frequency of upward flexibility test failures (number of intervals)

	Feb 2021	Mar 2021	Apr 2021	May 2021	Jun 2021	Jul 2021	Aug 2021	Sep 2021	Oct 2021	Nov 2021	Dec 2021	Jan 2022	Feb 2022	Mar 2022	Apr 2022
Arizona PS	13	7	—	19	—	1	—	7	—	10	1	1	5	2	—
Avista														—	7
BANC	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
California ISO	—	—	—	—	1	10	3	11	—	3	—	—	—	—	—
Idaho Power	4	—	—	—	—	—	—	—	—	—	1	—	6	—	—
LADWP			1	3	—	4	—	—	1	1	10	—	—	3	—
NorthWestern					18	108	20	46	247	14	14	—	4	4	8
NV Energy	13	11	12	20	27	12	15	4	8	1	1	1	20	11	28
PacifiCorp East	2	4	4	1	2	1	—	4	—	2	1	1	1	—	4
PacifiCorp West	5	3	4	1	—	1	2	—	—	16	7	1	1	2	7
Portland GE	15	3	7	7	8	14	5	—	1	—	5	10	1	—	—
Powerex	4	4	4	—	4	15	—	—	7	5	8	7	1	—	4
PSC New Mexico			11	1	3	15	—	2	—	2	—	—	—	2	1
Puget Sound En	—	—	—	4	2	1	1	—	—	2	—	—	—	1	2
Salt River Proj.	192	8	15	6	26	57	49	24	5	36	1	5	—	19	14
Seattle City Light	—	—	—	—	—	1	—	4	—	—	—	—	—	2	—
Tacoma Power														—	—
Turlock ID		—	—	9	—	—	—	2	5	—	—	—	—	—	—

Figure 3.4 Average shortfall of upward flexibility test failures (MW)

	Feb 2021	Mar 2021	Apr 2021	May 2021	Jun 2021	Jul 2021	Aug 2021	Sep 2021	Oct 2021	Nov 2021	Dec 2021	Jan 2022	Feb 2022	Mar 2022	Apr 2022
Arizona PS	1140	57	—	33	—	38	—	42	—	45	33	37	45	120	—
Avista														—	18
BANC	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
California ISO	—	—	—	—	404	585	400	735	—	540	—	—	—	—	—
Idaho Power	8	—	—	—	—	—	—	—	—	—	5	—	31	—	—
LADWP			32	59	—	70	—	—	10	11	97	—	—	106	—
NorthWestern					45	36	18	25	31	27	12	—	33	59	20
NV Energy	56	59	60	47	39	45	36	94	82	110	31	37	42	55	61
PacifiCorp East	26	61	67	47	53	44	—	21	—	57	10	124	59	—	83
PacifiCorp West	20	21	18	8	—	2	33	—	—	74	67	3	7	33	58
Portland GE	33	77	105	20	36	33	19	—	11	—	18	36	37	—	—
Powerex	64	26	69	—	137	111	—	—	50	88	41	202	26	—	366
PSC New Mexico			21	58	19	112	—	47	—	69	—	—	—	46	23
Puget Sound En	—	—	—	47	24	6	24	—	—	82	—	—	—	3	32
Salt River Proj.	64	27	75	27	69	61	53	50	32	65	10	43	—	45	36
Seattle City Light	—	—	—	—	—	7	—	14	—	—	—	—	—	8	—
Tacoma Power														—	—
Turlock ID		—	—	6	—	—	—	2	18	—	—	—	—	—	—

Figure 3.5 Frequency of downward capacity test failures (number of intervals)

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

Figure 3.6 Average shortfall of downward capacity test failures (MW)

	2021											2022			
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Arizona PS	—	—	—	8	—	—	—	—	—	63	—	240	—	—	—
Avista														—	—
BANC	1	6	—	—	—	—	—	—	—	—	—	—	—	—	—
California ISO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Idaho Power	—	—	—	—	—	—	—	—	—	38	—	—	—	—	—
LADWP			—	—	16	—	—	—	30	—	—	33	—	—	—
NorthWestern					—	—	—	—	55	—	—	—	—	—	—
NV Energy	—	—	—	—	26	—	—	—	—	—	—	—	—	—	—
PacifiCorp East	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PacifiCorp West	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Portland GE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Powerex	—	—	8	—	350	33	—	144	51	7	—	48	—	90	—
PSC New Mexico			—	—	—	—	—	—	22	65	—	—	—	40	—
Puget Sound En	—	—	—	—	—	—	—	—	33	—	—	—	—	—	—
Salt River Proj.	—	—	11	—	29	—	—	—	—	—	8	—	12	12	—
Seattle City Light	—	—	—	—	—	8	8	5	—	18	10	—	—	9	—
Tacoma Power														—	29
Turlock ID		—	—	4	4	3	8	2	5	1	3	1	1	—	3

Figure 3.7 Frequency of downward flexibility test failures (number of intervals)

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
	2021											2022			
Arizona PS	61	129	55	8	4	—	4	2	3	15	11	43	11	25	10
Avista														—	—
BANC	17	10	—	—	—	—	—	—	—	—	4	—	—	3	1
California ISO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Idaho Power	—	—	—	1	—	—	—	—	—	8	1	—	1	—	8
LADWP			—	—	2	—	—	—	2	—	—	4	—	—	—
NorthWestern					10	18	11	33	68	4	1	—	—	—	—
NV Energy	163	42	15	127	58	88	74	48	34	11	13	17	111	50	92
PacifiCorp East	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PacifiCorp West	—	2	—	—	4	—	—	—	—	1	—	—	—	1	1
Portland GE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Powerex	—	42	6	27	36	12	6	29	12	1	4	—	1	7	1
PSC New Mexico			39	—	1	—	—	4	11	20	4	9	1	36	10
Puget Sound En	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
Salt River Proj.	43	35	5	2	5	—	2	1	2	1	2	2	28	46	6
Seattle City Light	—	—	—	—	—	6	—	—	—	1	1	—	—	2	4
Tacoma Power														—	11
Turlock ID		3	4	16	—	—	1	—	18	3	5	6	—	14	16

Figure 3.8 Average shortfall of downward flexibility test failures (MW)

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
	2021											2022			
Arizona PS	94	52	73	38	26	—	50	27	36	81	51	69	32	42	54
Avista														—	—
BANC	16	13	—	—	—	—	—	—	—	—	71	—	—	18	7
California ISO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Idaho Power	—	—	—	9	—	—	—	—	—	31	40	—	43	—	18
LADWP			—	—	14	—	—	—	5	—	—	43	—	—	—
NorthWestern					259	14	29	17	25	21	7	—	—	—	—
NV Energy	49	56	64	74	65	141	70	83	39	34	24	44	92	55	86
PacifiCorp East	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PacifiCorp West	—	9	—	—	140	—	—	—	—	32	—	—	—	4	15
Portland GE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Powerex	—	64	26	38	199	83	44	121	101	16	163	—	15	184	3
PSC New Mexico			124	—	12	—	—	102	56	41	223	77	15	64	40
Puget Sound En	—	—	—	—	—	—	—	—	—	16	—	—	—	—	—
Salt River Proj.	45	55	47	65	44	—	25	100	22	4	11	45	35	49	74
Seattle City Light	—	—	—	—	—	2	—	—	—	2	3	—	—	10	6
Tacoma Power														—	5
Turlock ID		2	6	7	—	—	4	—	16	3	94	9	—	5	20

Figure 3.9 Upward capacity/flexibility test failure intervals by concurrence (April 2022)

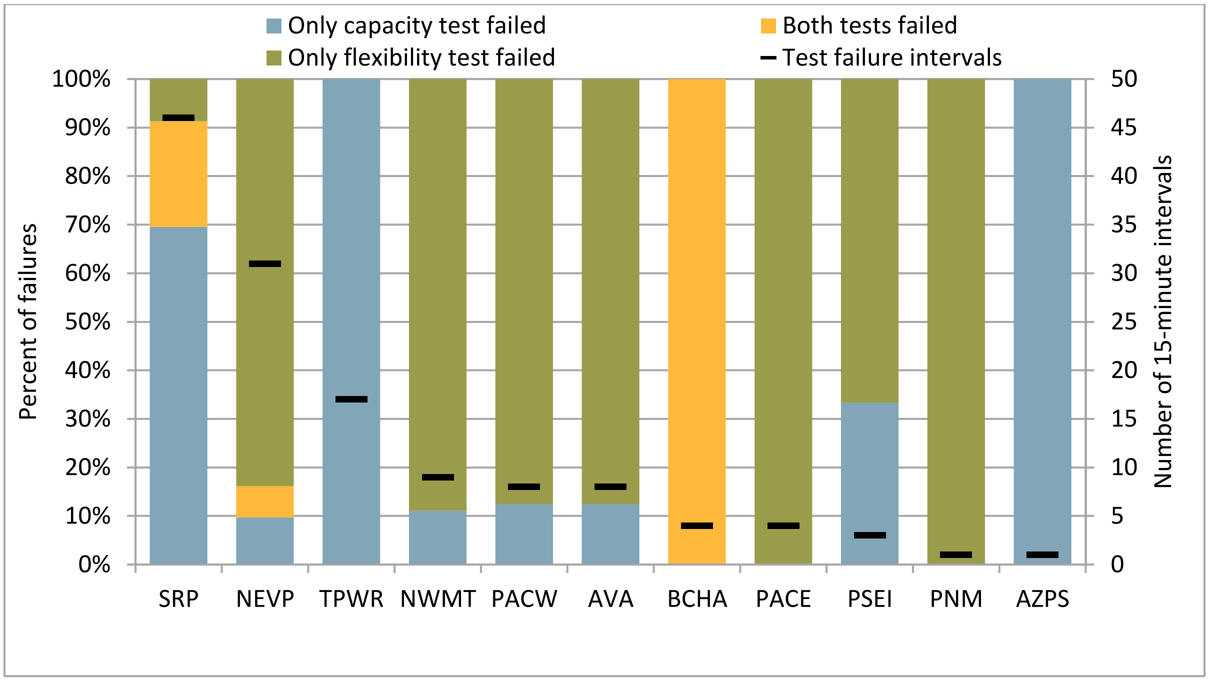
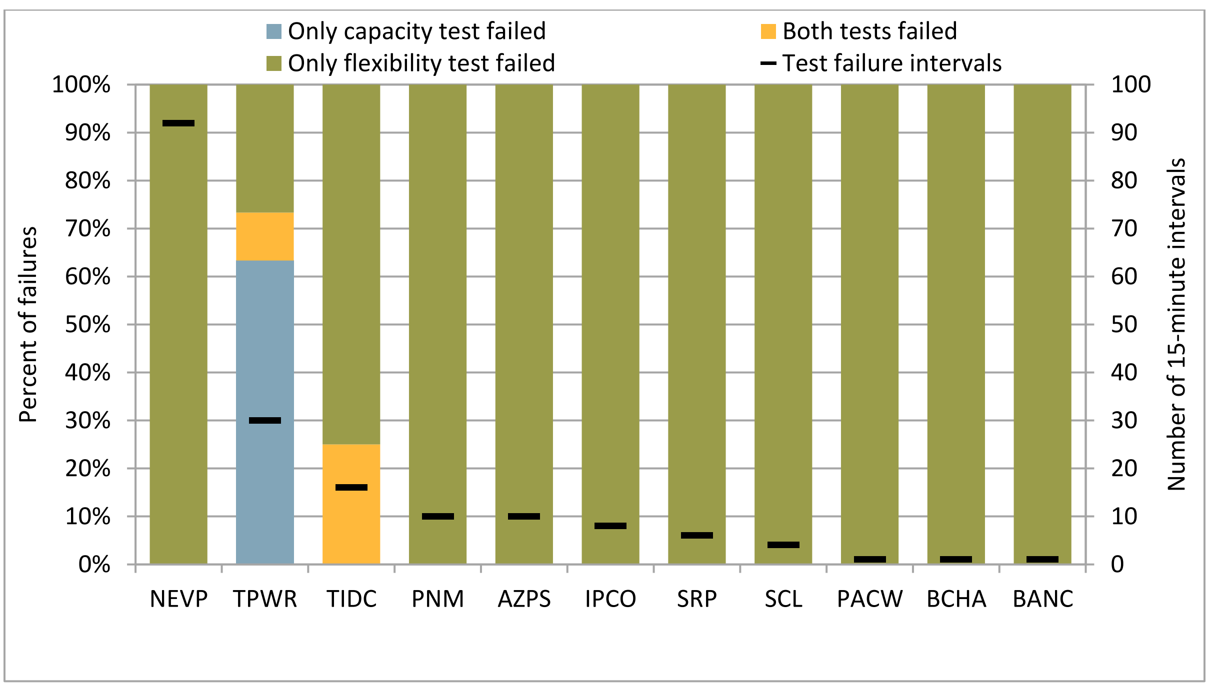


Figure 3.10 Downward capacity/flexibility test failure intervals by concurrence (April 2022)



4 WEIM limits and transfers following test failure

This section summarizes the import limits that are imposed when a WEIM entity fails either the bid-range capacity or 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 4.1 summarizes the import limits after failing either test by the source of the limit. The black horizontal line (right axis) shows the number of 15-minute intervals with either a capacity or a flexibility test failure while the bars (left axis) show the percent of failure intervals in which the WEIM import limit was capped by either the base transfer or the last 15-minute market transfer.

Figure 4.1 Upward capacity/flexibility test failure intervals by source of import limit (April 2022)

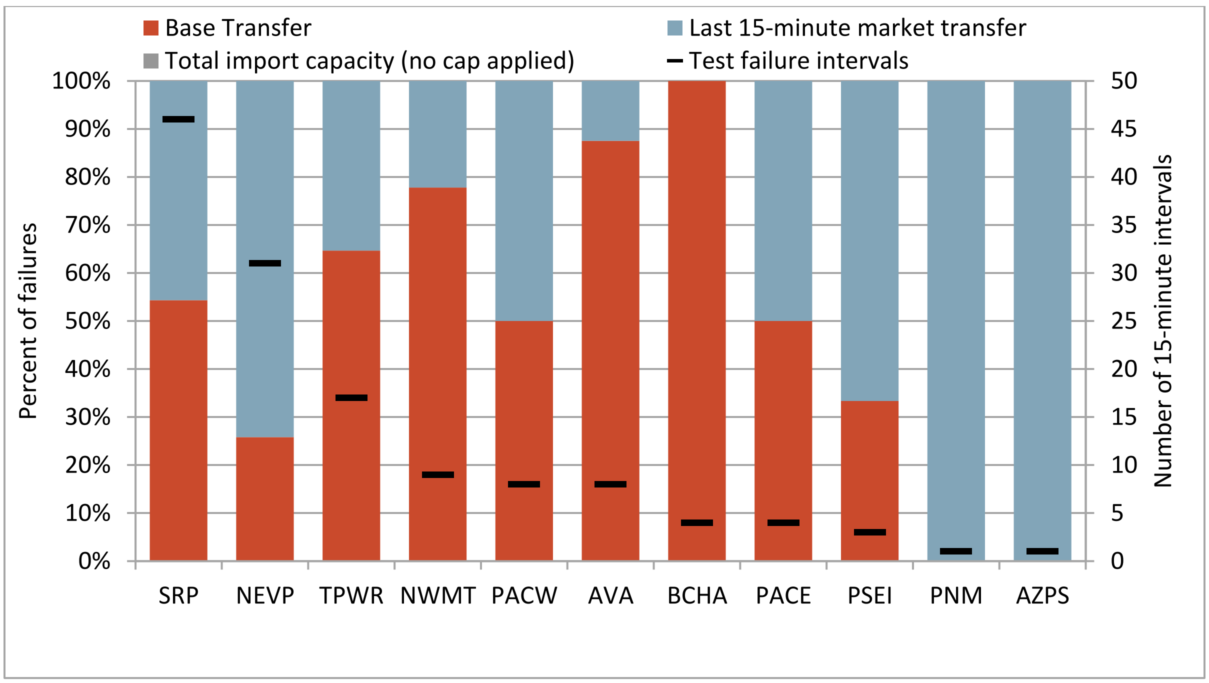
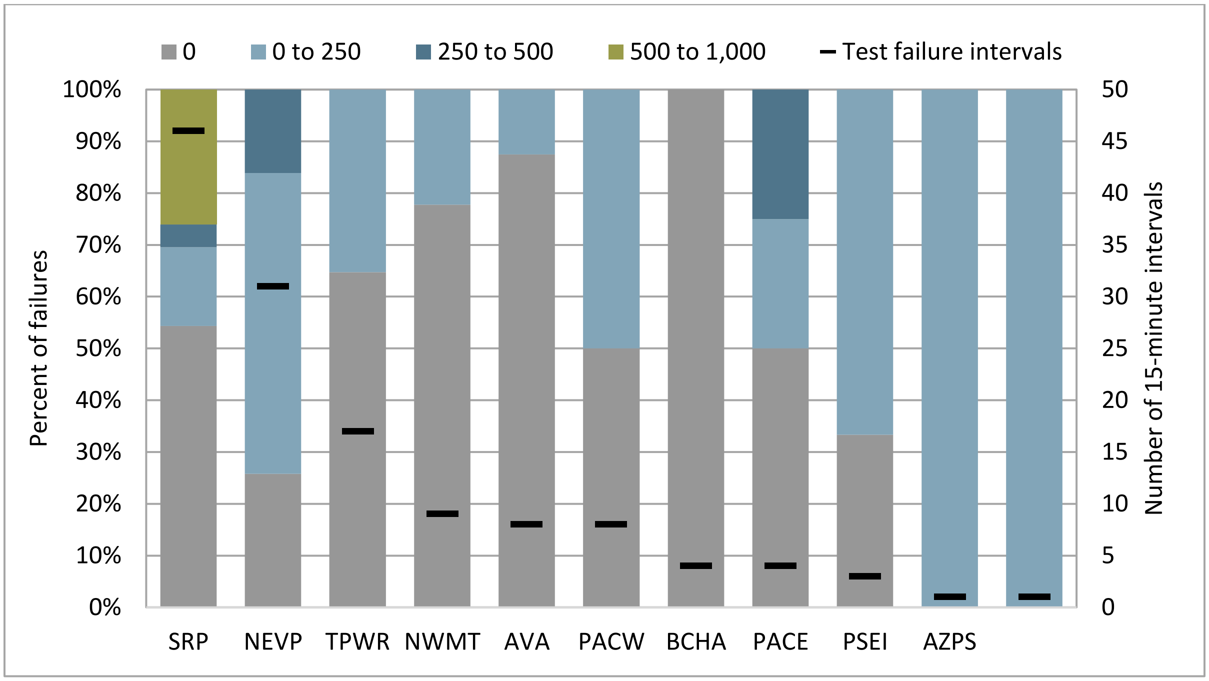


Figure 4.2 summarizes *incremental* WEIM import limits above base transfers (fixed bilateral transactions between WEIM entities) after failing either test in the upward direction. From this perspective, the incremental WEIM import limit after a test failure is set by the greater of (1) zero or (2) the transfer from the last 15-minute market interval minus the current base transfer. Therefore, the incremental import limits 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 or imposed import limits during the month were excluded.[7]

Figure 4.2 Upward capacity/flexibility test failure intervals by incremental import limit (April 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 4.3 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 4.4 summarizes the same information with the net transfer quantity categorized by various levels.

As shown by Figure 4.3, WEIM balancing areas were commonly optimized as a net exporters during the month despite failing the resource sufficiency evaluation. This result is in part driven from *uncertainty* that is included in both the capacity and the flexibility test. During this period, the capacity test included intertie uncertainty in the requirement. The flexibility test includes net load uncertainty in the requirement. In some cases, the balancing area would fail the resource sufficiency evaluation in part because of the uncertainty component in either test, but then in the real-time market it could then be economically optimal to export if that uncertainty does not materialize.

[7] 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.

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 4.5 summarizes whether the import limit that was imposed after failing either test in the upward direction ultimately impacted market transfers. 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 4.3 Upward test failure by dynamic net WEIM transfer status (April 2022)

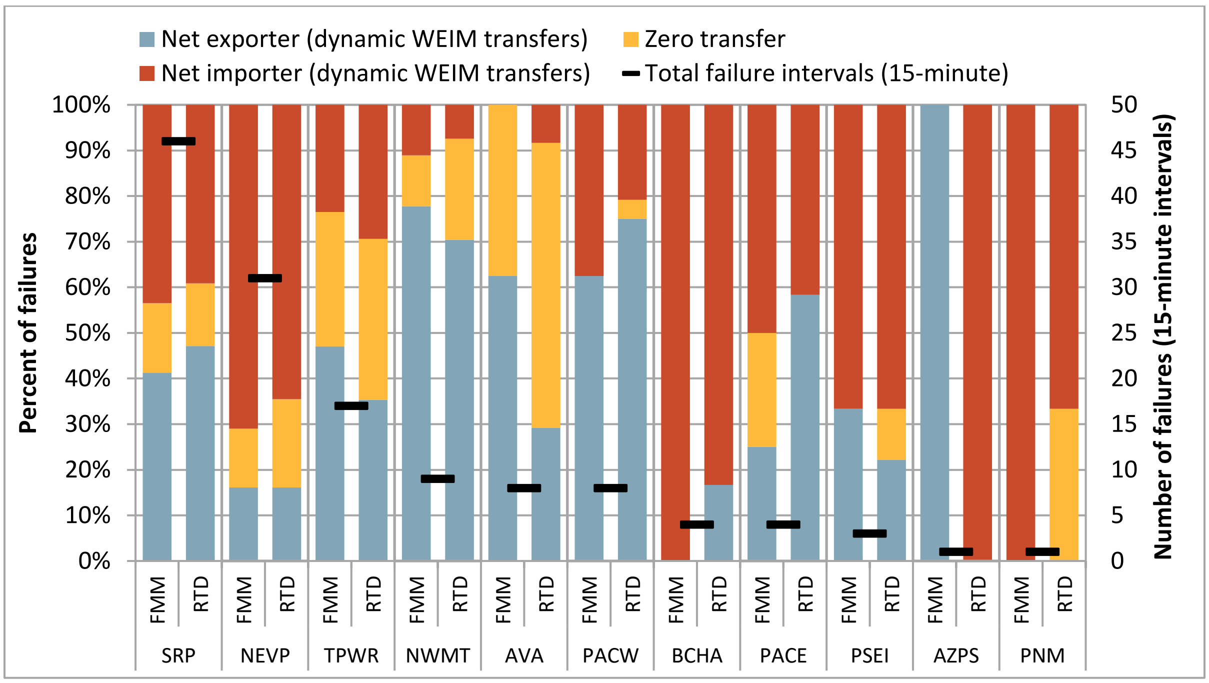


Figure 4.4 Upward test failure by dynamic net WEIM transfer amount (April 2022)

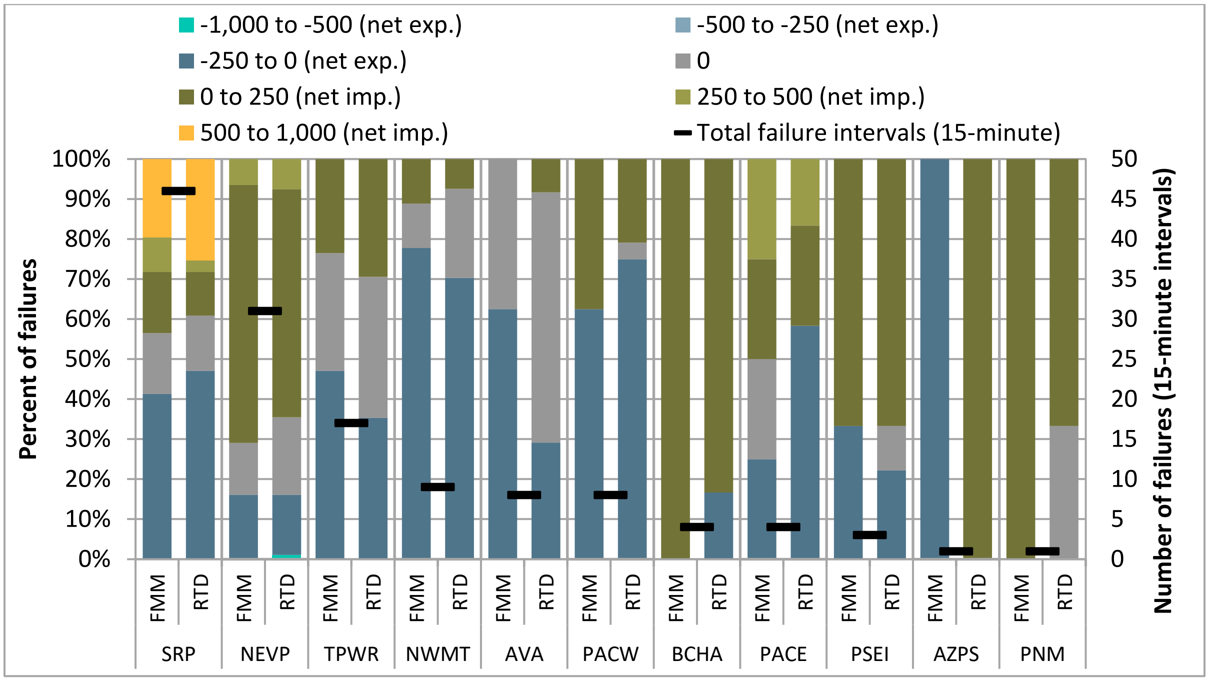
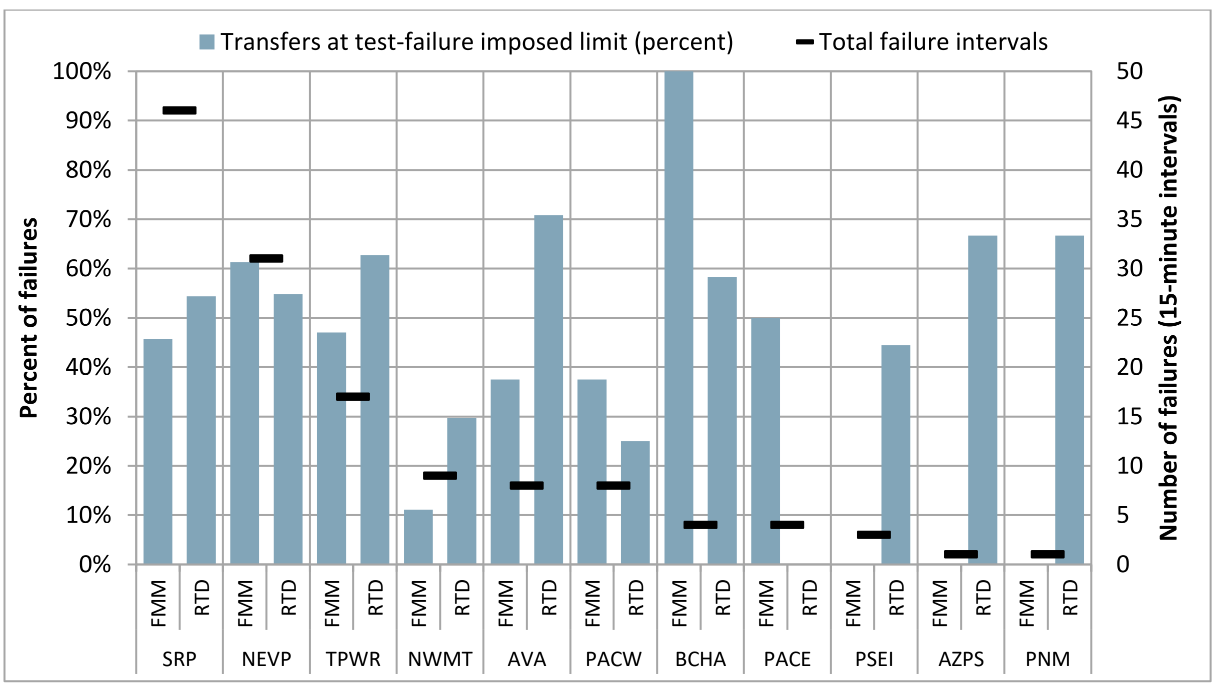


Figure 4.5 Percent of upward test failure intervals with market transfers at the imposed cap (April 2022)



5 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.[8] 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.

Figure 5.1 summarizes average hour-ahead and 15-minute market imbalance conformance adjustments entered by the CAISO operators during the month. Figure 5.2 shows the hourly distribution of 15-minute market imbalance conformance.

Figure 5.3 shows the same information for each of the WEIM entities with substantial imbalance conformance and Figure 5.4 shows adjustments as a percent of total load.[9]

Table 5.1 summarizes the average frequency and size of 15-minute and 5-minute market imbalance conformance for all balancing authority areas.

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

[9] 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 5.1 Average CAISO hour-ahead and 15-minute market imbalance conformance (April 2022)

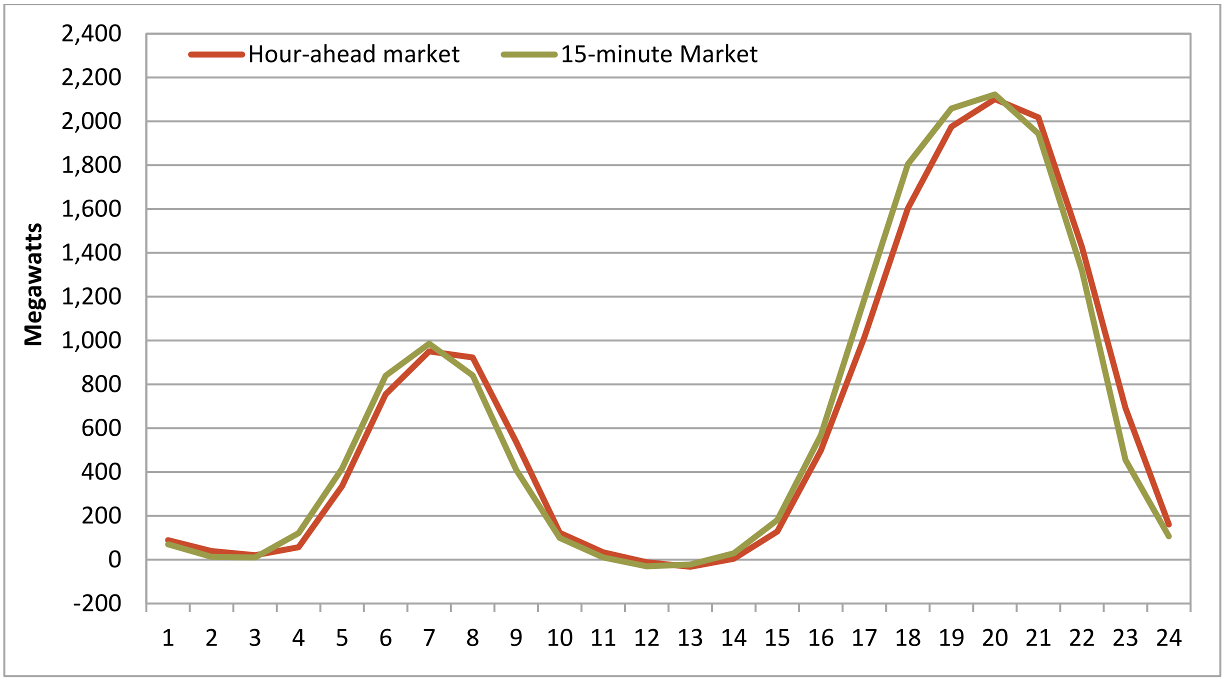

Figure 5.2 Distribution of CAISO 15-minute market imbalance conformance (April 2022)

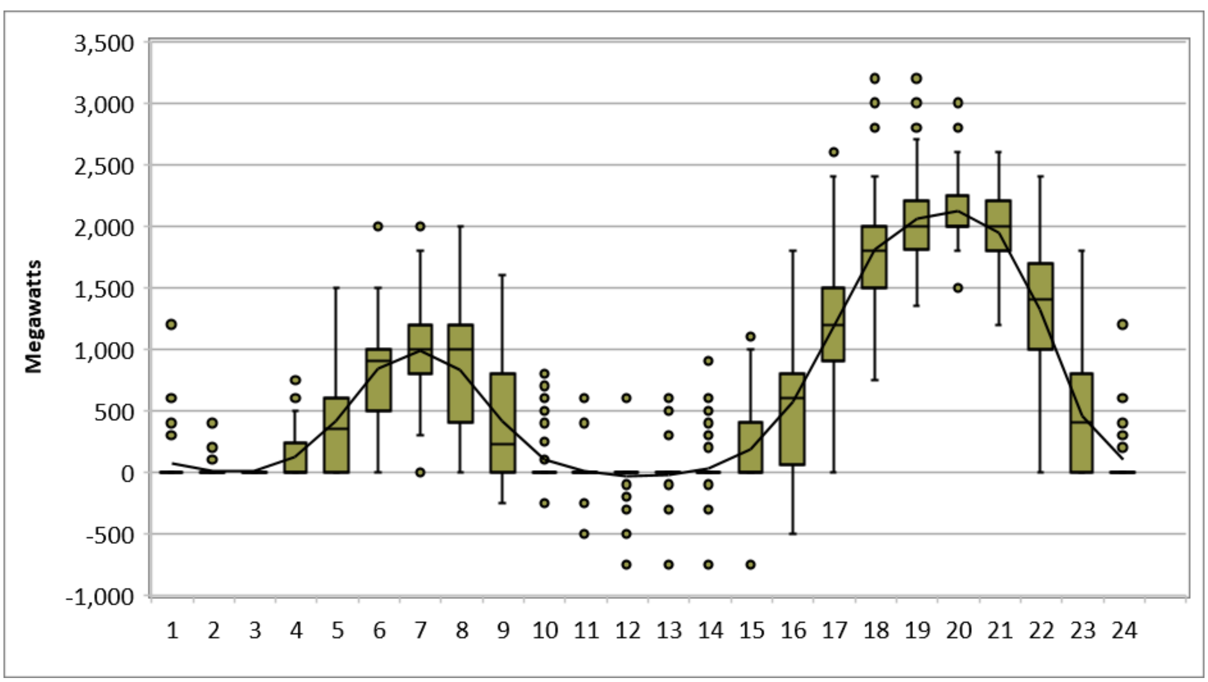

Figure 5.3 Average hourly non-CAISO 15-minute market imbalance conformance (April 2022)

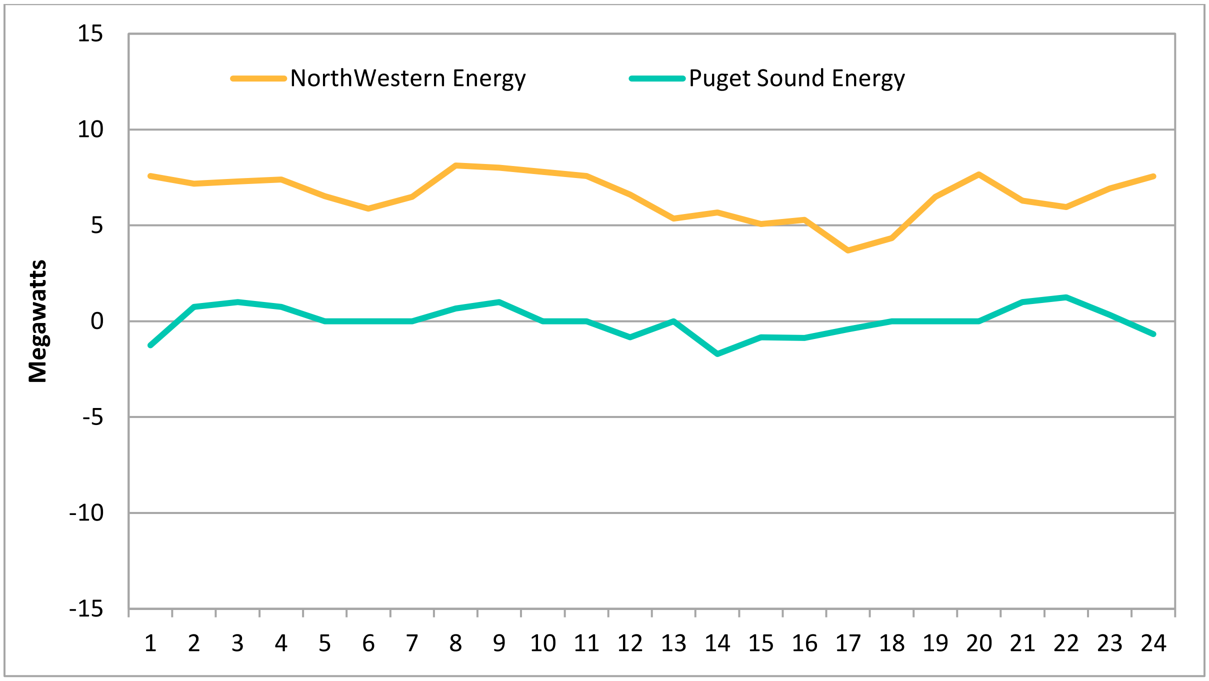

Figure 5.4 Average hourly 15-minute market imbalance conformance *as a percent of load* (April 2022)

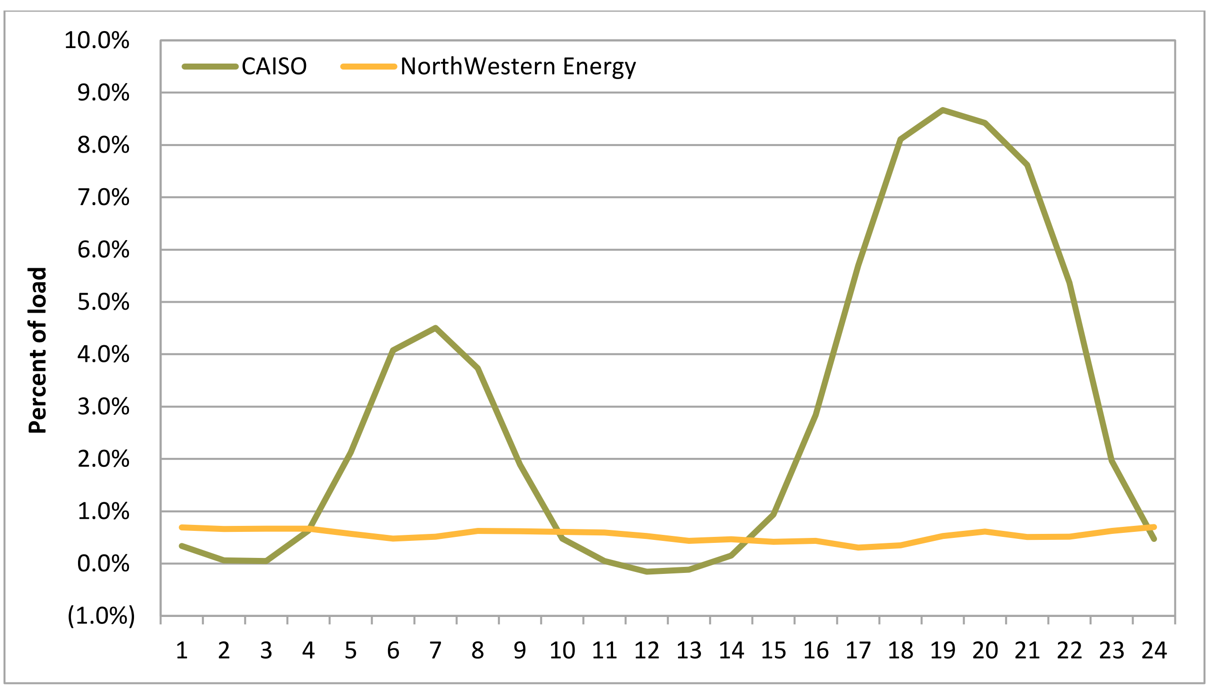

Table 5.1 Average frequency and size of imbalance conformance (April 2022)

		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	0.03%	100	3.0%	1%	-50	1.5%	0
	5-minute market	33%	56	1.8%	32%	-52	2%	2
Avista	15-minute market	0.3%	16	1.4%	0.6%	-24	2%	0
	5-minute market	1.2%	19	2%	0.8%	-17	2%	0
BANC	15-minute market	0%	N/A	N/A	0.1%	-15	1.0%	0
	5-minute market	0%	N/A	N/A	0.1%	-15	1.0%	0
California ISO	15-minute market	53%	1243	5.6%	1.6%	-407	2.0%	648
	5-minute market	54%	292	1.3%	23%	-246	1.3%	103
Idaho Power	15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
	5-minute market	16%	50	2.9%	9%	-53	3.1%	3
LADWP	15-minute market	0.8%	51	2.5%	0.2%	-50	2.1%	0
	5-minute market	11%	37	1.7%	10%	-52	2.2%	-1
NorthWestern Energy	15-minute market	50%	14	1.1%	2%	-14	1.2%	7
	5-minute market	64%	14	1.1%	2%	-21	1.6%	9
NV Energy	15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
	5-minute market	11%	109	2.9%	21%	-130	3.6%	-15
PacifiCorp East	15-minute market	0%	N/A	N/A	0.2%	-125	2.4%	0
	5-minute market	17%	111	2.3%	40%	-139	2.9%	-38
PacifiCorp West	15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
	5-minute market	8%	60	2.6%	26%	-65	2.8%	-13
Portland General Electric	15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
	5-minute market	9%	25	1.0%	2%	-27	1.2%	2
Public Service Co. New Mexico	15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
	5-minute market	8%	99	8.2%	31%	-93	7.5%	-21
Puget Sound Energy	15-minute market	2%	33	1.2%	0.9%	-59	2.2%	0
	5-minute market	4%	30	1.1%	27%	-33	1.2%	-8
Salt River Project	15-minute market	0.3%	66	2.0%	0.1%	-50	1.7%	0
	5-minute market	5%	47	1.4%	1%	-68	2.2%	2
Seattle City Light	15-minute market	1.5%	28	2.8%	2%	-20	2.0%	0
	5-minute market	5%	20	1.9%	56%	-23	2.2%	-12
Tacoma Power	15-minute market	0%	N/A	N/A	0.03%	-12	3.0%	0
	5-minute market	7%	14	2.6%	5%	-12	2.4%	0
Turlock Irrigation District	15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
	5-minute market	0%	N/A	N/A	0%	N/A	N/A	0

6 Changes in capacity crediting in the bid-range capacity test

As part of the resource sufficiency evaluation enhancements stakeholder initiative, the CAISO has proposed to omit offline capacity from the bid-range capacity test that could not start within the short-term unit commitment (STUC) horizon.[10] The analysis estimates offline capacity that would not have been counted under the proposal after accounting for bid availability and start-times within the applicable short-term unit commitment horizon.[11]

As shown by this analysis, the proposed enhancements do help to remove clear cases in which capacity should be excluded from the test. For example, long-start resources which cannot realistically start within the real-time horizon. This will provide a more accurate assessment of capacity that has been made available in each balancing area.

Impact to the CAISO on the highest load days of summer 2021

This first section highlights the impact on the CAISO after omitting this subset of offline capacity for the peak hours of the highest load days of summer 2021. In particular, the analysis shows that the proposed changes would not have had a significant impact on CAISO passing or failing the test during this period.

Figure 6.1 summarizes the impact of the proposal on the bid-range capacity test for the CAISO during the peak load hours of July 9, 2021. During this period, the CAISO hit a Stage 2 Energy Emergency as well as the third highest instantaneous peak load of the year. The total height of the bars shows capacity that was credited in the upward capacity test. The red bars reflect capacity that would have been excluded as part of the proposal. The CAISO also proposes to temporarily suspend both net load and intertie uncertainty from the capacity test.[12] The solid and dotted black lines show the capacity requirement with and without all uncertainty, respectively.

As a point of comparison, the dashed gray regions highlight capacity that is not operationally available in real-time after accounting for all resource constraints.[13] DMM reiterates that the capacity test should reflect capacity that suppliers made available for the WEIM optimization to utilize.[14] This can include capacity which was offline or not operationally available at the time of the resource sufficiency evaluation but could have been accessed based on the economics and dispatch decisions in prior intervals. This capacity should be considered in the capacity test as it could have been available had the balancing area been required to meet its load on its own.

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[10] *EIM Resource Sufficiency Evaluation Enhancements Phase 1 Revised Draft Final* Proposal, December 16, 2021. http://www.caiso.com/InitiativeDocuments/RevisedDraftFinalProposal-EIMResourceSufficiencyEvaluationEnhancements.pdf

[11] This analysis only summarizes the impact of the proposal with respect to the treatment of offline resources. It does not estimate the impact of the proposal with respect to the treatment of storage resources.

[12] Net load uncertainty was removed from the bid-range capacity test requirement on February 15, 2022. Intertie uncertainty is expected to be removed at a future date.

[13] Capacity that was considered available in the bid-range capacity test but unavailable for the flexible ramp sufficiency test after accounting for resource constraints. This includes start-up times, transition times, ramp rates, and other intertemporal constraints.

[14] *Comments on EIM Resource Sufficiency Evaluation Enhancements Draft Final Proposal*, October 22, 2021. http://www.caiso.com/Documents/DMM-Comments-on-EIM-Resource-Sufficiency-Evaluation-Enhancements-Draft-Final-Proposal-Oct-22-2021.pdf

As shown in Figure 6.1, 500 MW of capacity would have been excluded under the proposal in each interval of the peak load period for July 9. This was because of a single extremely long-start unit that incurred a forced outage in the morning, and was not able to return in any short-term unit commitment horizon during the peak load hours. Using the original requirement — *including uncertainty* — the proposal would have resulted in two additional failure intervals (hour-ending 18 interval 4 and hour-ending 21 interval 1). With all uncertainty adders excluded from the requirement, the proposal would have resulted in no additional failure intervals and one additional pass interval (hour-ending 19 interval 3) for this day.

Figure 6.1 CAISO upward bid range capacity test and proposal impact — July 9, 2021 (Stage 2 Energy Emergency and third highest load day for the year)

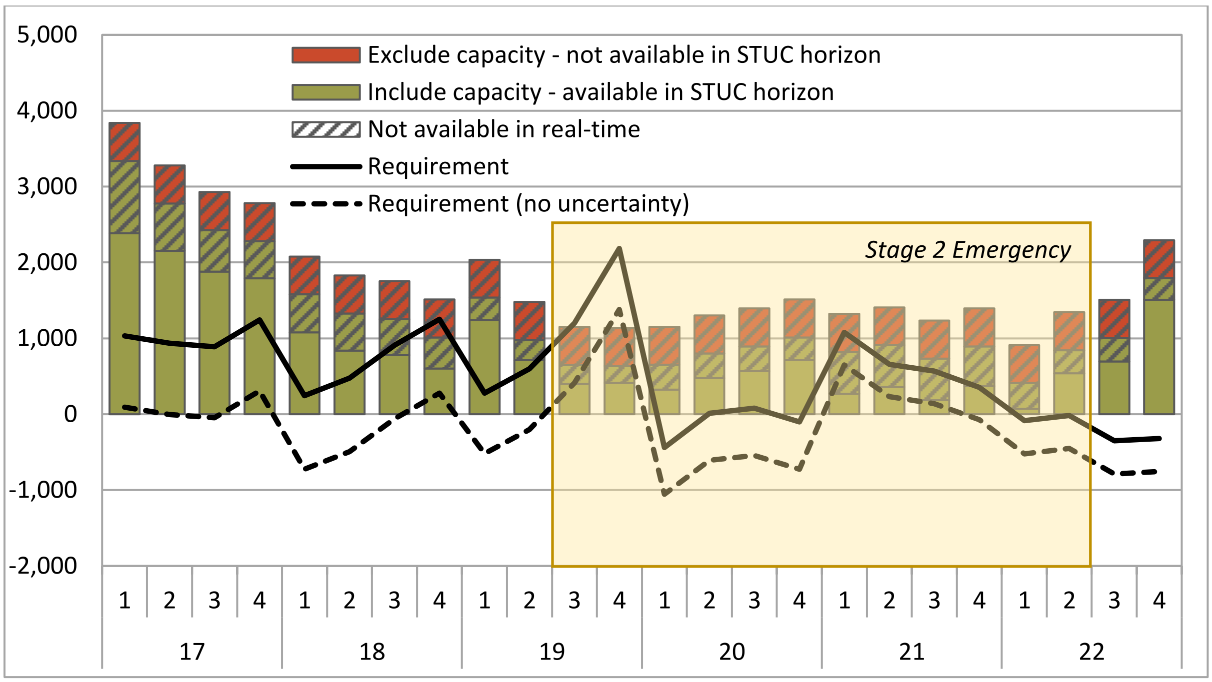


Figure 6.2 and Figure 6.3 show the same analysis for September 8 and 9, which were the first and second highest load days of 2021, respectively. For each of these days, under 500 MW of offline capacity would have been excluded in hour-ending 17, but otherwise the proposal had little impact on available capacity during the other highest load hours. The excluded capacity was associated with long-start resources, which were scheduled for the highest load hours, but could not be committed within the short-term unit commitment horizon for hour-ending 17. For these two days, the proposal's exclusion of offline capacity would not have led to any additional failure intervals.

Figure 6.4 and Figure 6.5 show the results for August 16 and September 7, which were the fourth and fifth highest load days of 2021. Similar to the previous two examples, the proposed changes with respect to the treatment of offline capacity, would not have changed whether or not the CAISO failed the test.

With the proposed omission of non-committable offline capacity, the CAISO would have incurred six additional failure intervals in total during the summer of 2021. Two of these occurred on July 9, and the remaining four occurred on July 28. Figure 6.6 shows the results for July 28. On this day, a single resource (around 230 MW) had just returned from outage in hour-ending 19 and was unable to start within the short-term unit commitment horizon.

Figure 6.2 CAISO upward bid range capacity test and proposal impact — September 8, 2021 (highest load day for the year)

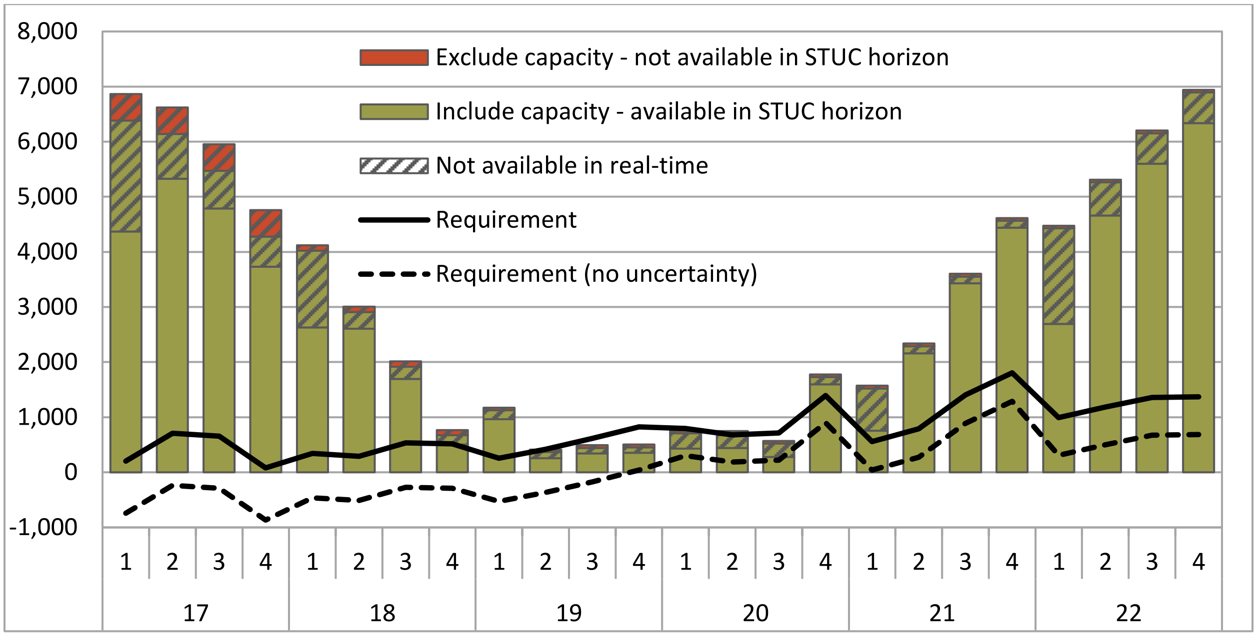


Figure 6.3 CAISO upward bid range capacity test and proposal impact — September 9, 2021 (second highest load day for the year)

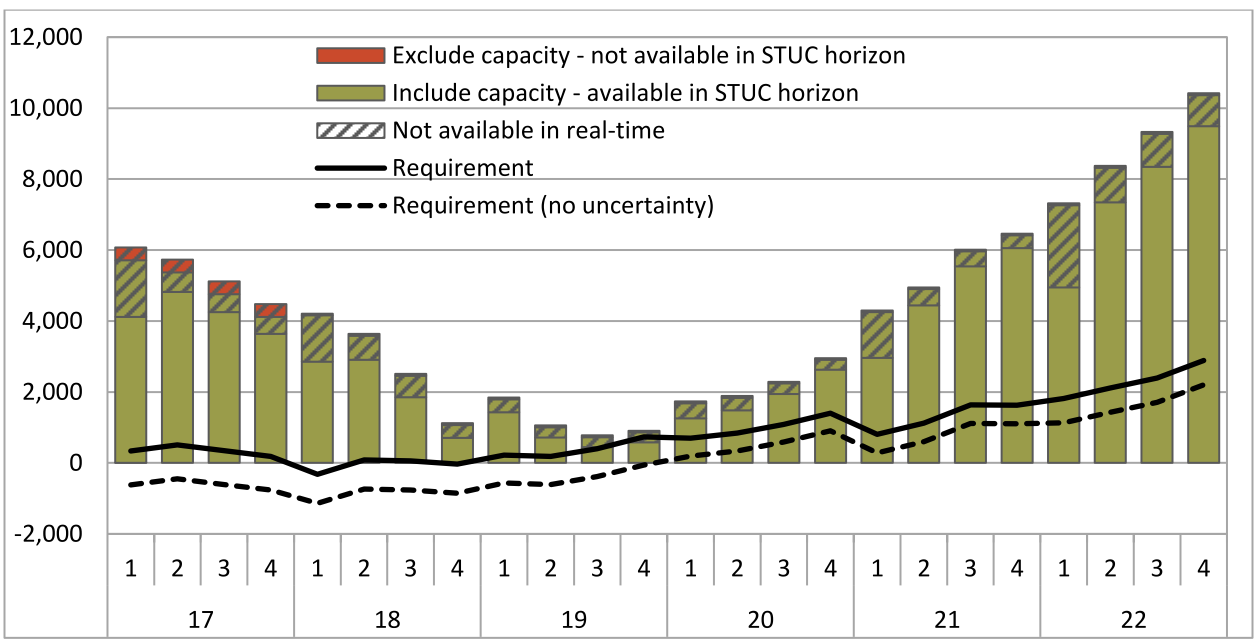


Figure 6.4 CAISO upward bid range capacity test and proposal impact — August 16, 2021 (fourth highest load day for the year)

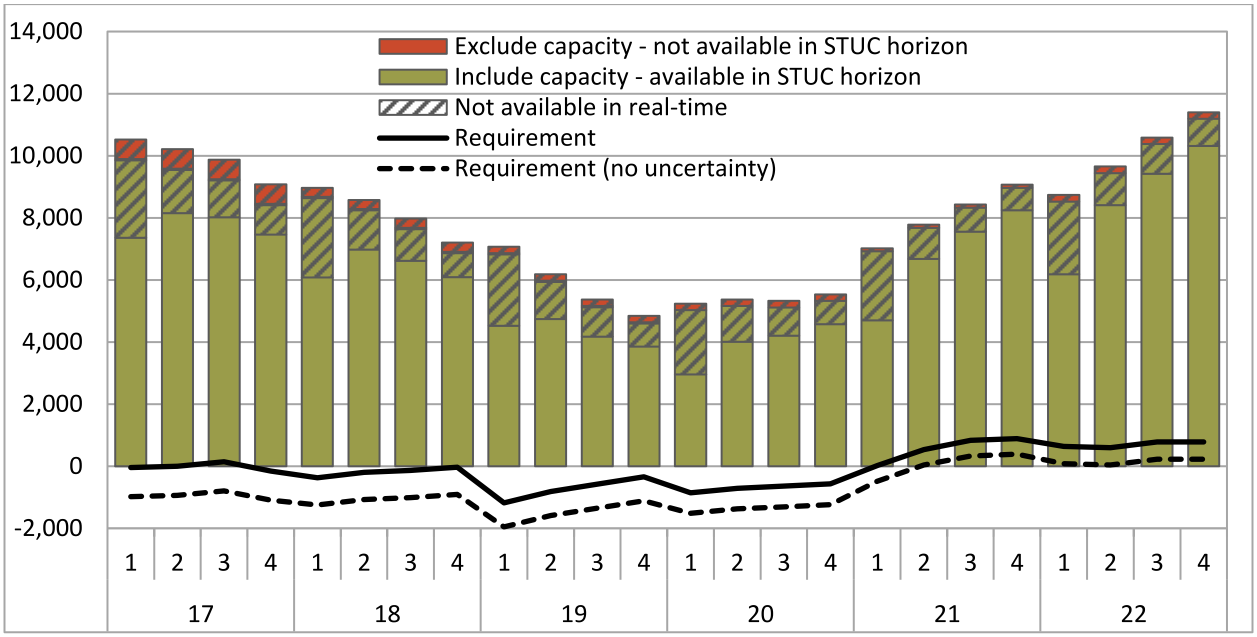


Figure 6.5 CAISO upward bid range capacity test and proposal impact — September 7, 2021 (fifth highest load day for the year)

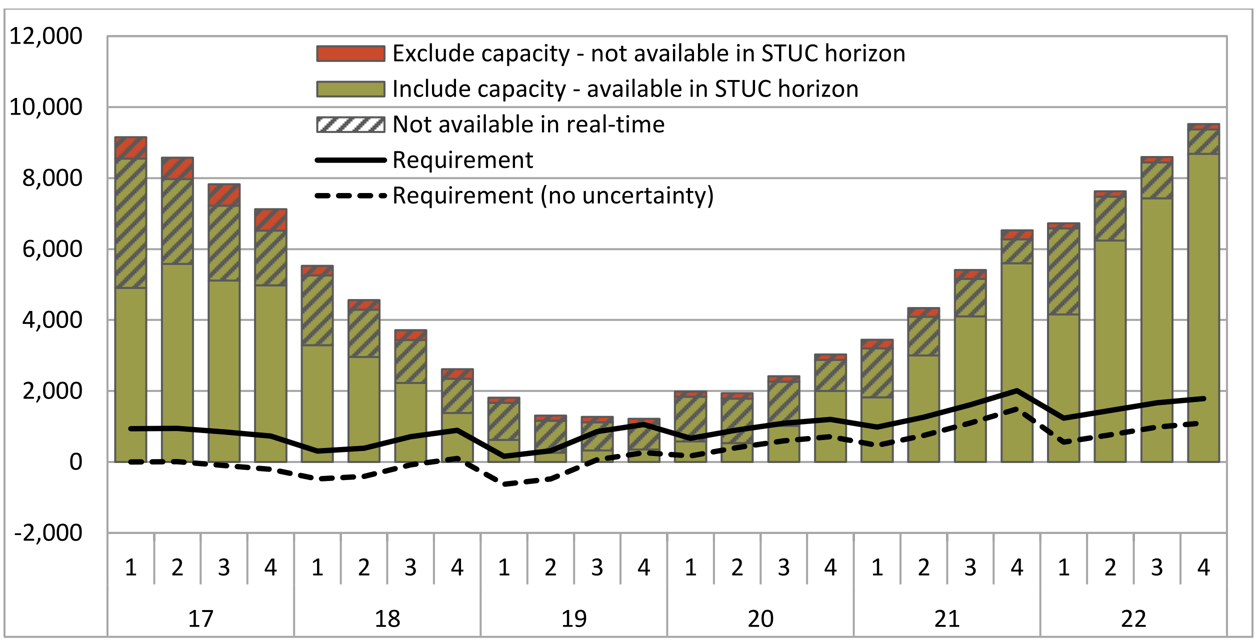
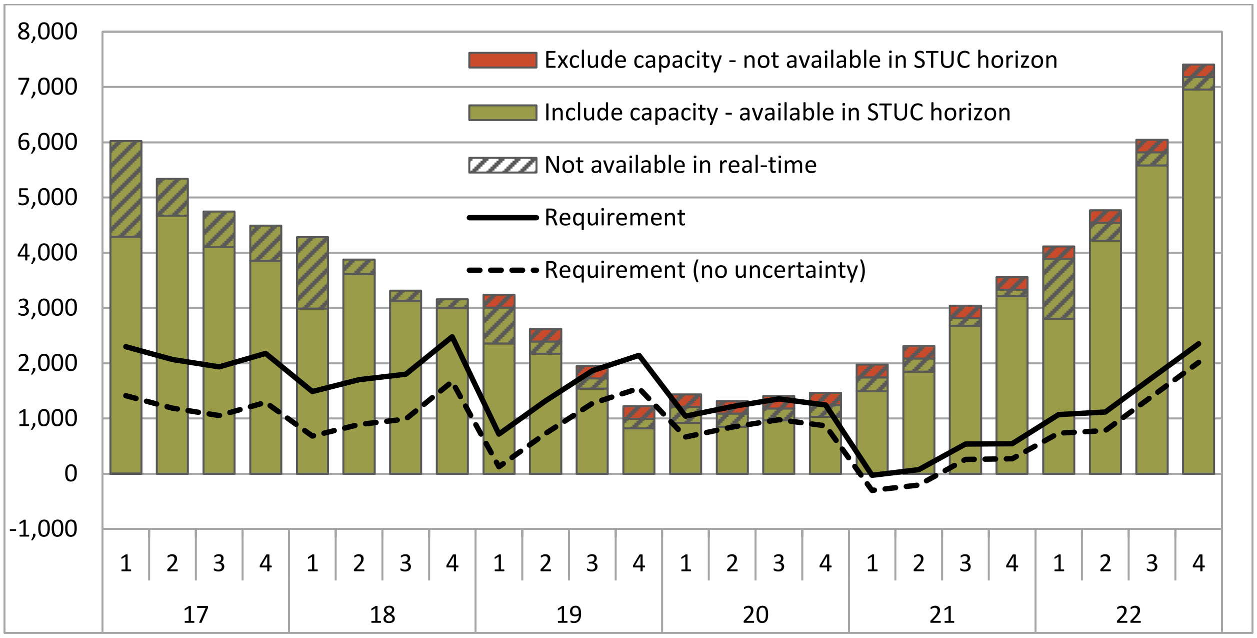


Figure 6.6 CAISO upward bid range capacity test and proposal impact — July 28, 2021



Impact across the Western Energy Imbalance Market

This next section summarizes the estimated impact across the Western Energy Imbalance Market because of the proposed changes for crediting offline capacity in the bid-range capacity test. Figure 6.7 shows these *additional* capacity test failures since June.[15] The dashed gray regions identify the subset of additional capacity test failures in which the flexibility test also failed. In these cases, WEIM transfers would have been capped regardless of the capacity test result because the consequence for failing either test is the same. These results all assume the same net load and intertie uncertainty that was in place at the time. With all uncertainty instead removed, the proposal would have had almost no impact.

As shown in Figure 6.7, the proposed changes for the treatment of offline resources in the bid-range capacity test would have impacted Salt River Project the most. During the summer of 2021, the market software would have limited WEIM imports into this area by 25 additional intervals (or around 6 hours).

As an example day, Figure 6.8 shows capacity that would have been excluded under the proposal for Salt River Project during the evening of August 16, 2021. Here, around 160 MW would have been excluded resulting in 15 additional capacity test failures. This was because of two units which were offline at the time of the resource sufficiency evaluation, and whose cycle time exceeded the short-term unit commitment horizon.[16] Therefore, this capacity was not made available to the market.

DMM also reviewed capacity that would have been excluded using the real-time unit commitment horizon (2 hours), instead of the short-term unit commitment horizon (4.5 hours), which the proposal maintains. Based on the summer 2021 period, DMM did not find any meaningful differences between these two approaches. Here, the small subsets of resources which would not have been committable in

[15] Areas that wouldn't have had any additional capacity test failures were excluded in the metric.

[16] Cycle time is the combined start-up and minimum up time.

the shorter real-time horizon, but could have been committed in the longer real-time horizon, were already positioned online at the time of the resource sufficiency evaluation.

Figure 6.7 Additional capacity test failures from proposed treatment of offline capacity

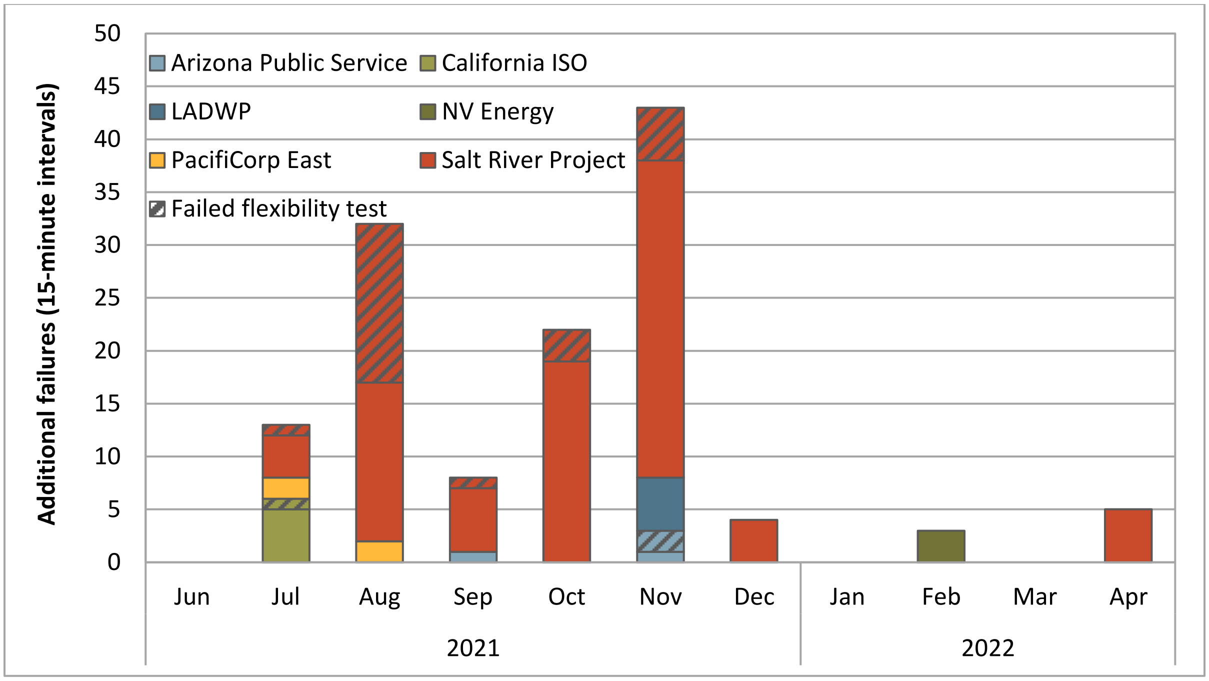
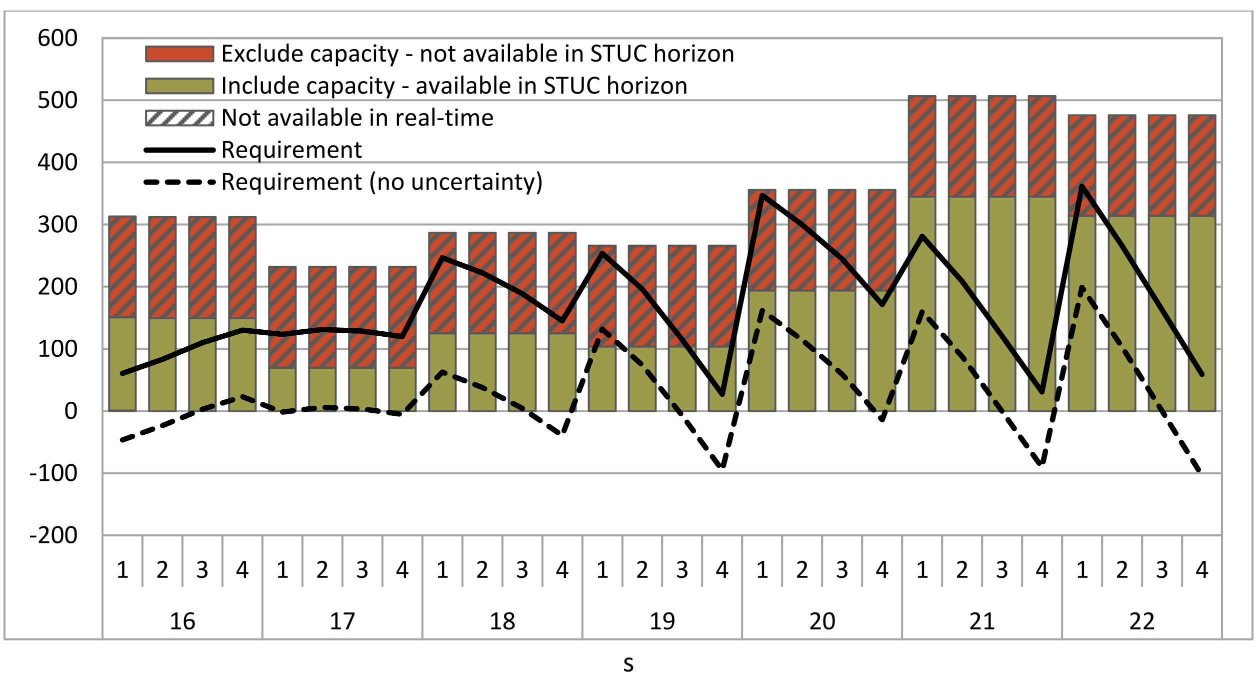


Figure 6.8 Salt River Project upward bid range capacity test and proposal impact — August 16, 2021



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

DMM reviewed cases in the CAISO balancing area when optimized net WEIM imports in the market significantly exceeded the unloaded capacity calculated by the resource sufficiency evaluation — but the CAISO still passed the test. DMM analysis found that this outcome was driven by differences between inputs in the resource sufficiency evaluation and inputs used in the market.

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.

Figure 7.1 compares the imbalance requirement in the bid-range capacity test with advisory WEIM transfers from the latest 15-minute market run, on average for the month. The red bars show the imbalance requirement, including intertie and net load uncertainty, while the yellow bars show the same requirement without the uncertainty components. In other words, the yellow bars are the *test perspective* (prior to adding uncertainty) for the amount needed to overcome to balance internal supply without WEIM transfers. The green bars show advisory net WEIM imports in the 15-minute market and reflect the latest market results available at the time of the resource sufficiency evaluation for the upcoming hour.[17]

These values can be interpreted as the WEIM imports balancing supply and demand in the advisory interval, or the *market perspective* for the amount needed to replace to balance internal supply without WEIM transfers.[18] Figure 7.1 compares these advisory net WEIM imports (green bars) to the imbalance requirement used in the bid-range capacity test excluding the uncertainty components (yellow bars).

The energy imbalance (without WEIM transfers) used in the bid-range capacity test can differ from the expected net WEIM transfers from the last market run; Figure 7.2 summarizes the source of this difference by input. 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.

[17] The advisory intervals are pulled from the market run binding in interval 4 of the hour immediately prior to the test hour.

[18] If there were a power balance shortage, this insufficiency would also need to be covered to meet load.

Figure 7.1 Average capacity test imbalance requirement and net WEIM imports (April 2022)

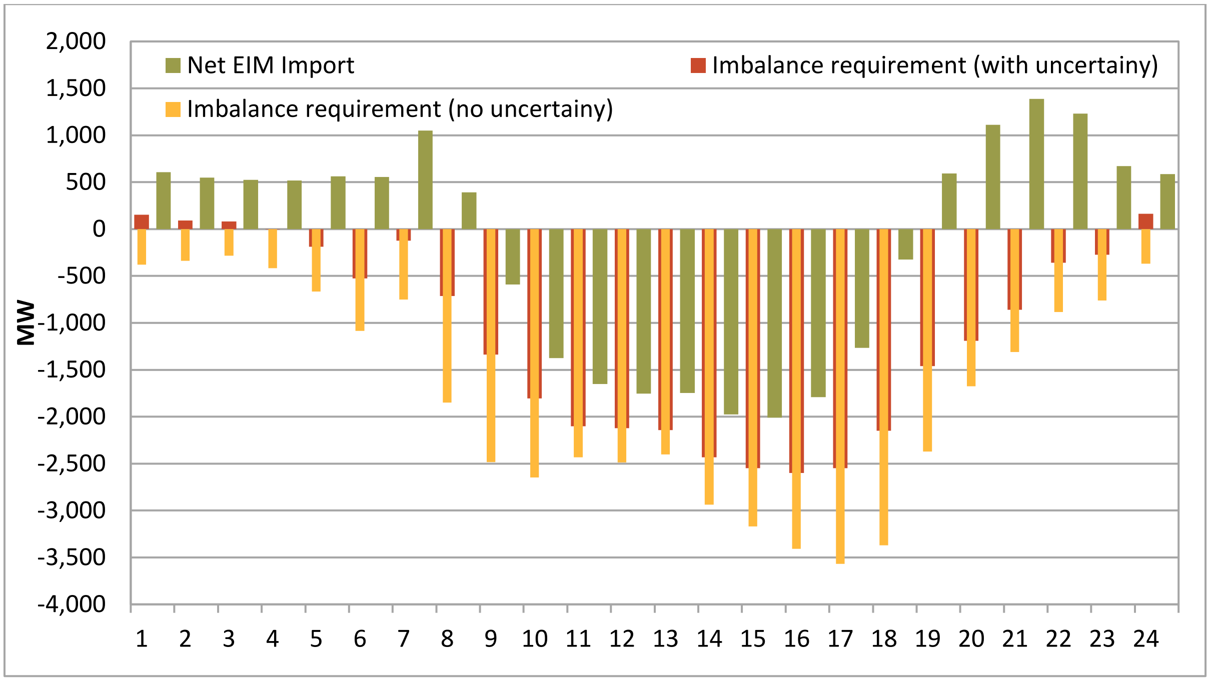
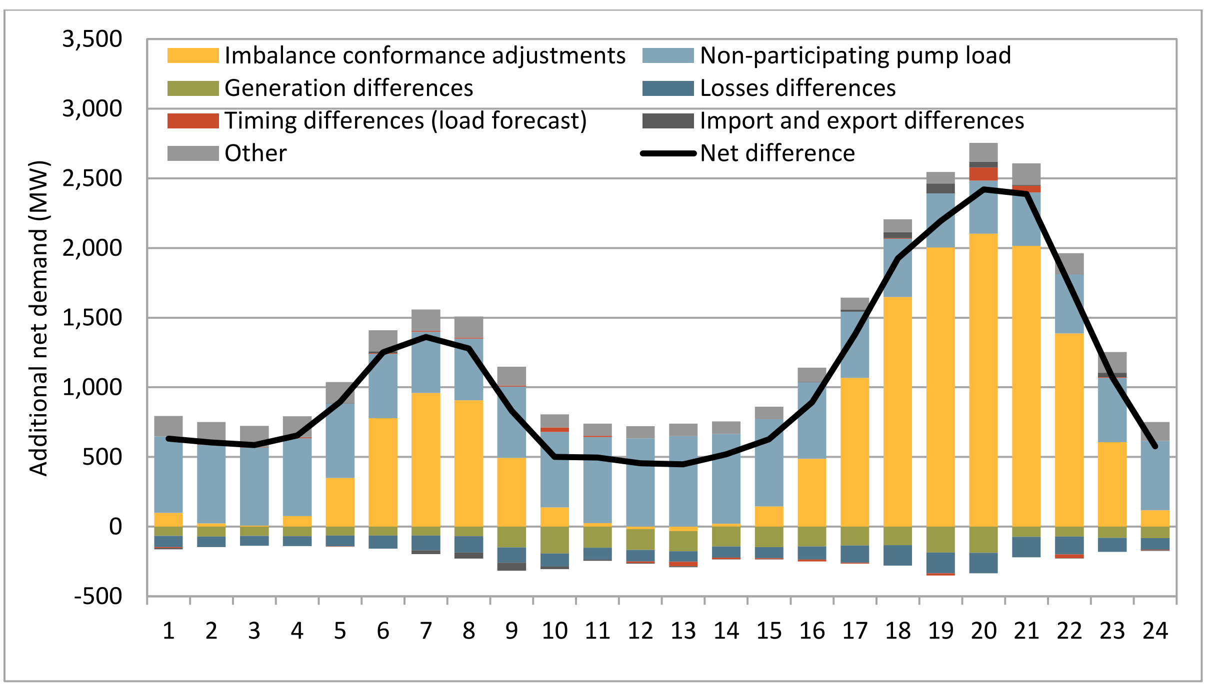


Figure 7.2 Additional net demand in the latest 15-minute market run not accounted for in the bid-range capacity test (April 2022)



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-mintue market run (that produced the net WEIM imports shown in the figure) 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.

These differences mean that net WEIM imports have previously exceeded unloaded capacity without a test failure. Inspecting the components can also help flag potential accuracy issues. DMM recommends that the CAISO and stakeholders review some of these differences to potentially improve the accuracy of the test.

8 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.[19] 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.[20]

Further, the resource sufficiency evaluation occurs in a different timeframe than the 15-minute market. Figure 8.1 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.[21]

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

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[19] 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.

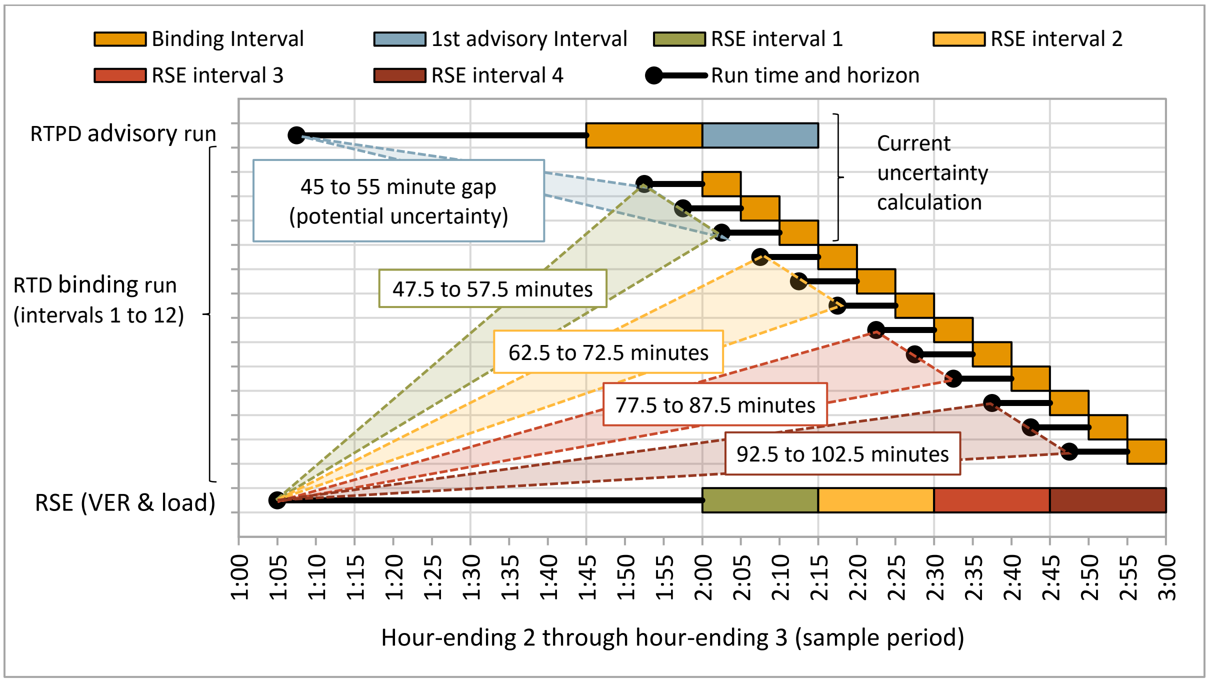
[20] *Comments on EIM Resource Sufficiency Evaluation Enhancements Issue Paper*, September 8, 2021. http://www.caiso.com/Documents/DMM-Comments-on-EIM-Resource-Sufficiency-Evaluation-Enhancements-Issue-Paper-Sep-8-2021.pdf

[21] 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 8.1 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 8.2 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 8.3 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 8.4 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).

Figure 8.5 through Figure 8.55 provide the same information for all WEIM entities.

Figure 8.2 CAISO average uncertainty by component (weekdays, April 2022)

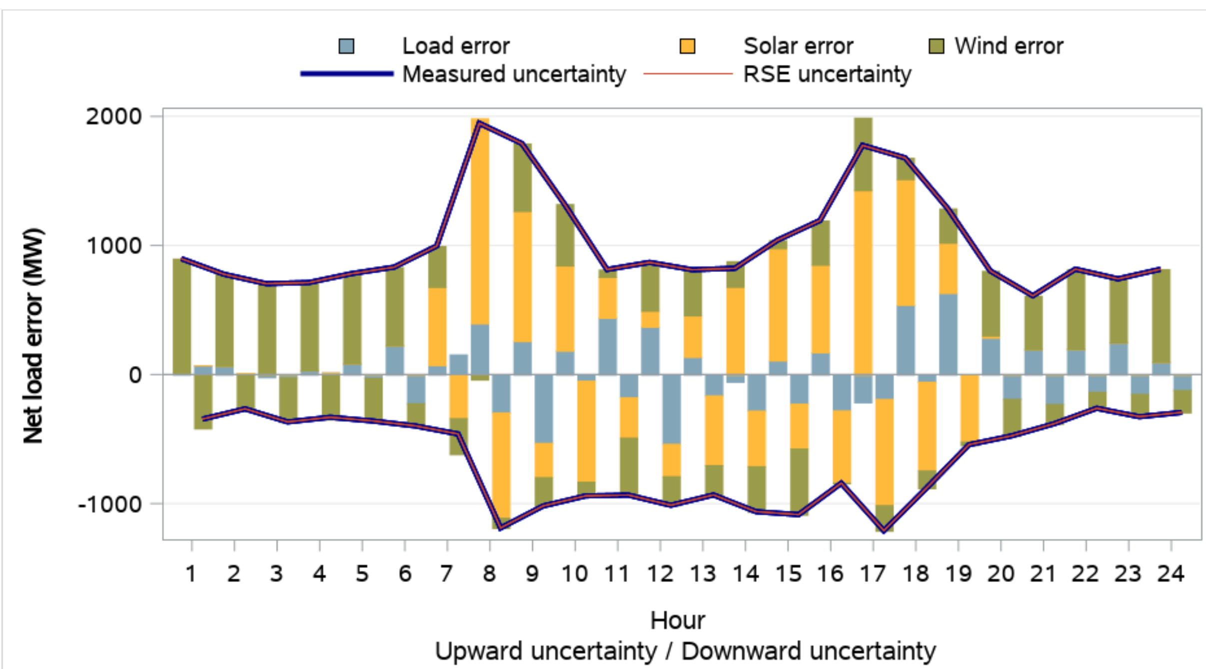


Figure 8.3 CAISO distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, April 2022)

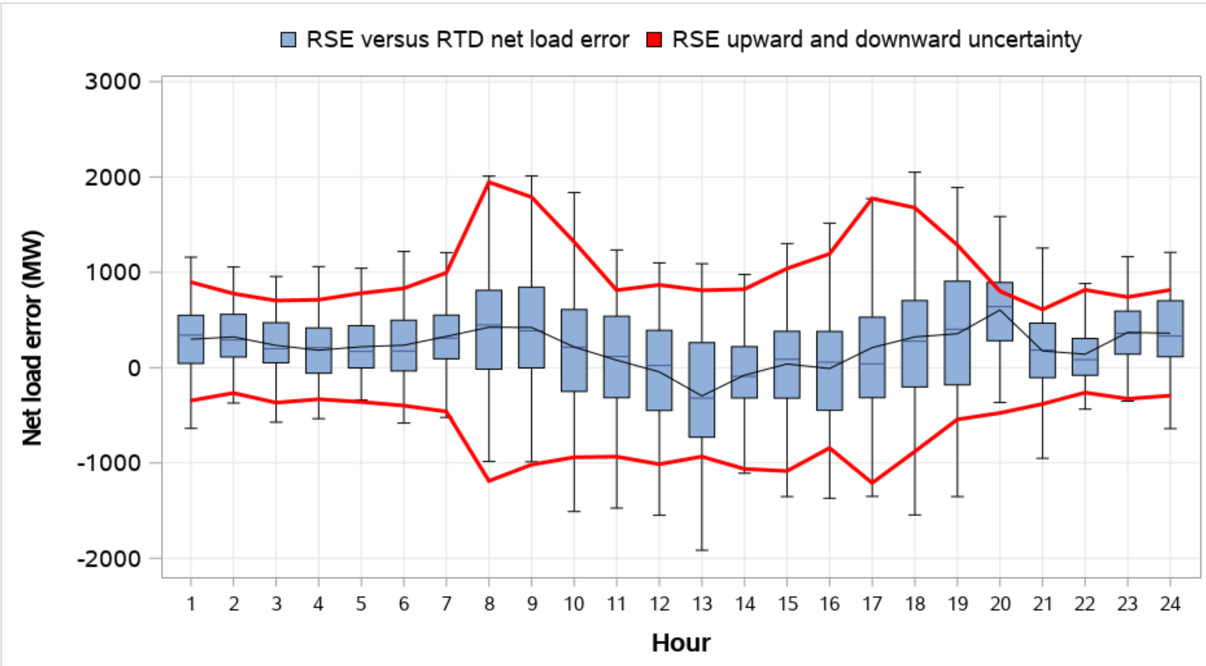


Figure 8.4 CAISO distribution of RSE and RTD load and VER error (weekdays, April 2022)

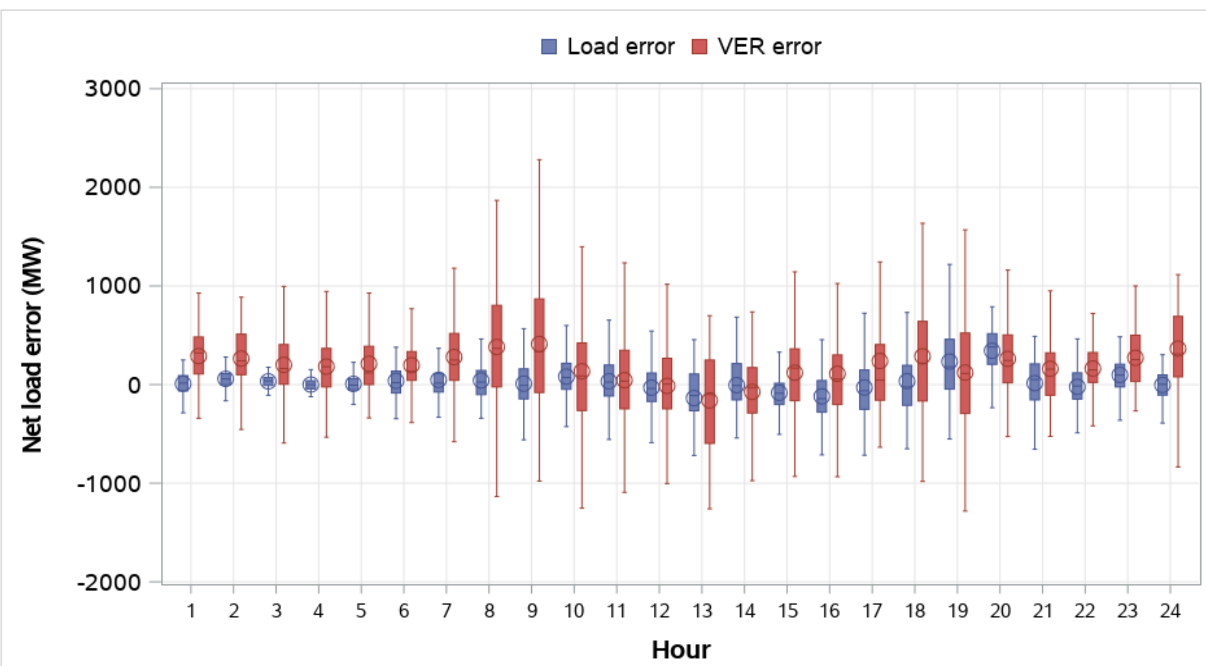


Figure 8.5 Arizona Public Service average uncertainty by component (weekdays, April 2022)

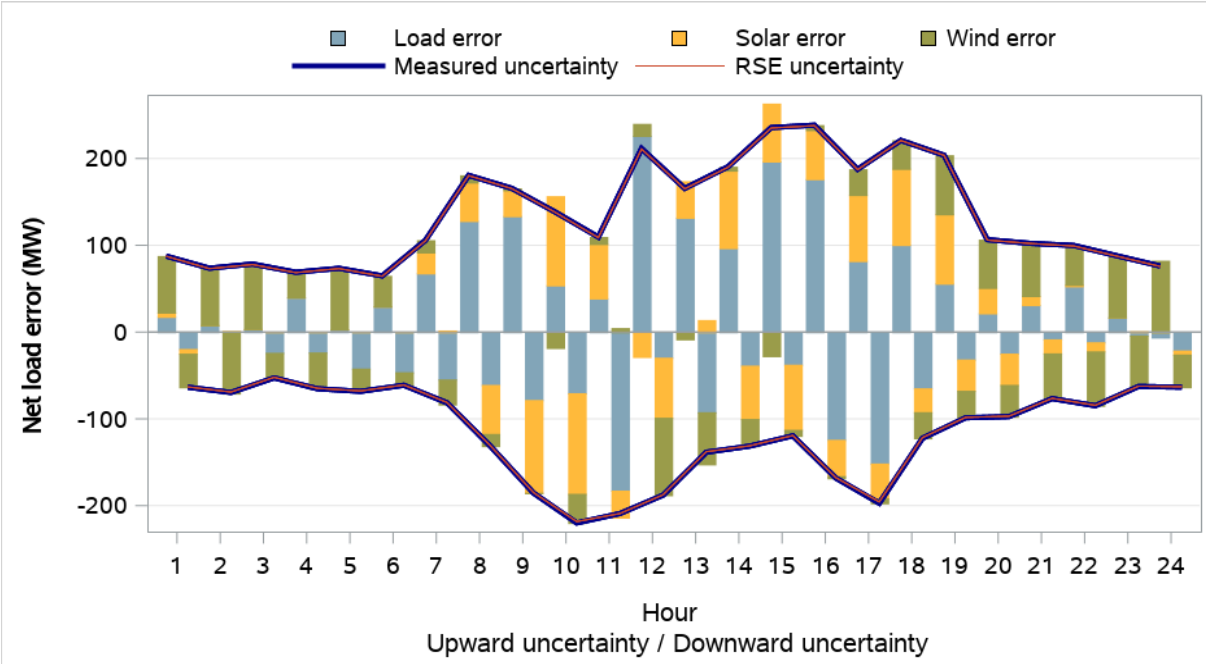


Figure 8.6 Arizona Public Service distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, April 2022)

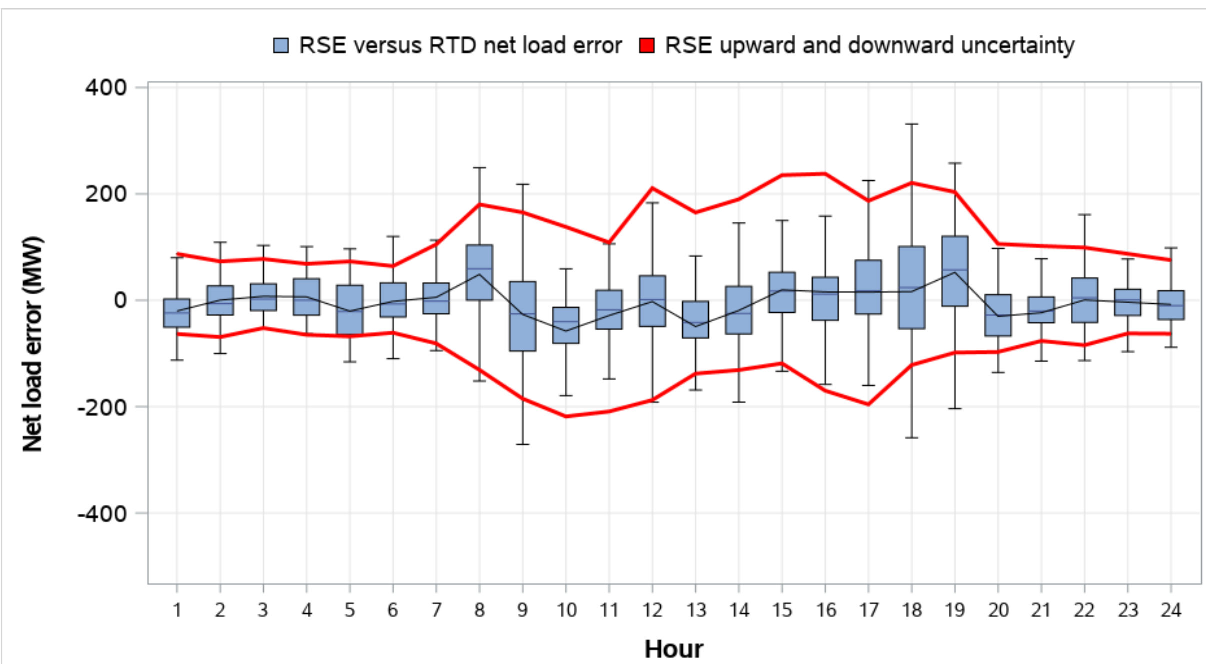


Figure 8.7 Arizona Public Service distribution of RSE and RTD load and VER error (weekdays, April 2022)

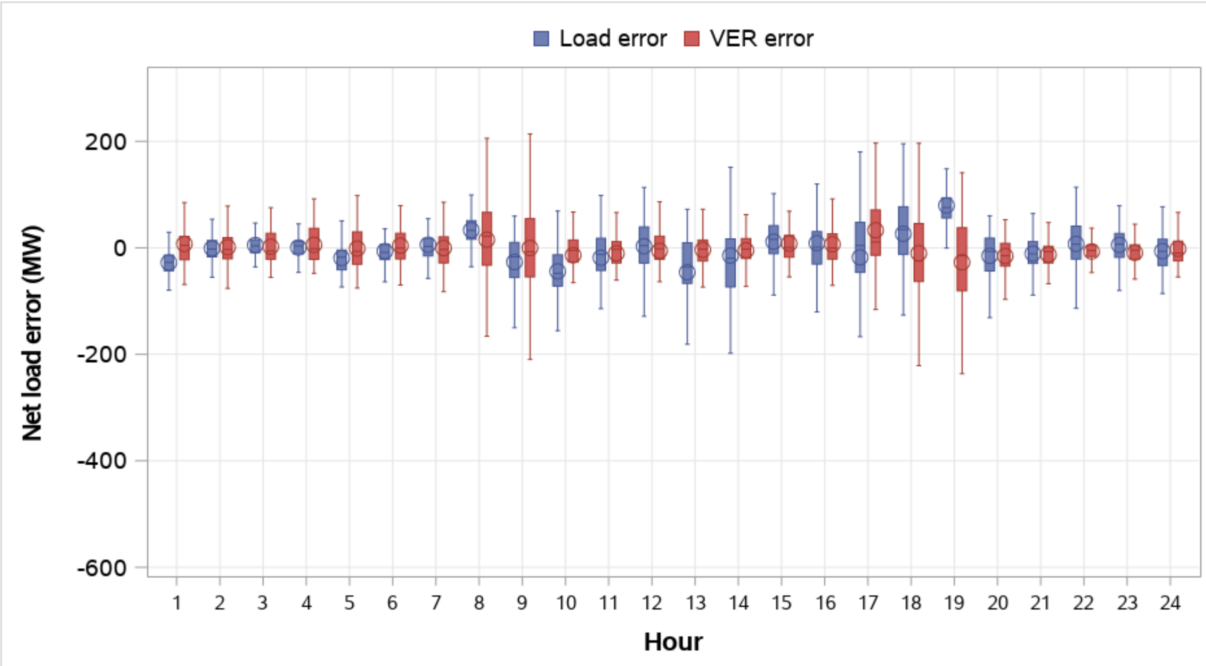


Figure 8.8 Avista average uncertainty by component (weekdays, April 2022)

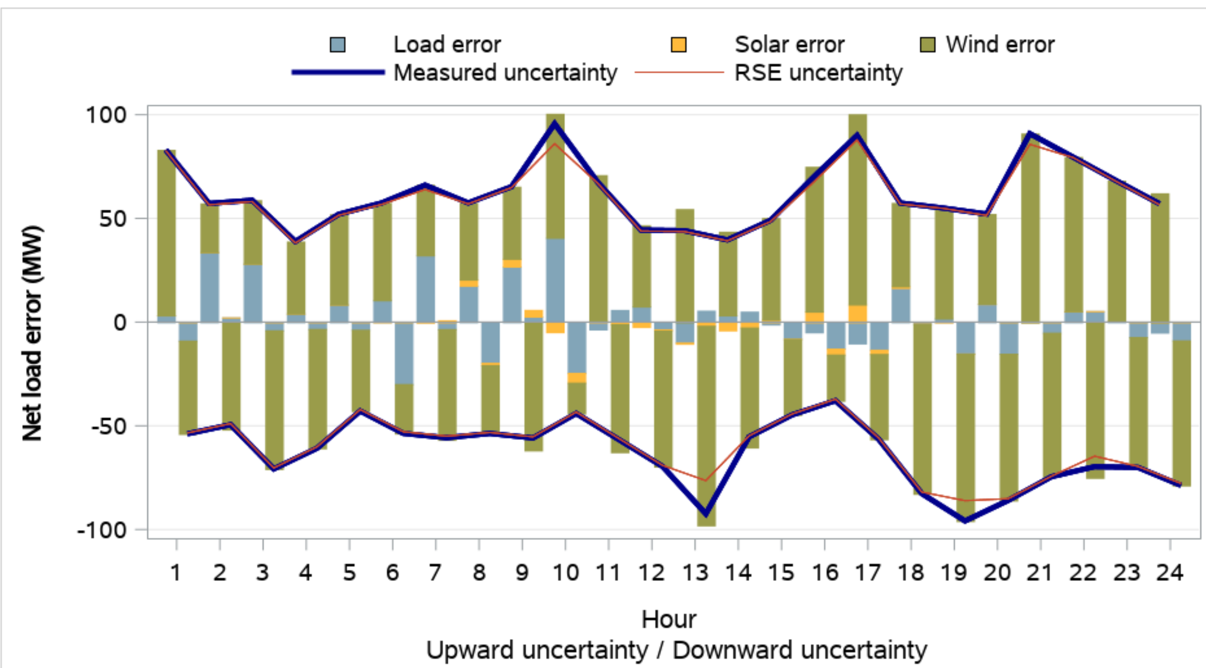


Figure 8.9 Avista distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, April 2022)

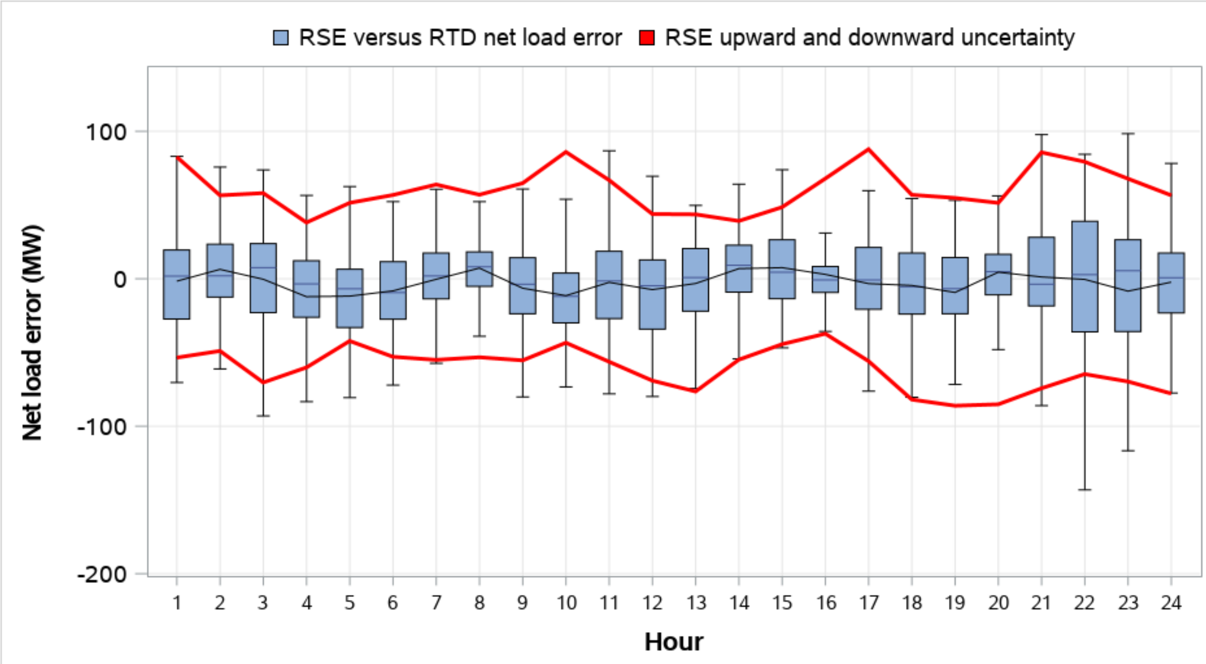


Figure 8.10 Avista distribution of RSE and RTD load and VER error (weekdays, April 2022)

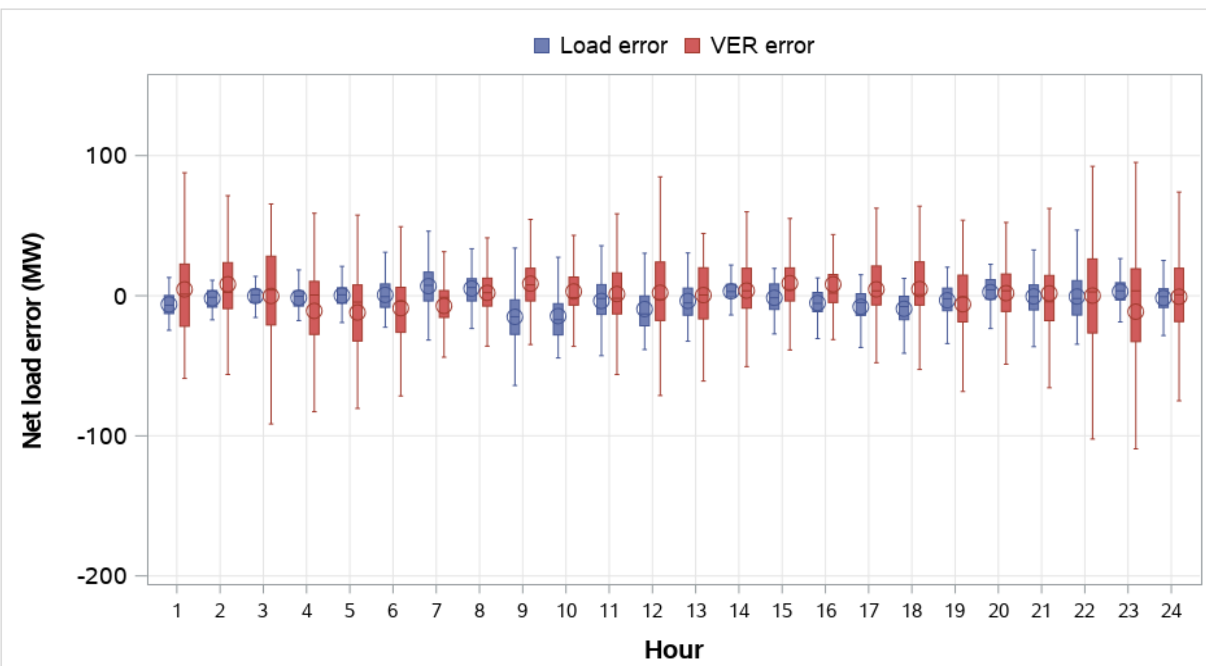


Figure 8.11 BANC average uncertainty by component (weekdays, April 2022)

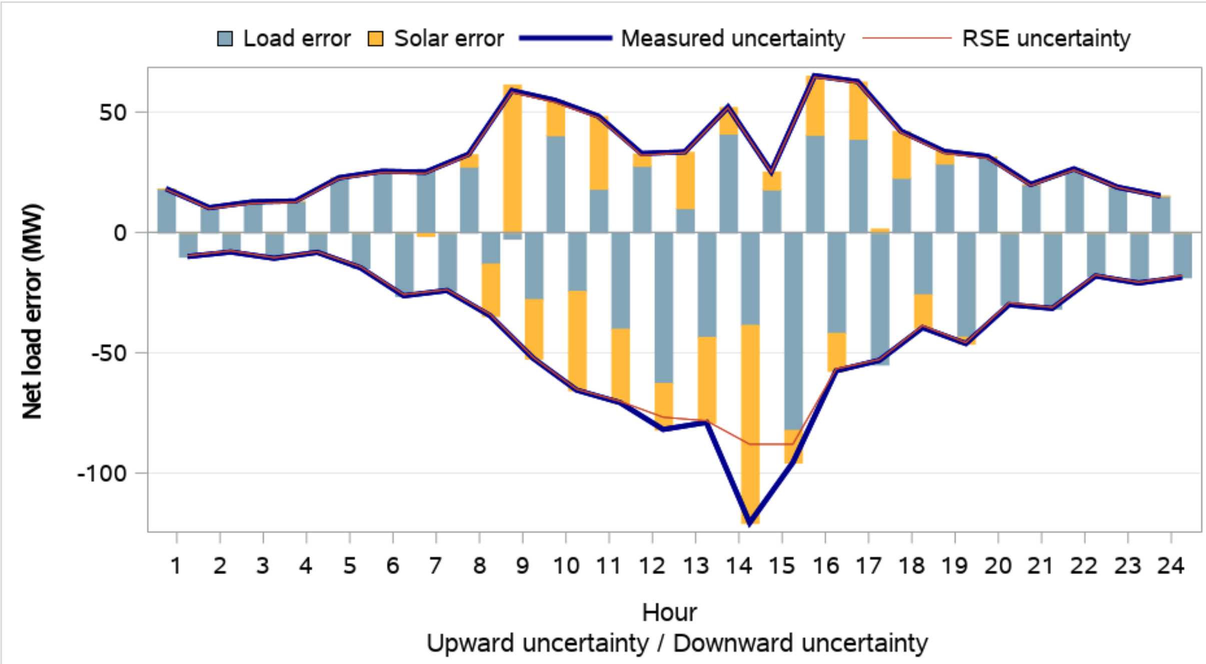


Figure 8.12 BANC distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, April 2022)

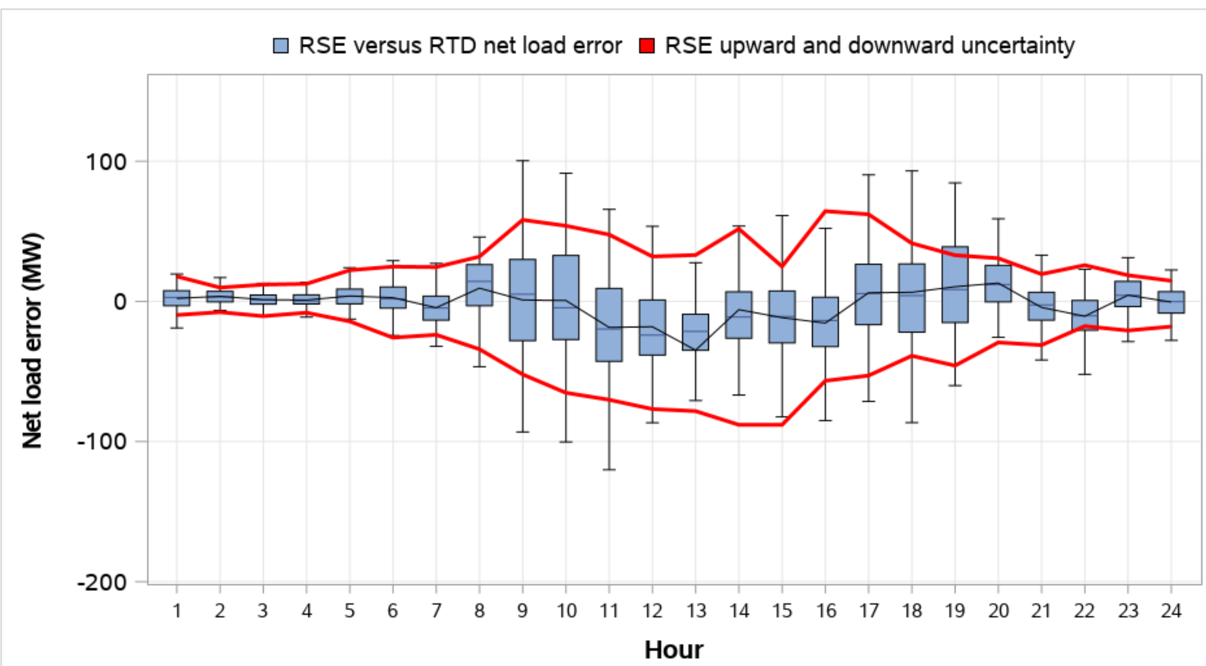


Figure 8.13 BANC distribution of RSE and RTD load and VER error (weekdays, April 2022)

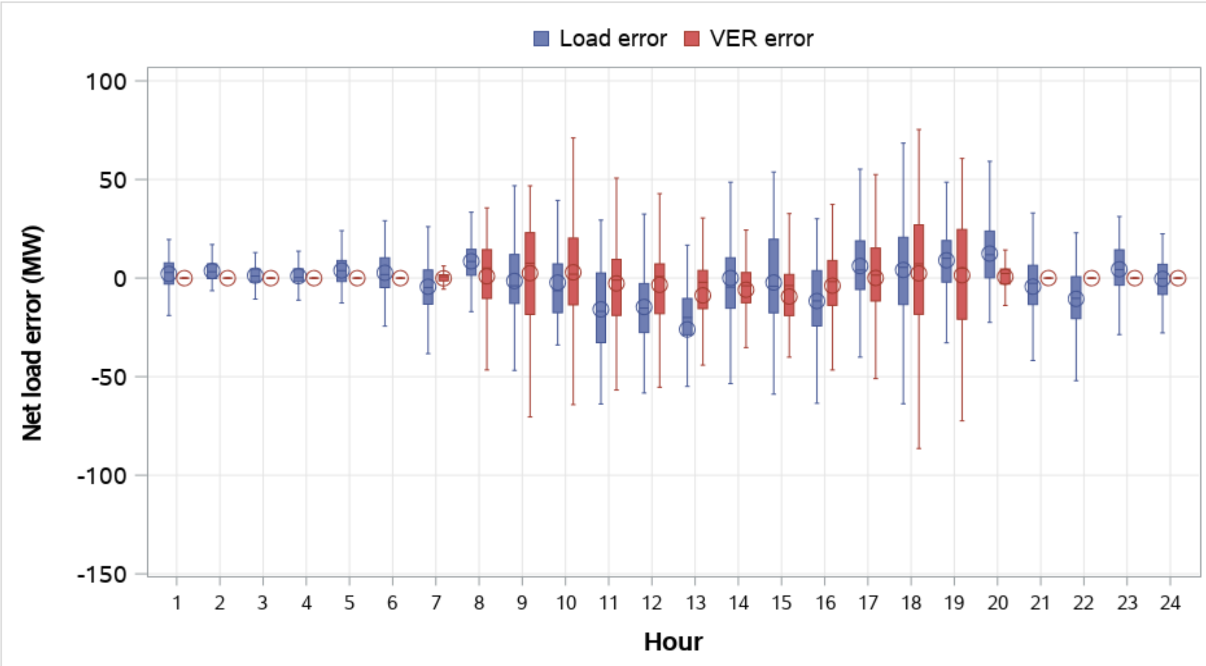


Figure 8.14 Idaho Power average uncertainty by component (weekdays, April 2022)

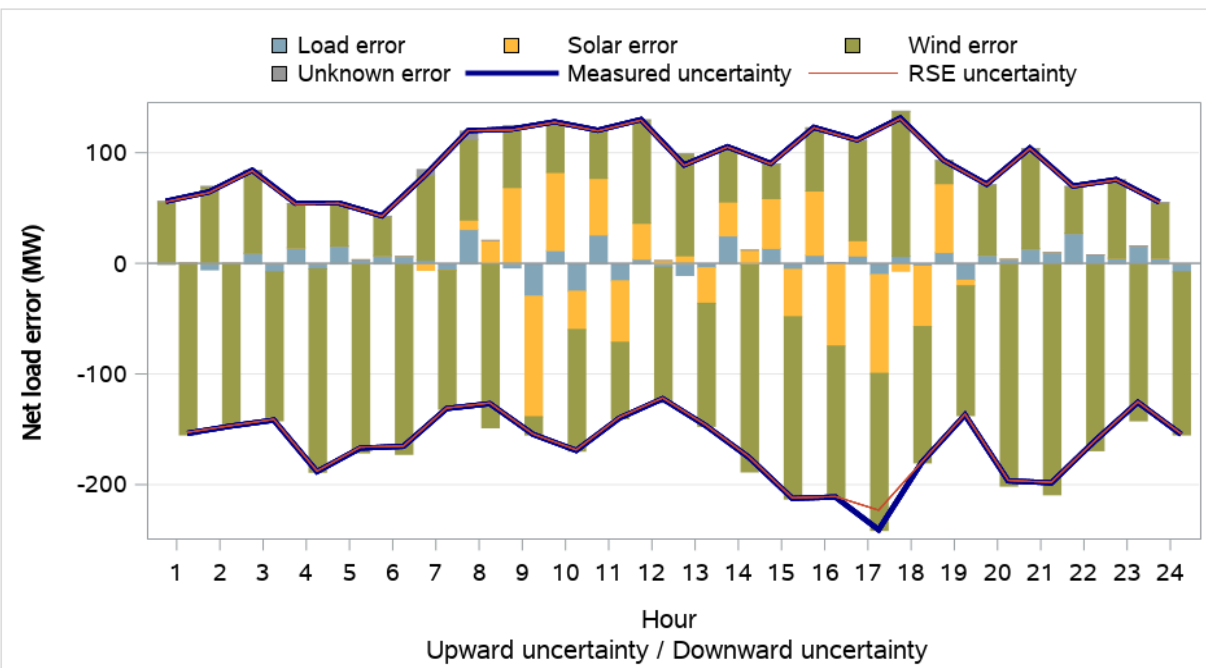


Figure 8.15 Idaho Power distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, April 2022)

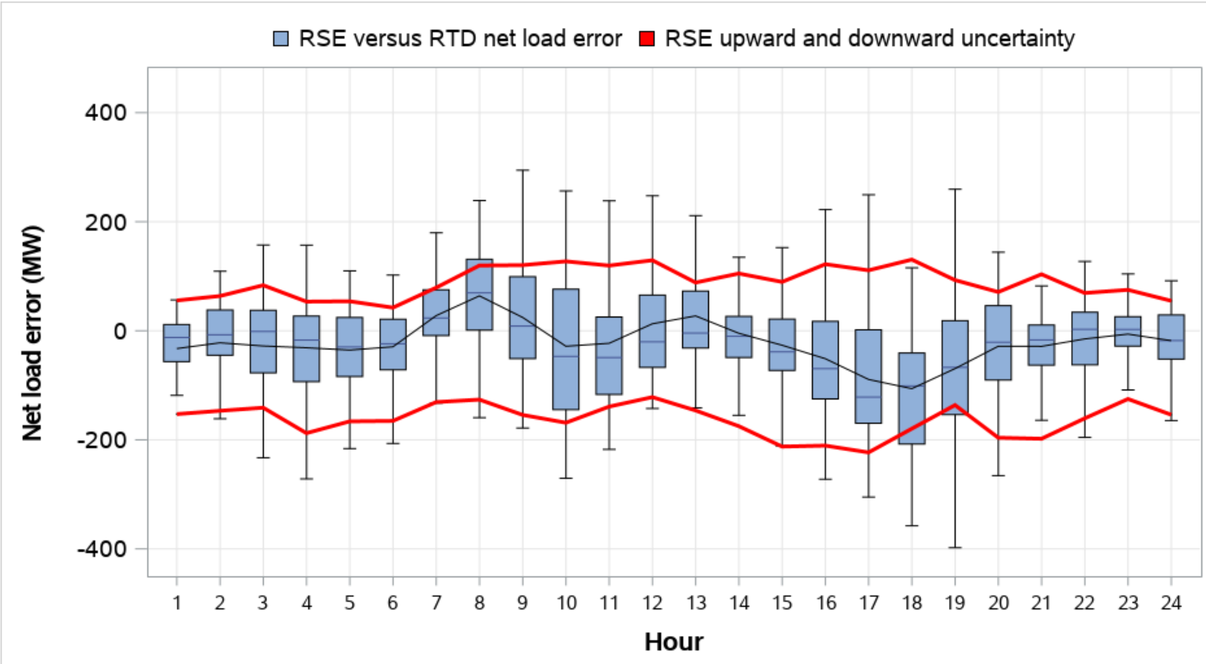


Figure 8.16 Idaho Power distribution of RSE and RTD load and VER error (weekdays, April 2022)

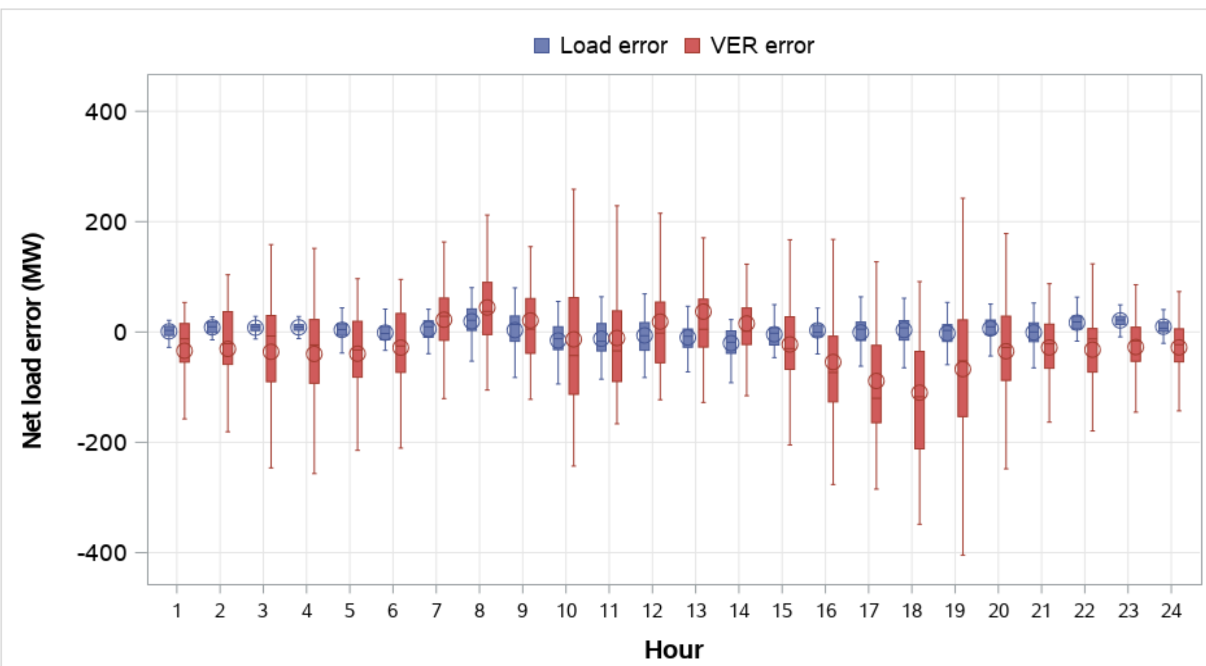


Figure 8.17 LADWP average uncertainty by component (weekdays, April 2022)

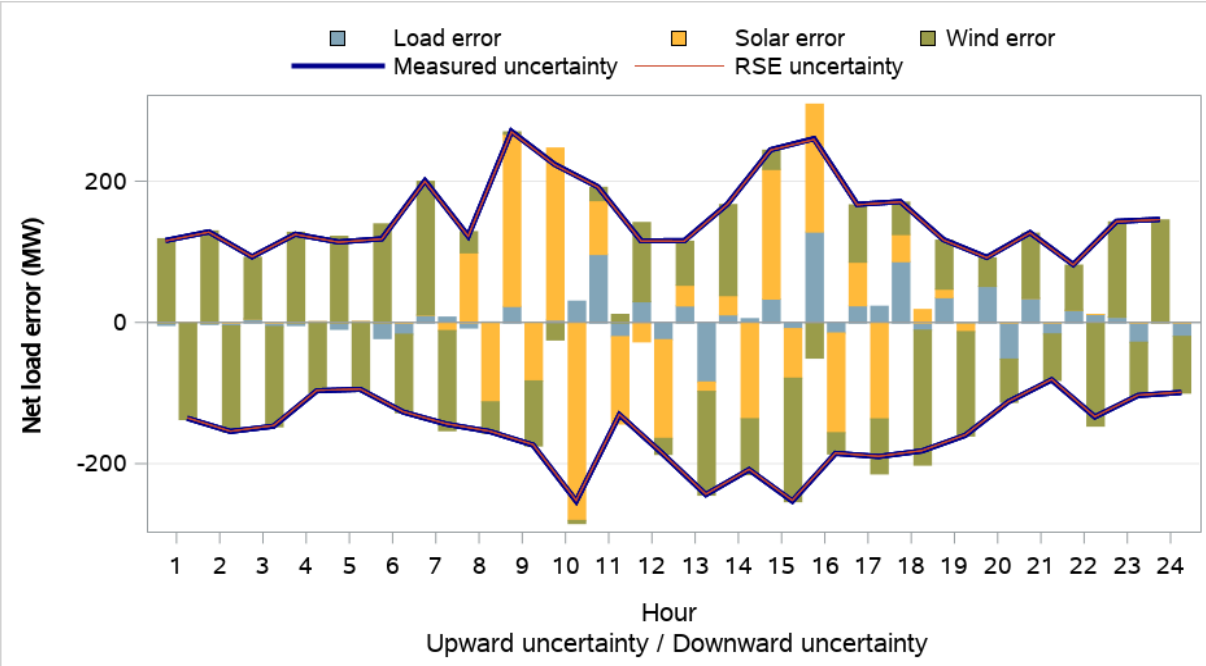


Figure 8.18 LADWP distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, April 2022)

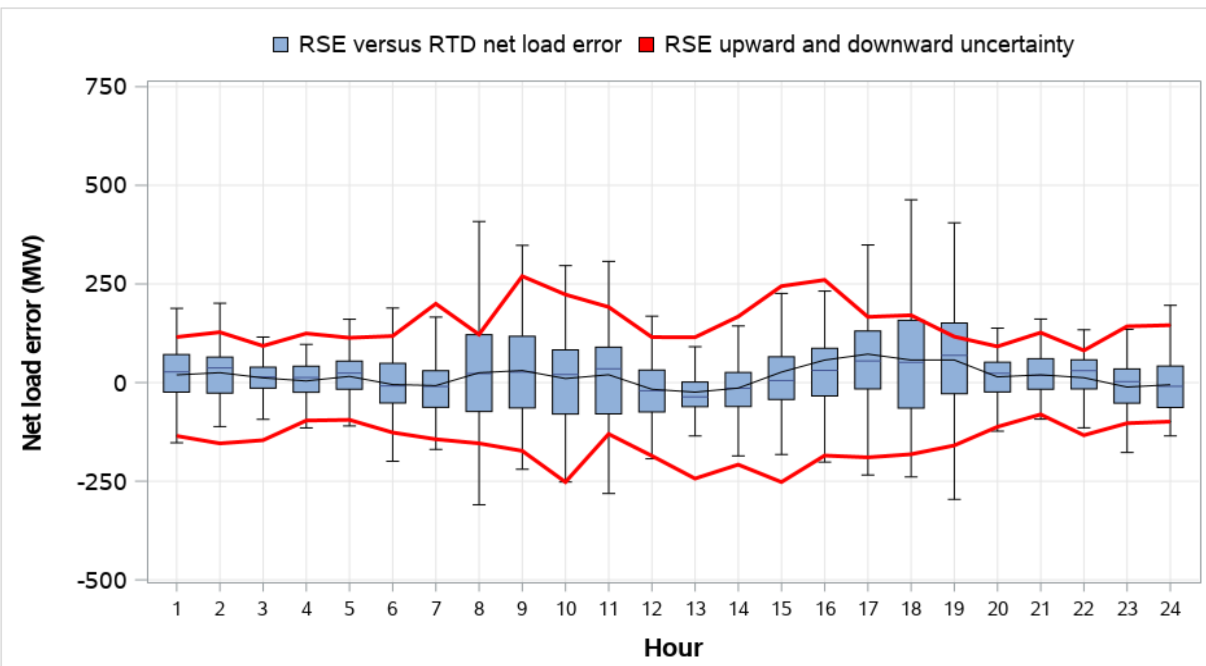


Figure 8.19 LADWP distribution of RSE and RTD load and VER error (weekdays, April 2022)

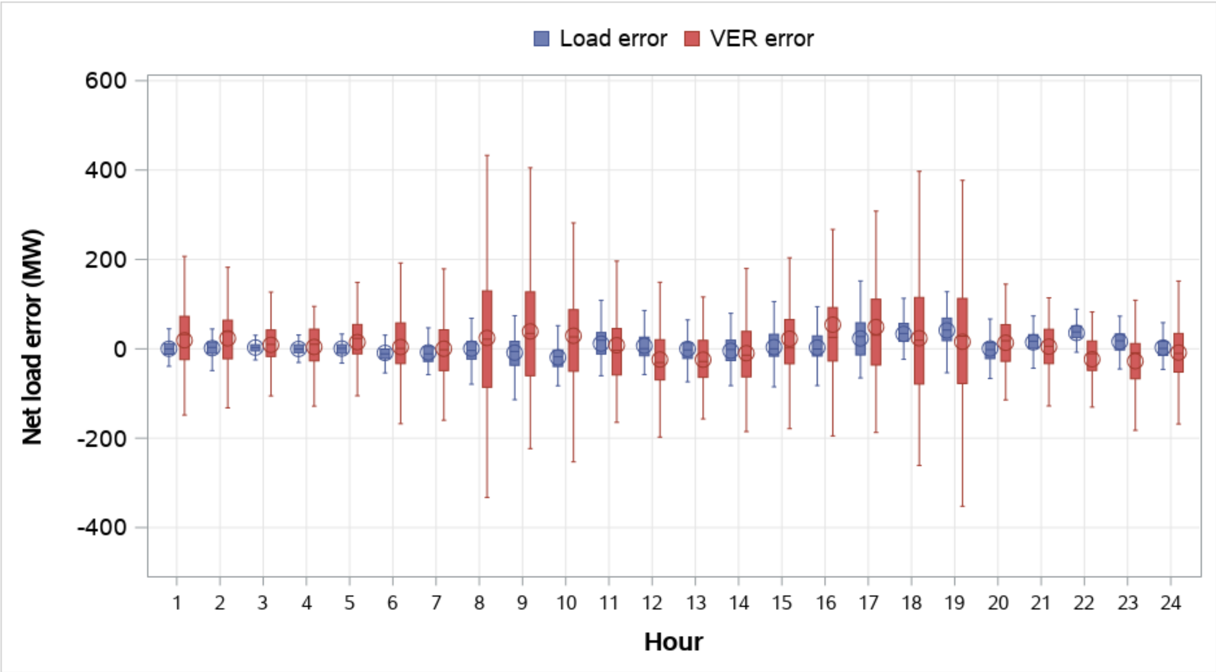


Figure 8.20 NorthWestern Energy average uncertainty by component (weekdays, April 2022)

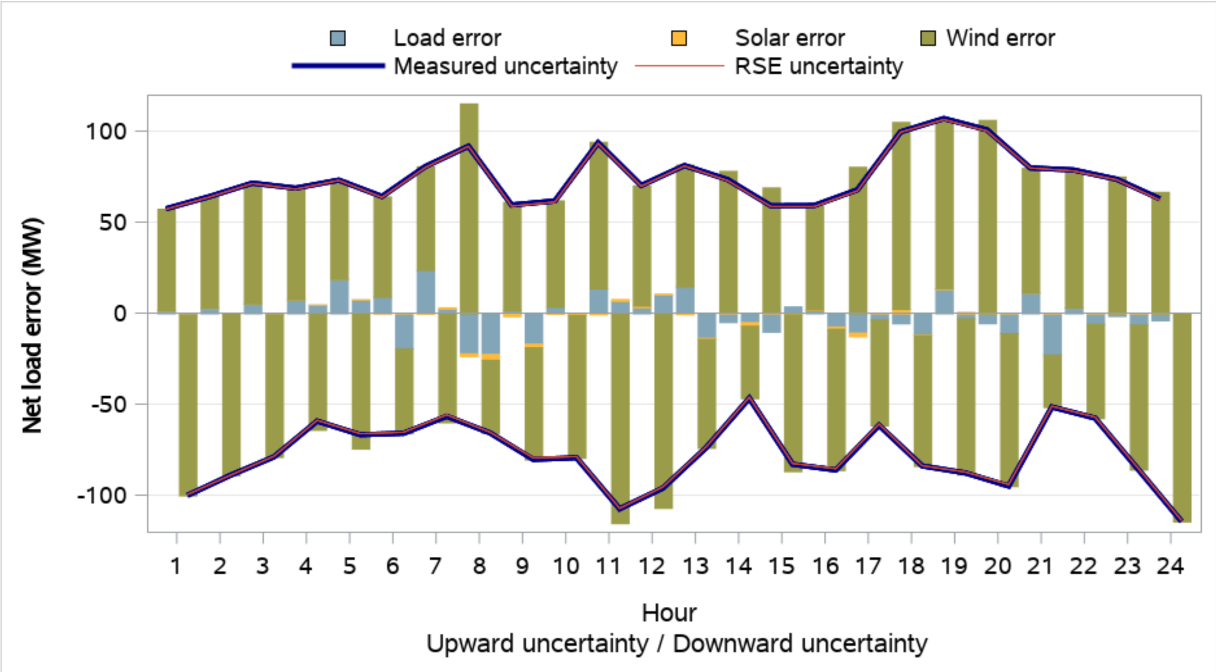


Figure 8.21 NorthWestern Energy distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, April 2022)

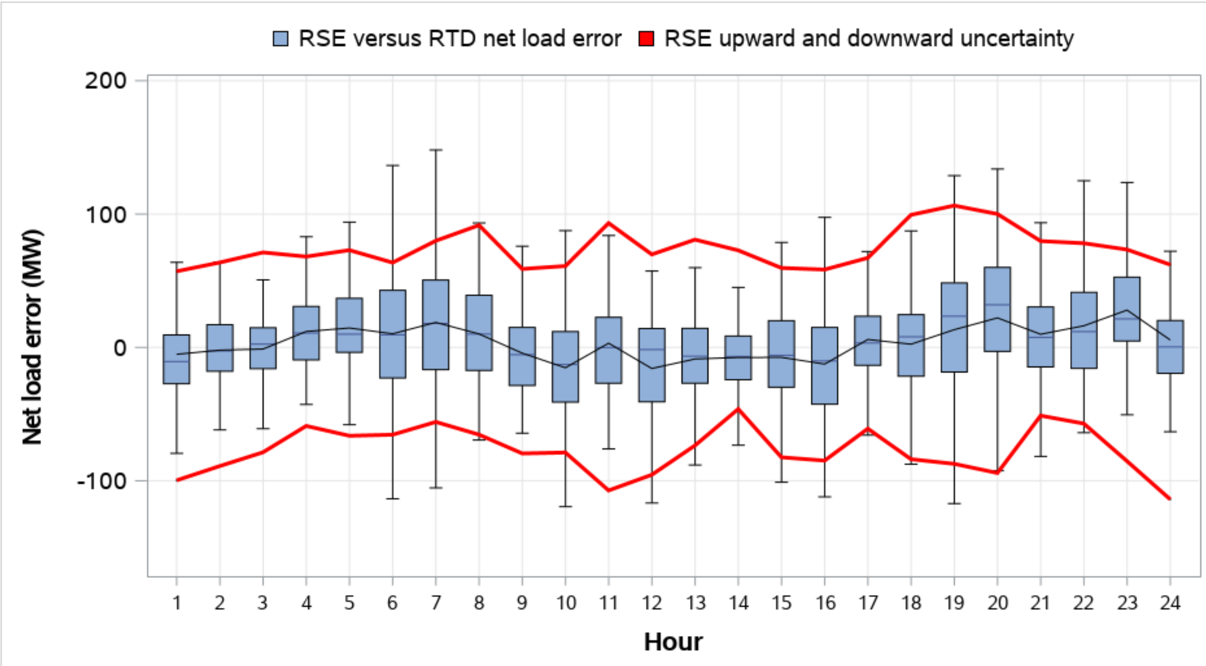


Figure 8.22 NorthWestern Energy distribution of RSE and RTD load and VER error (weekdays, April 2022)

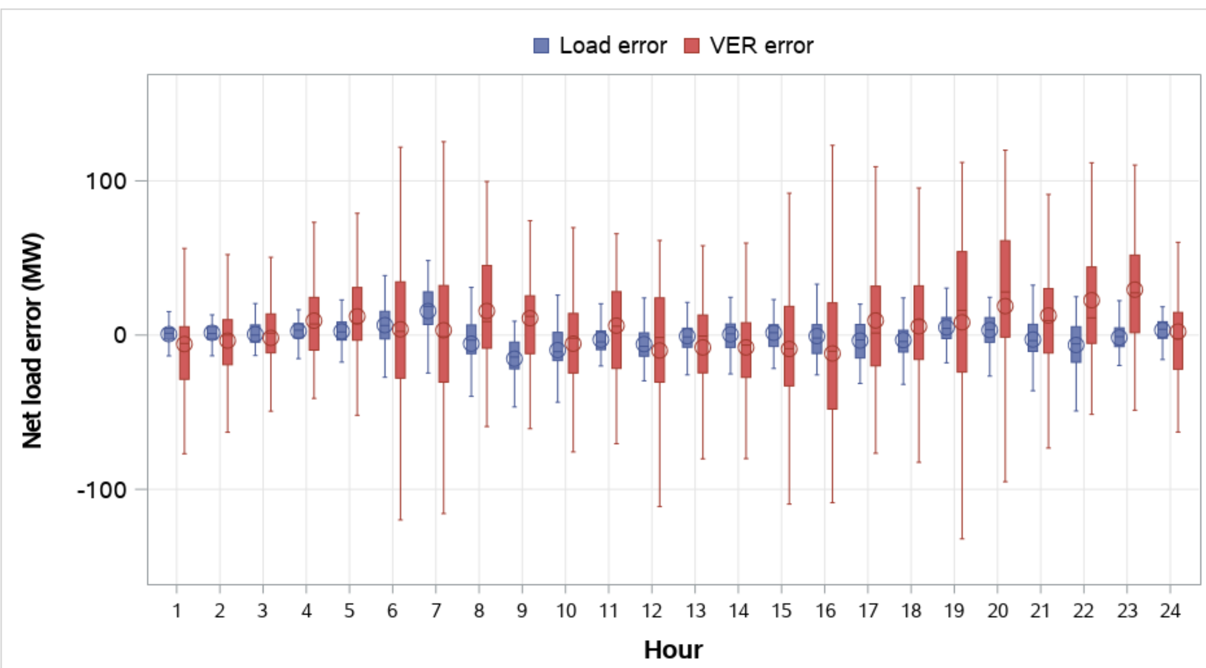


Figure 8.23 NV Energy average uncertainty by component (weekdays, April 2022)

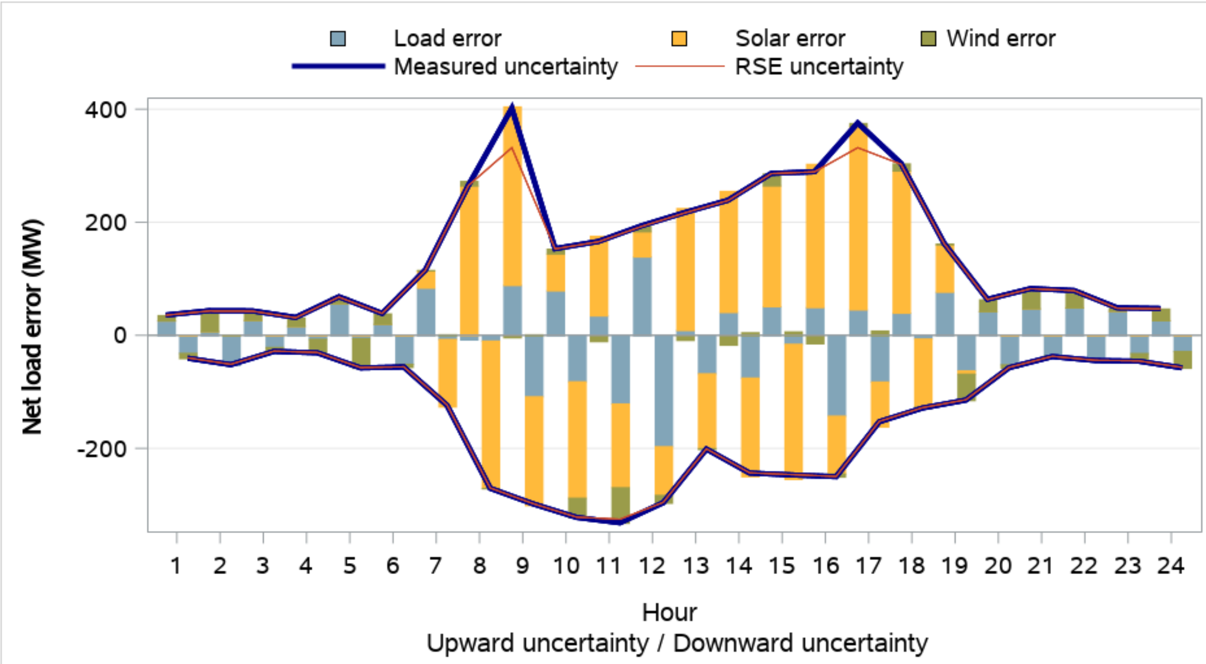


Figure 8.24 NV Energy distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, April 2022)

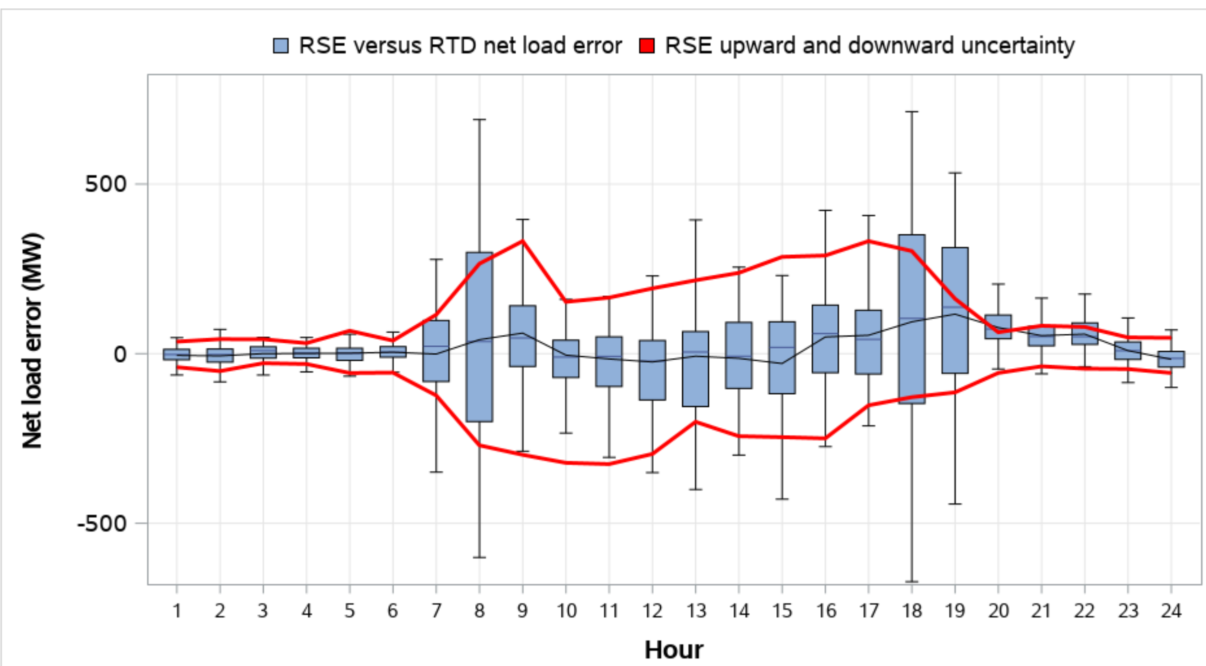


Figure 8.25 NV Energy distribution of RSE and RTD load and VER error (weekdays, April 2022)

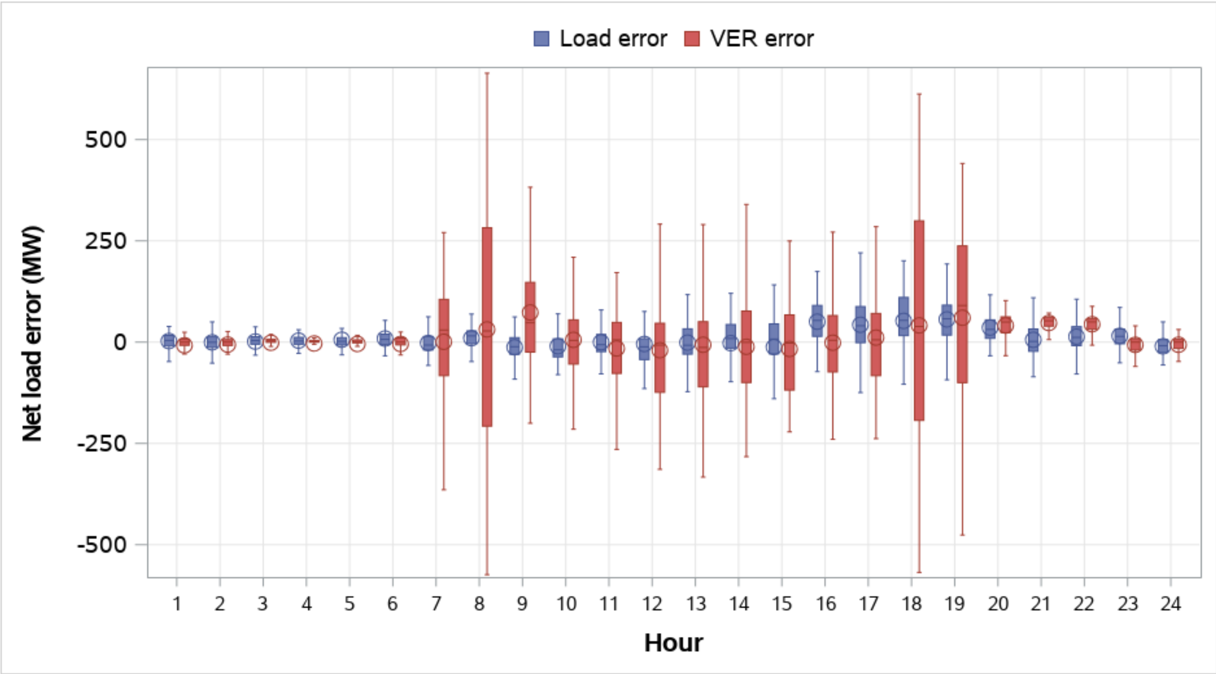


Figure 8.26 PacifiCorp East average uncertainty by component (weekdays, April 2022)

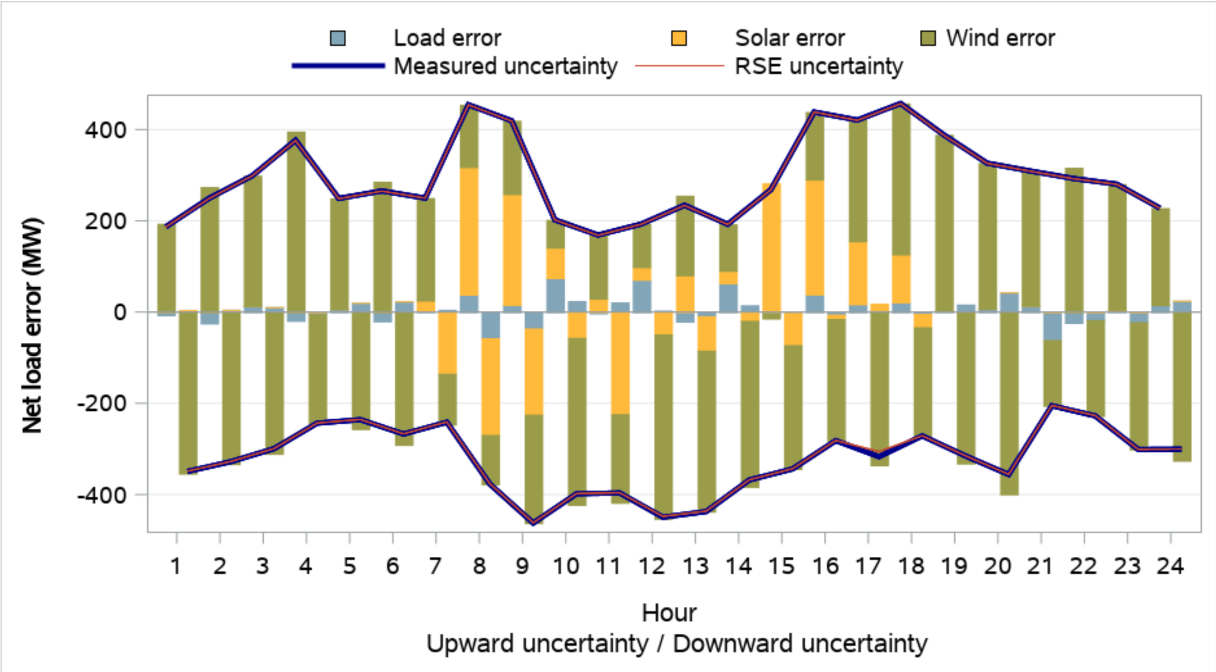


Figure 8.27 PacifiCorp East distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, April 2022)

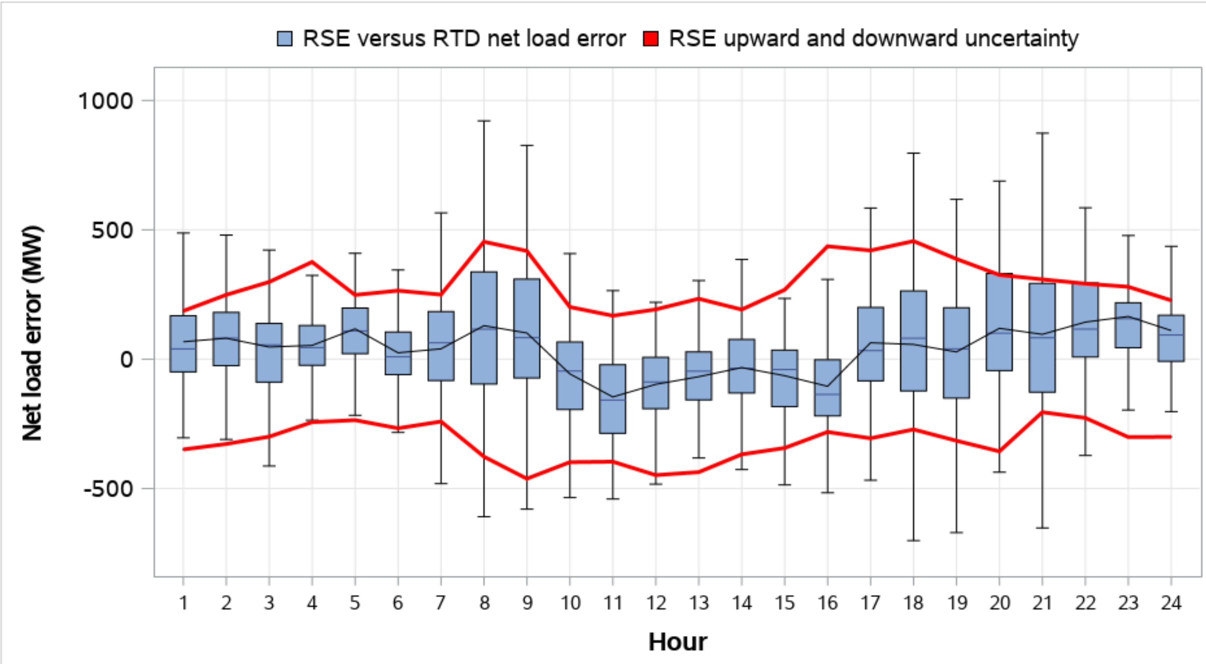


Figure 8.28 PacifiCorp East distribution of RSE and RTD load and VER error (weekdays, April 2022)

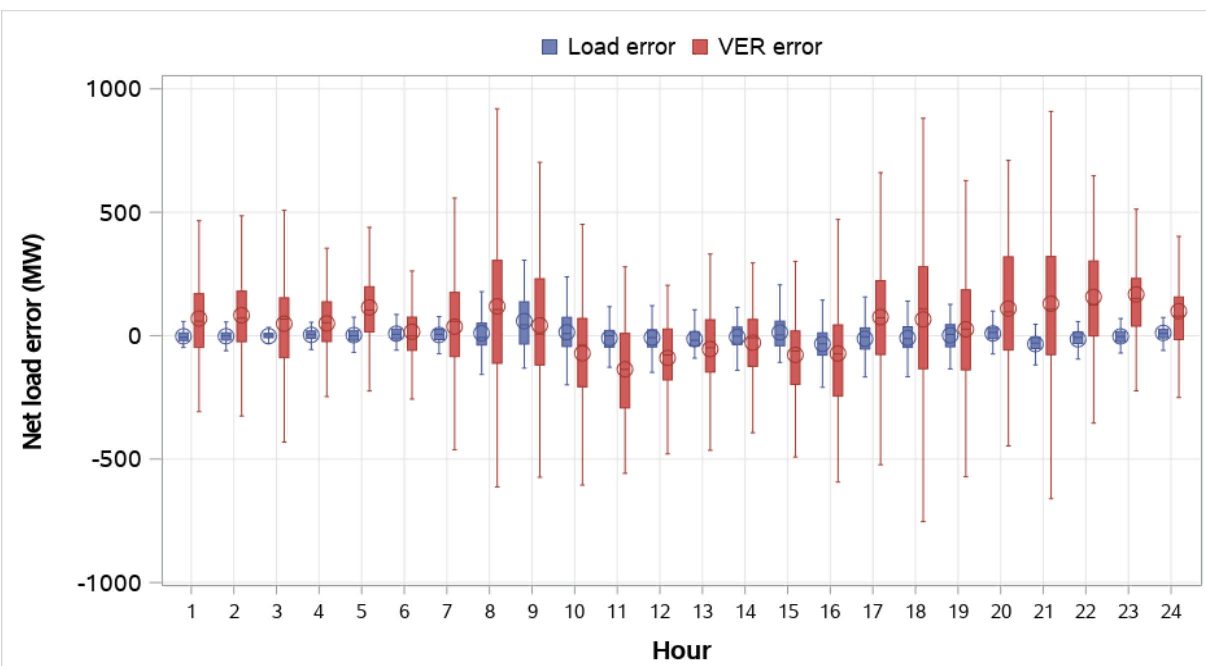


Figure 8.29 PacifiCorp West average uncertainty by component (weekdays, April 2022)

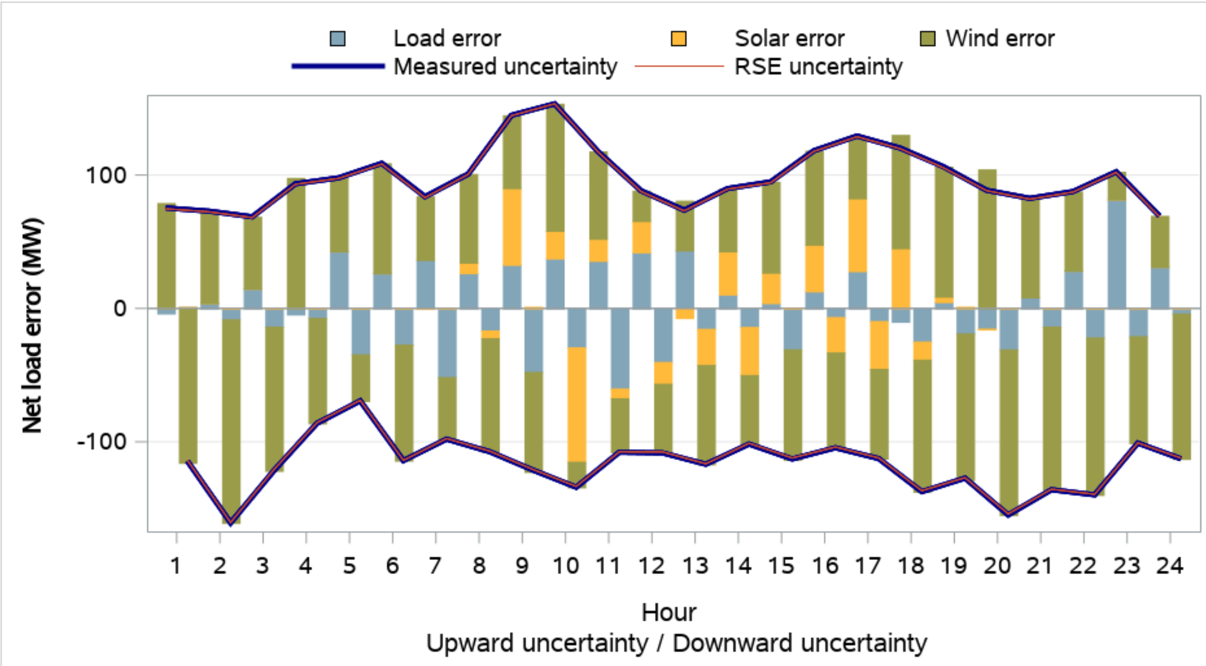


Figure 8.30 PacifiCorp West distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, April 2022)

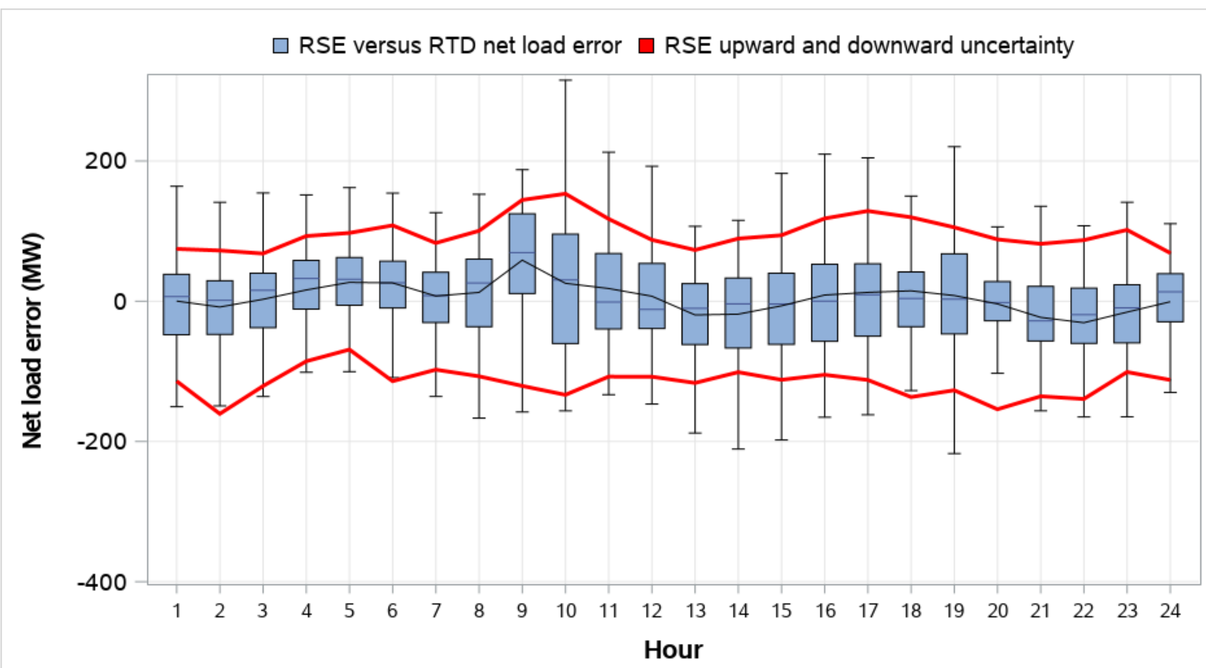


Figure 8.31 PacifiCorp West distribution of RSE and RTD load and VER error (weekdays, April 2022)

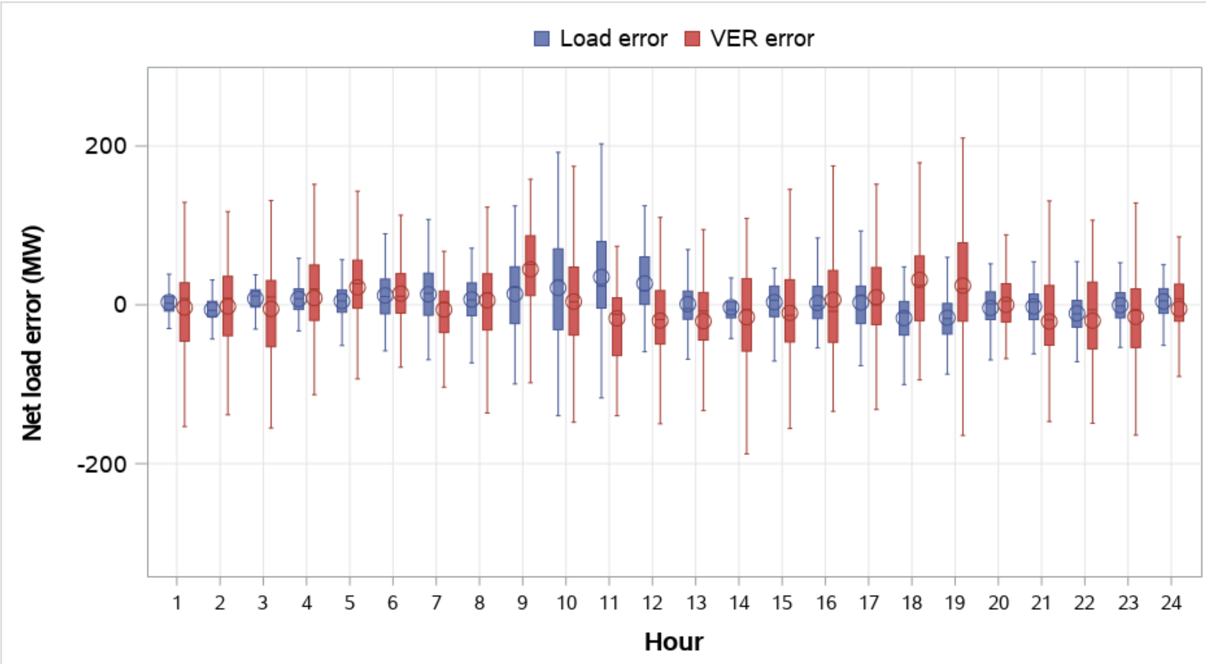


Figure 8.32 Portland General Electric average uncertainty by component (weekdays, April 2022)

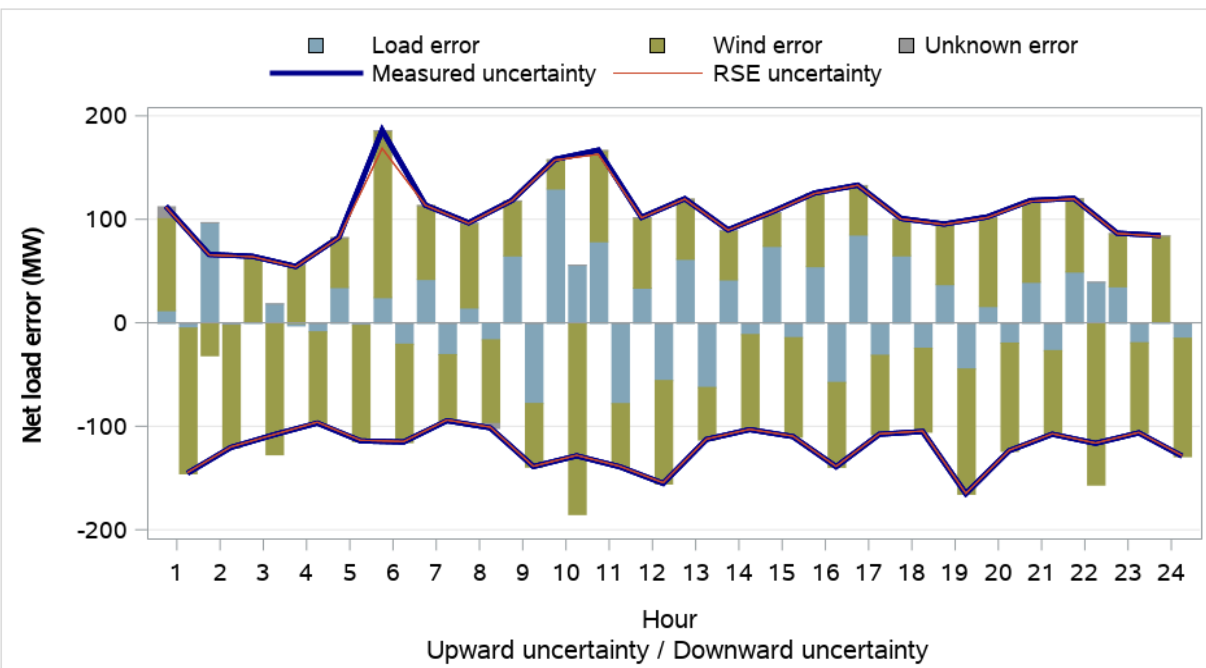


Figure 8.33 Portland General Electric distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, April 2022)

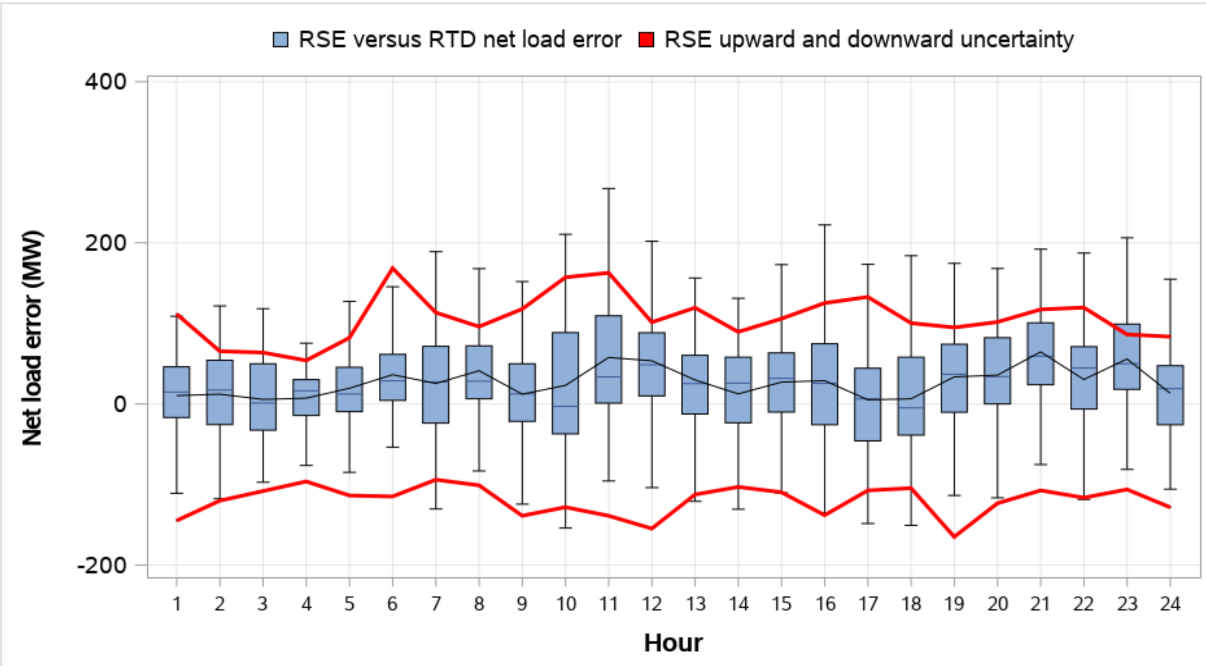


Figure 8.34 Portland General Electric distribution of RSE and RTD load and VER error (weekdays, April 2022)

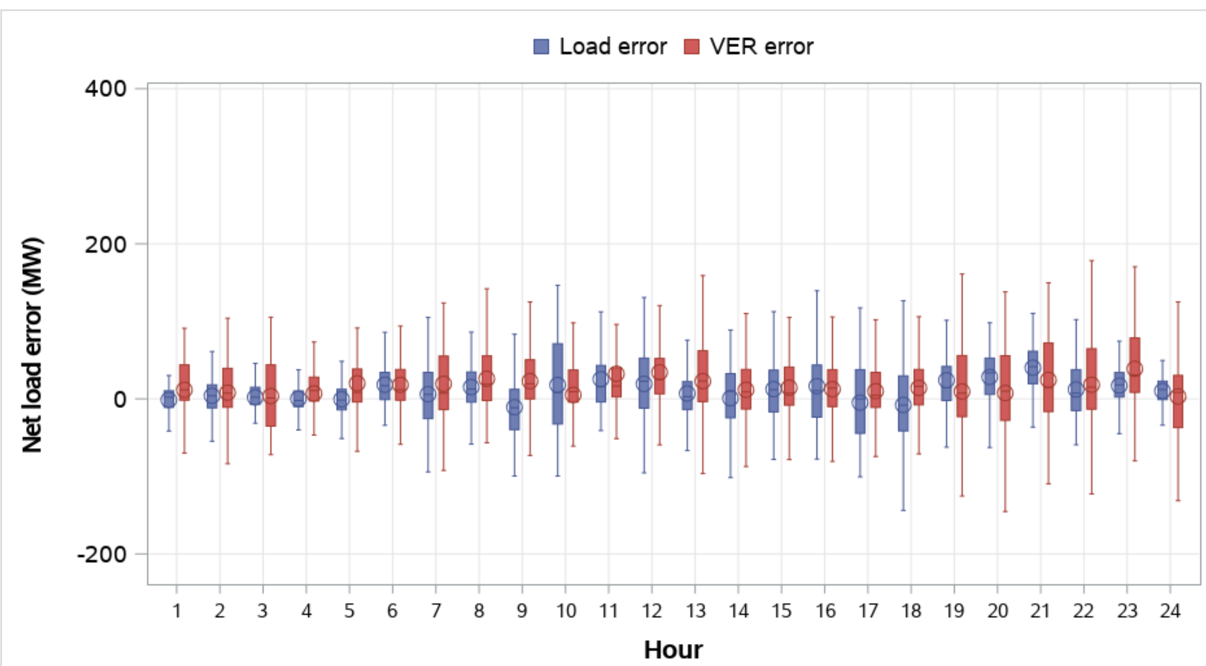


Figure 8.35 Powerex average uncertainty by component (weekdays, April 2022)

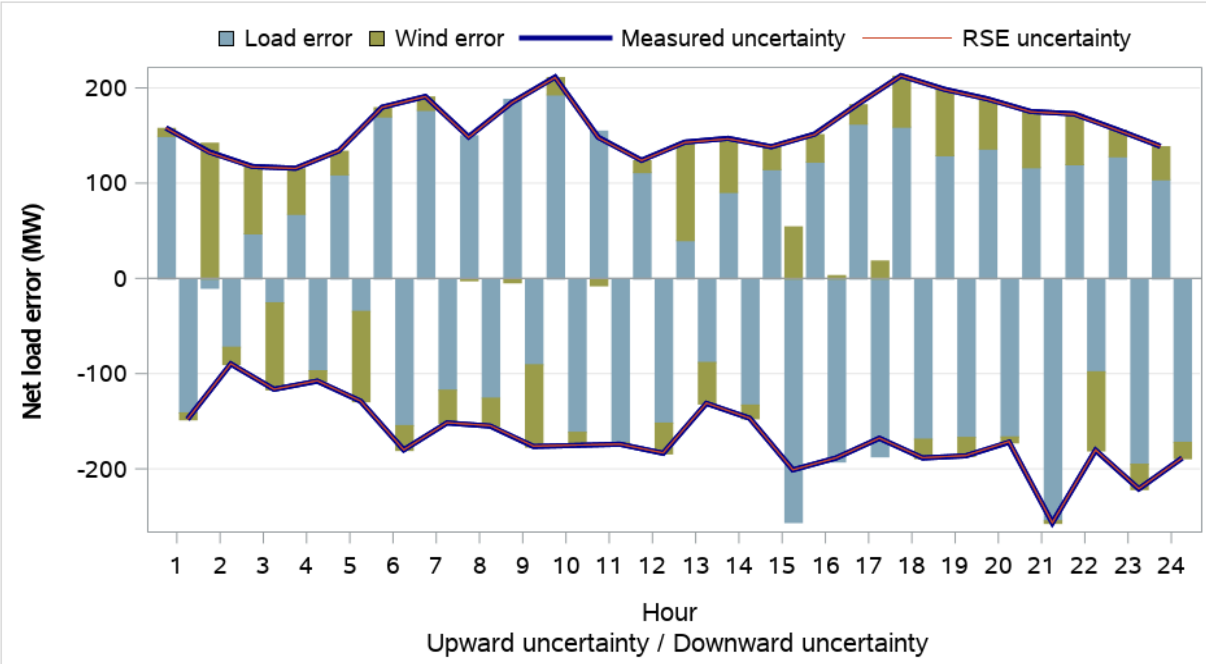


Figure 8.36 Powerex distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, April 2022)

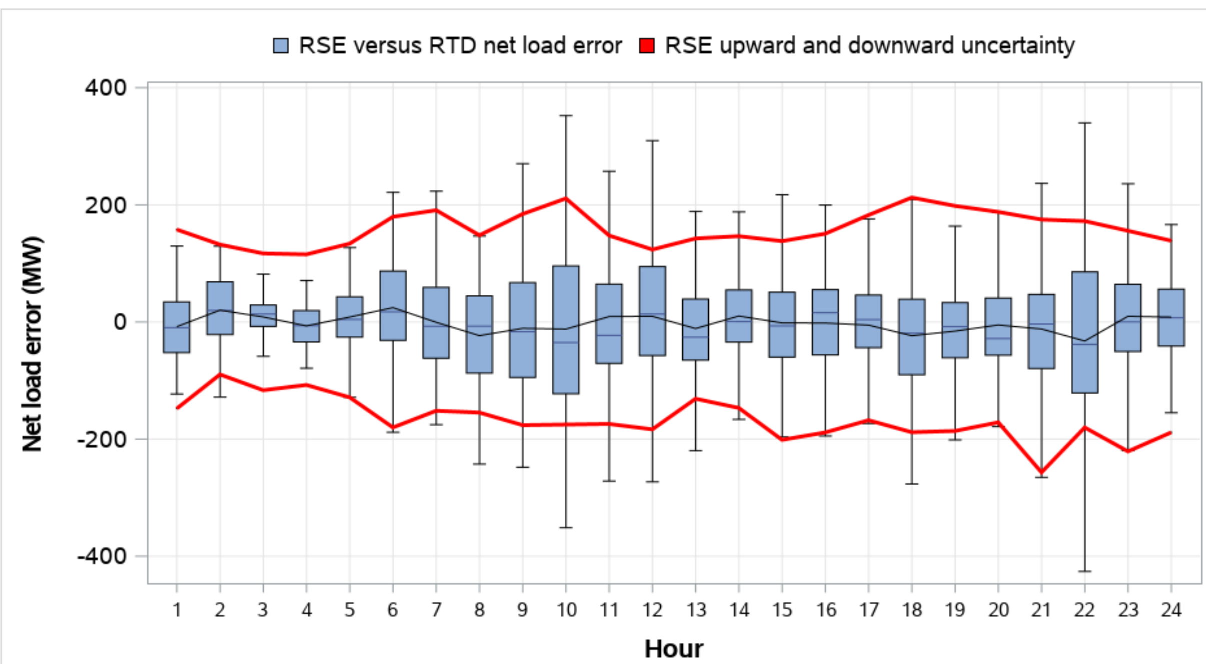


Figure 8.37 Powerex distribution of RSE and RTD load and VER error (weekdays, April 2022)

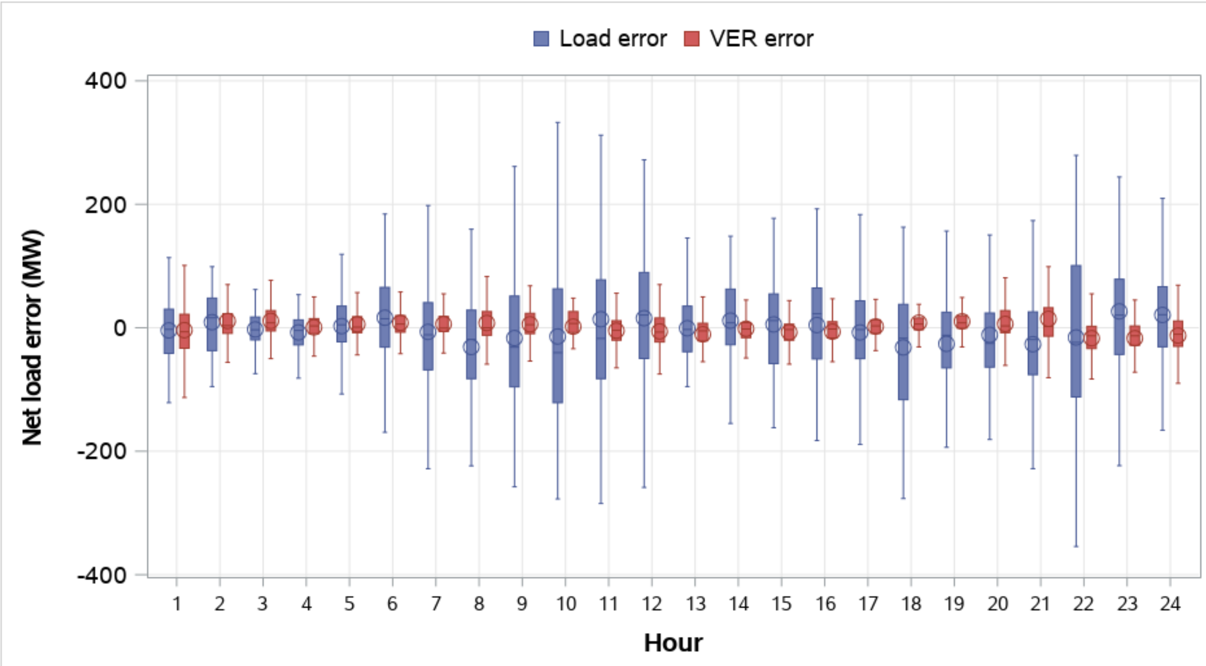


Figure 8.38 PNM average uncertainty by component (weekdays, April 2022)

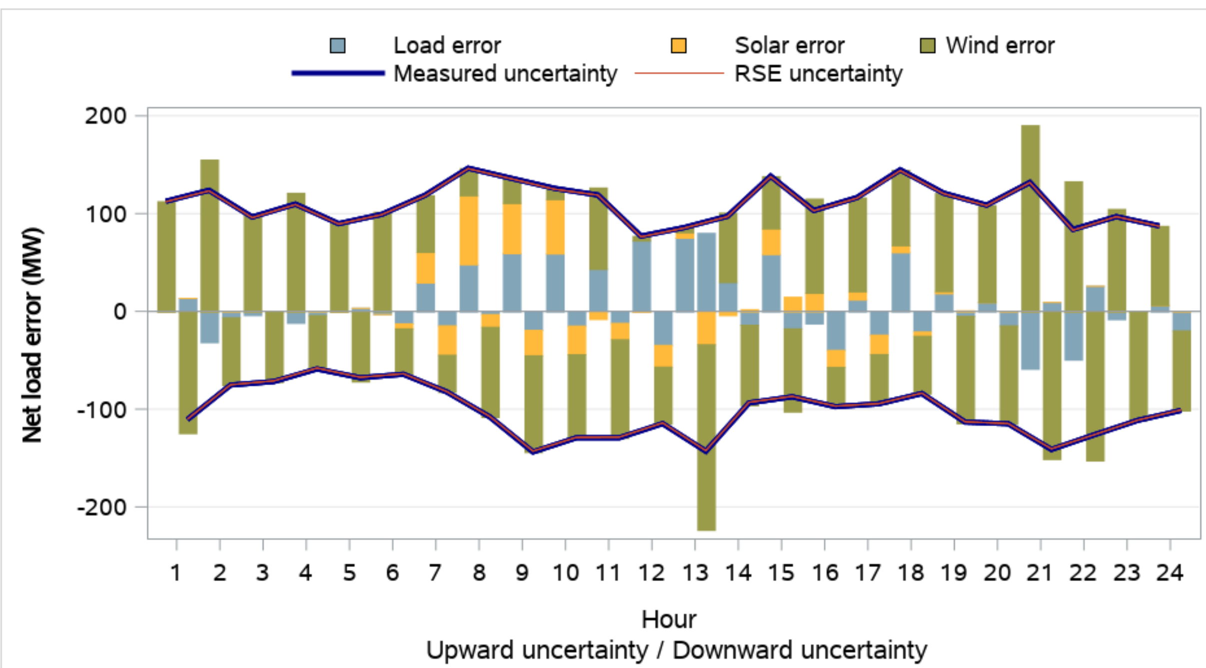


Figure 8.39 PNM distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, April 2022)

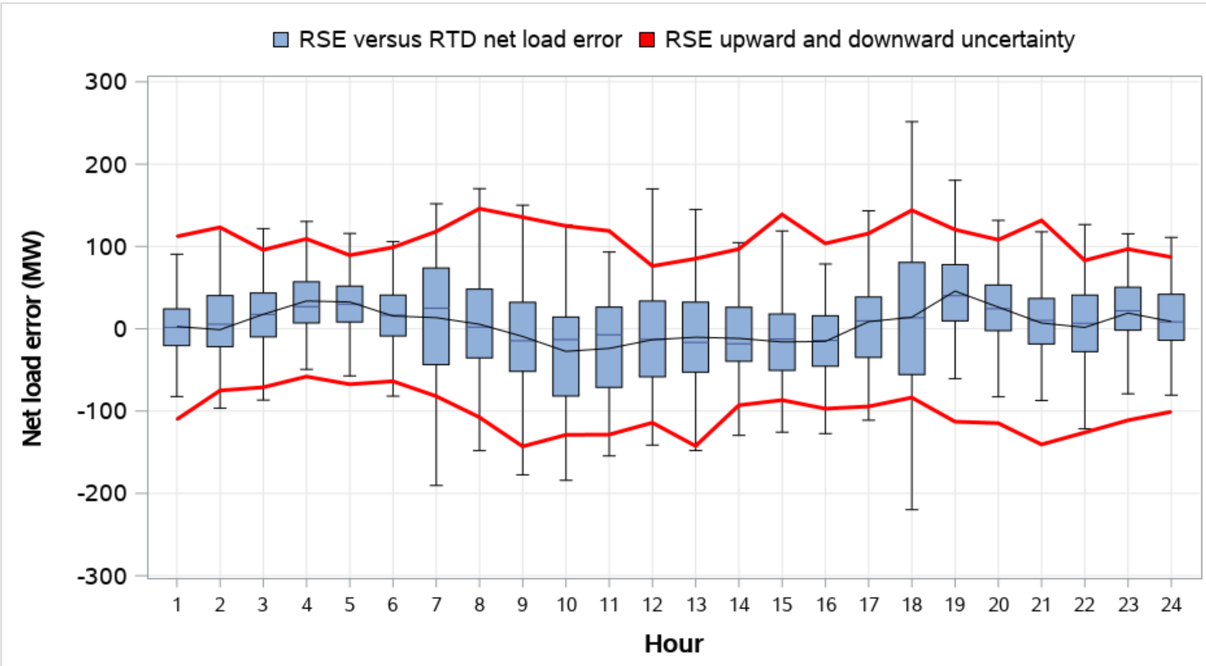


Figure 8.40 PNM distribution of RSE and RTD load and VER error (weekdays, April 2022)

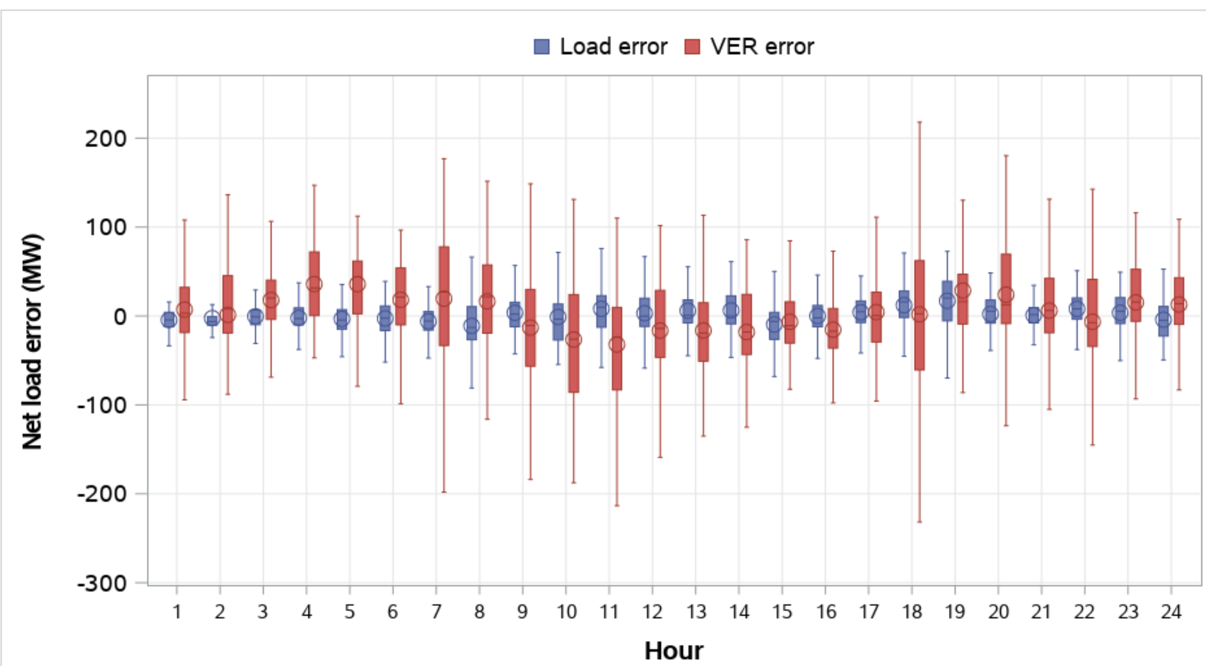


Figure 8.41 Puget Sound Energy average uncertainty by component (weekdays, April 2022)

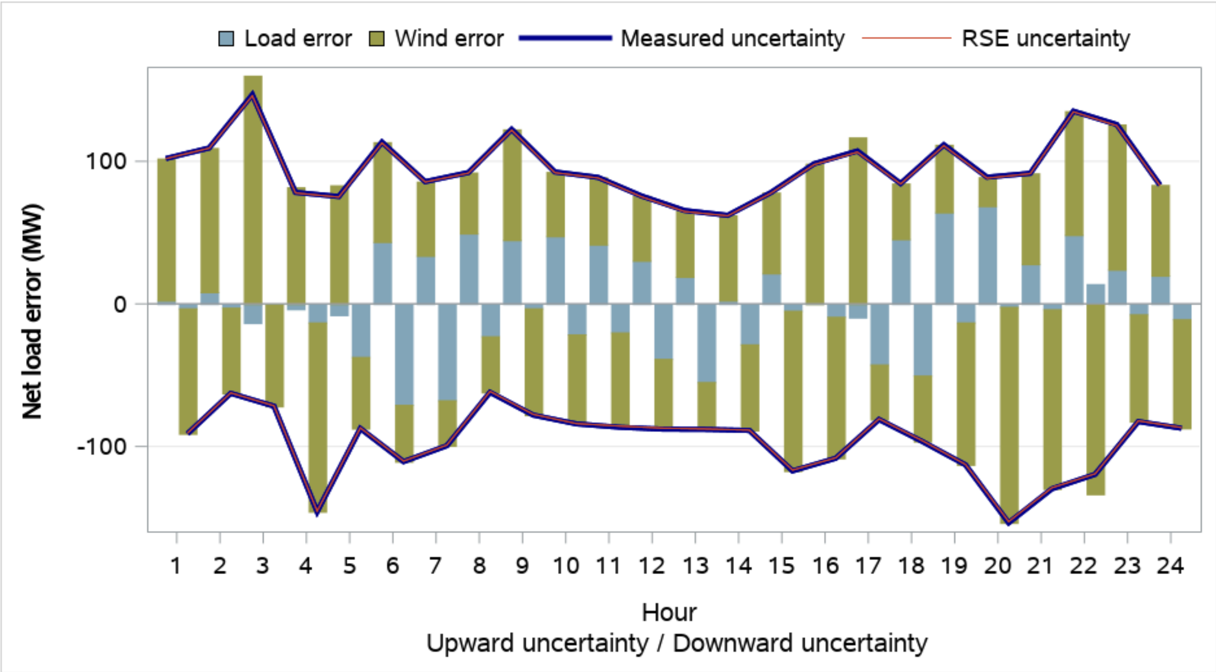


Figure 8.42 Puget Sound Energy distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, April 2022)

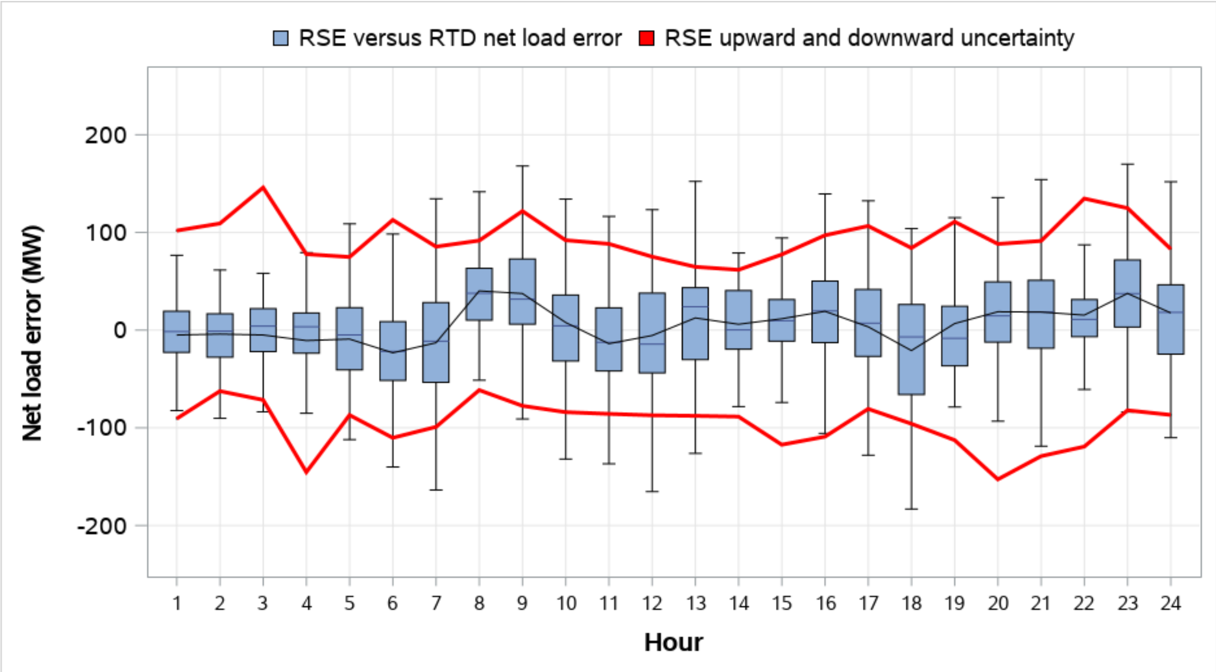


Figure 8.43 Puget Sound Energy distribution of RSE and RTD load and VER error (weekdays, April 2022)

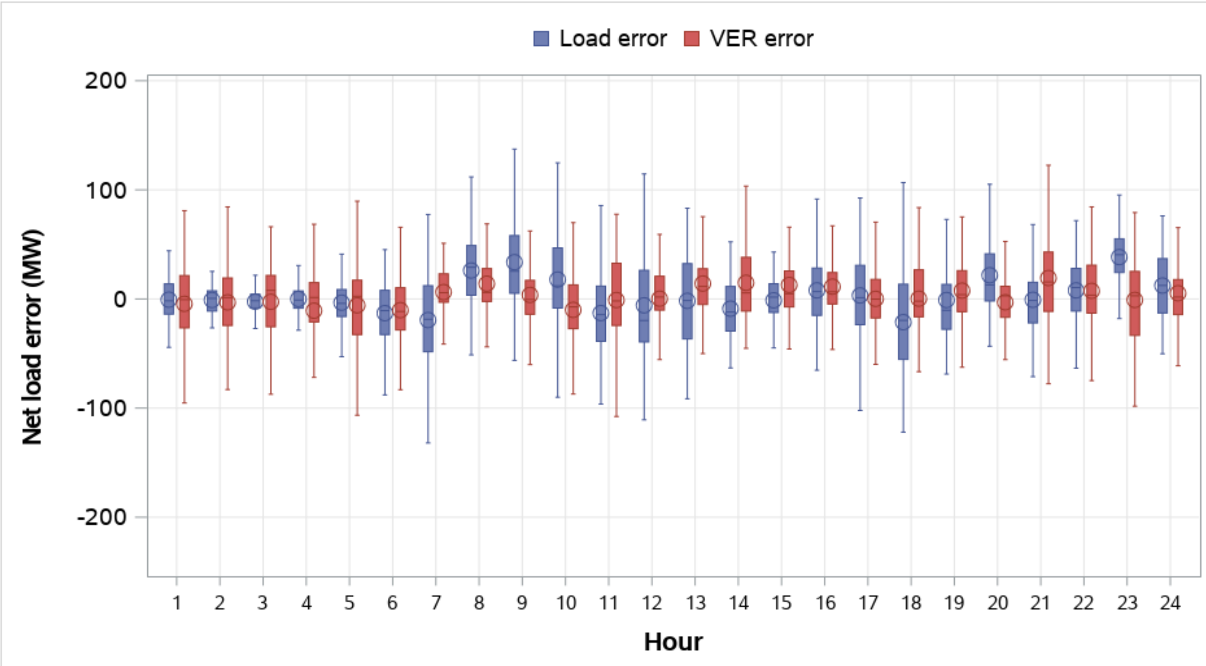


Figure 8.44 Salt River Project average uncertainty by component (weekdays, April 2022)

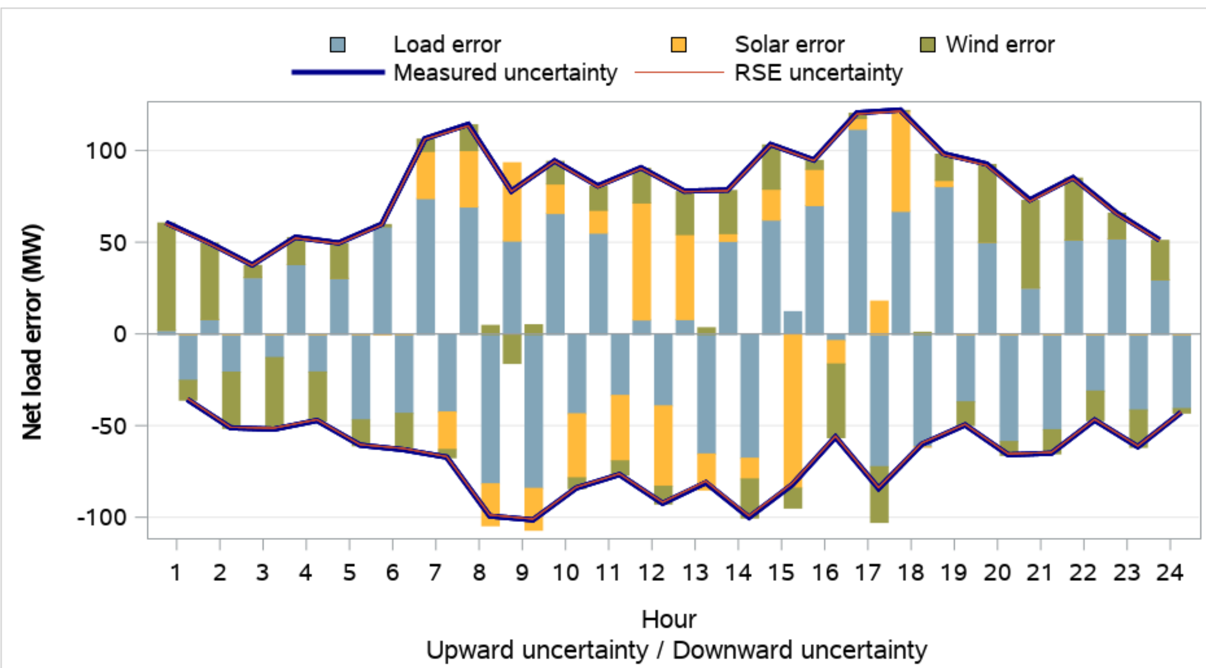


Figure 8.45 Salt River Project distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, April 2022)

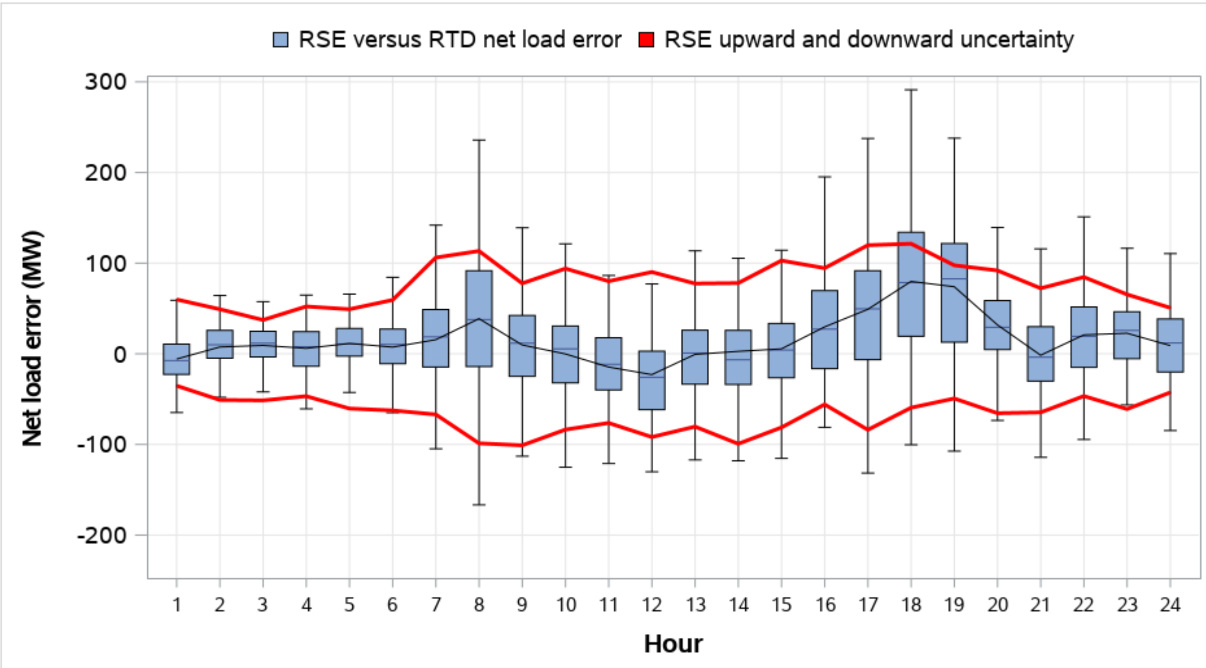


Figure 8.46 Salt River Project distribution of RSE and RTD load and VER error (weekdays, April 2022)

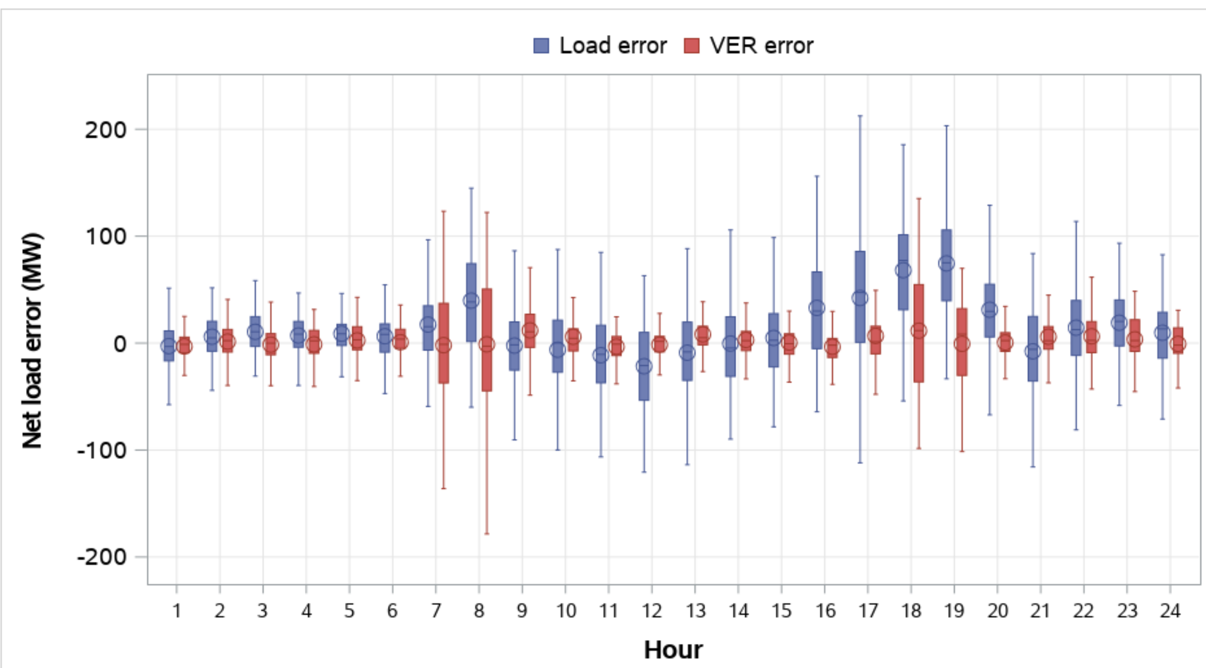


Figure 8.47 Seattle City Light average uncertainty by component (weekdays, April 2022)

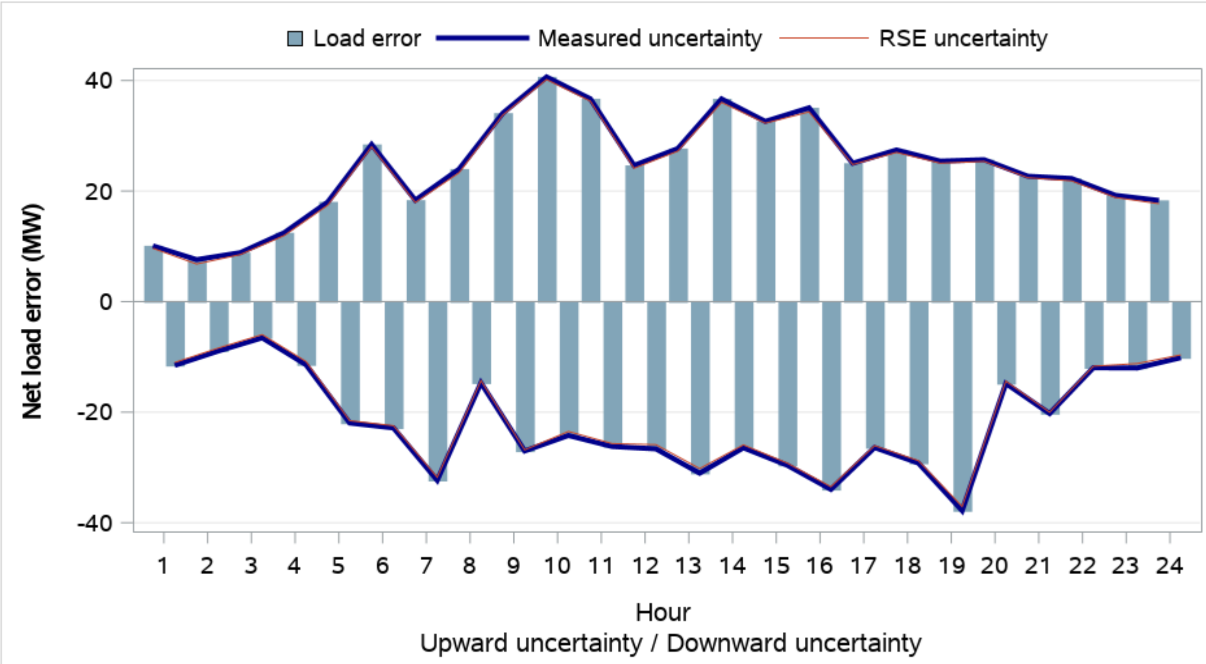


Figure 8.48 Seattle City Light distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, April 2022)

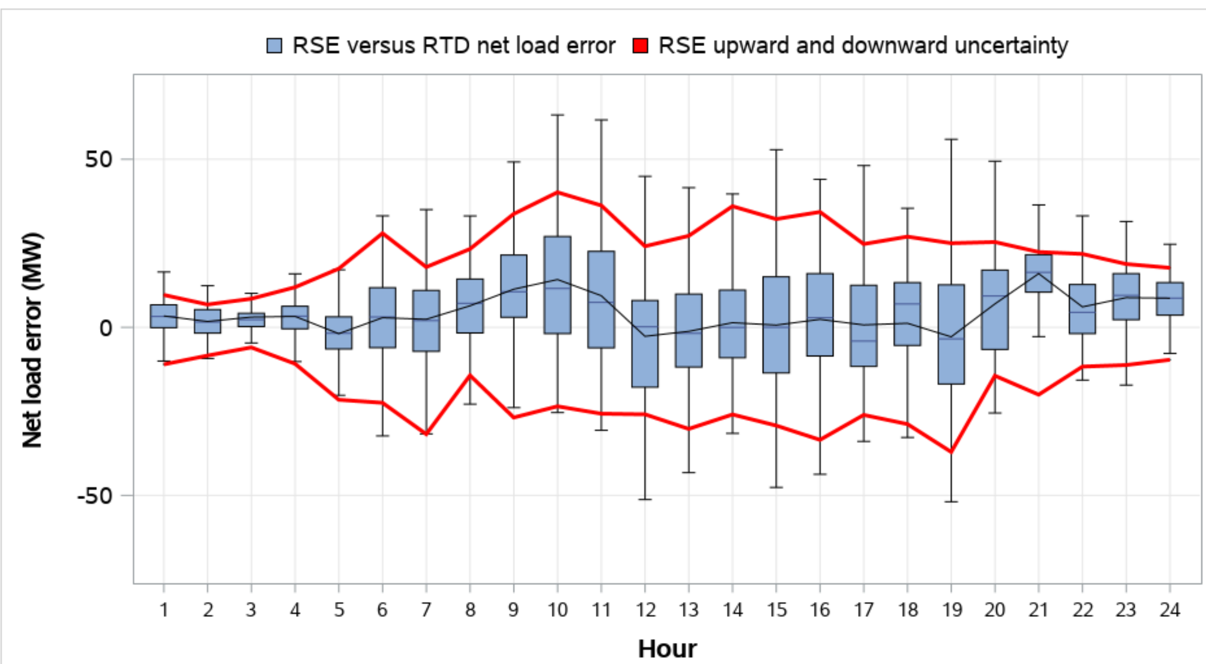


Figure 8.49 Seattle City Light distribution of RSE and RTD load and VER error (weekdays, April 2022)

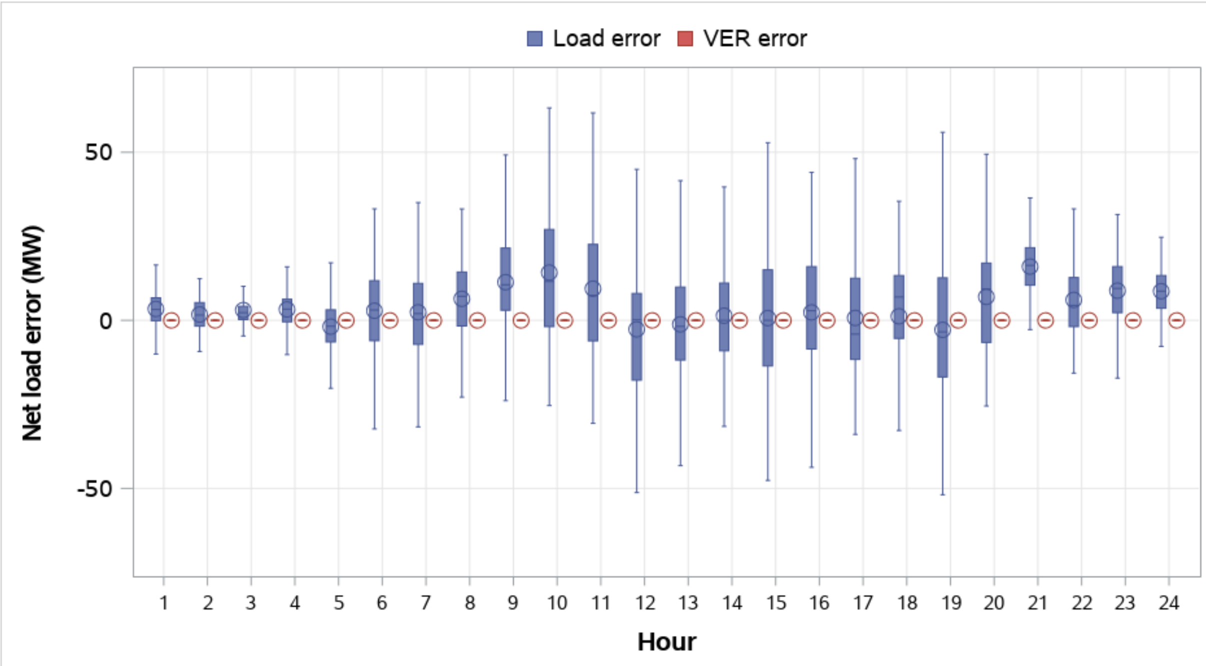


Figure 8.50 Tacoma Power average uncertainty by component (weekdays, April 2022)

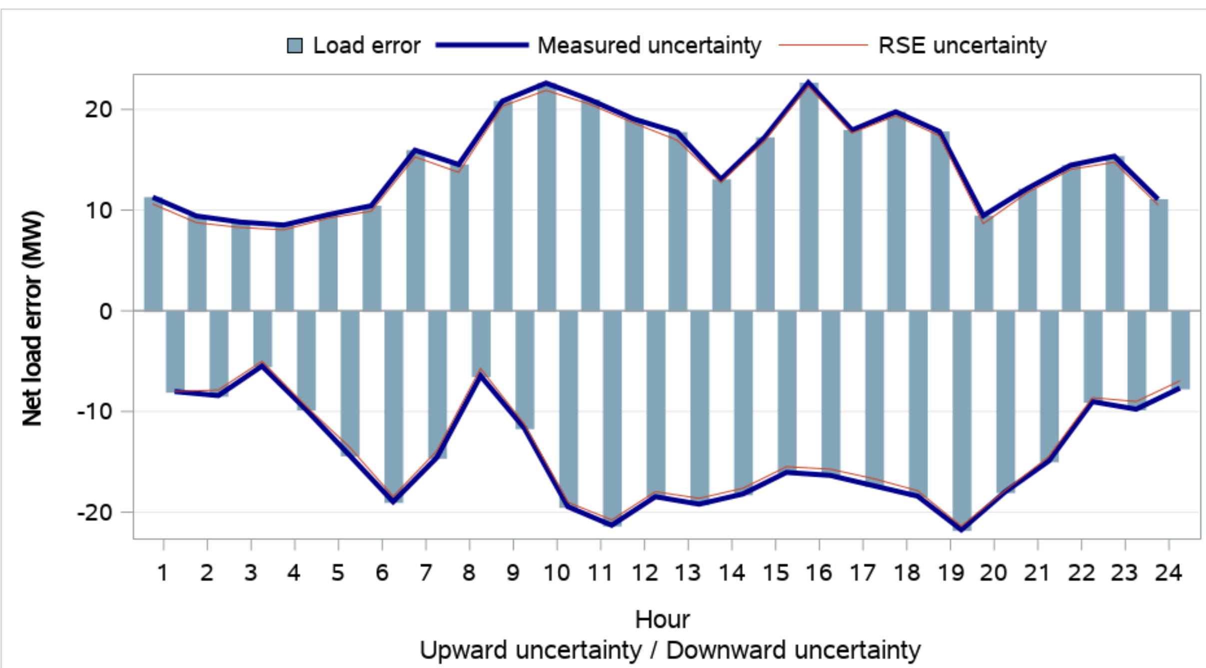


Figure 8.51 Tacoma Power distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, April 2022)

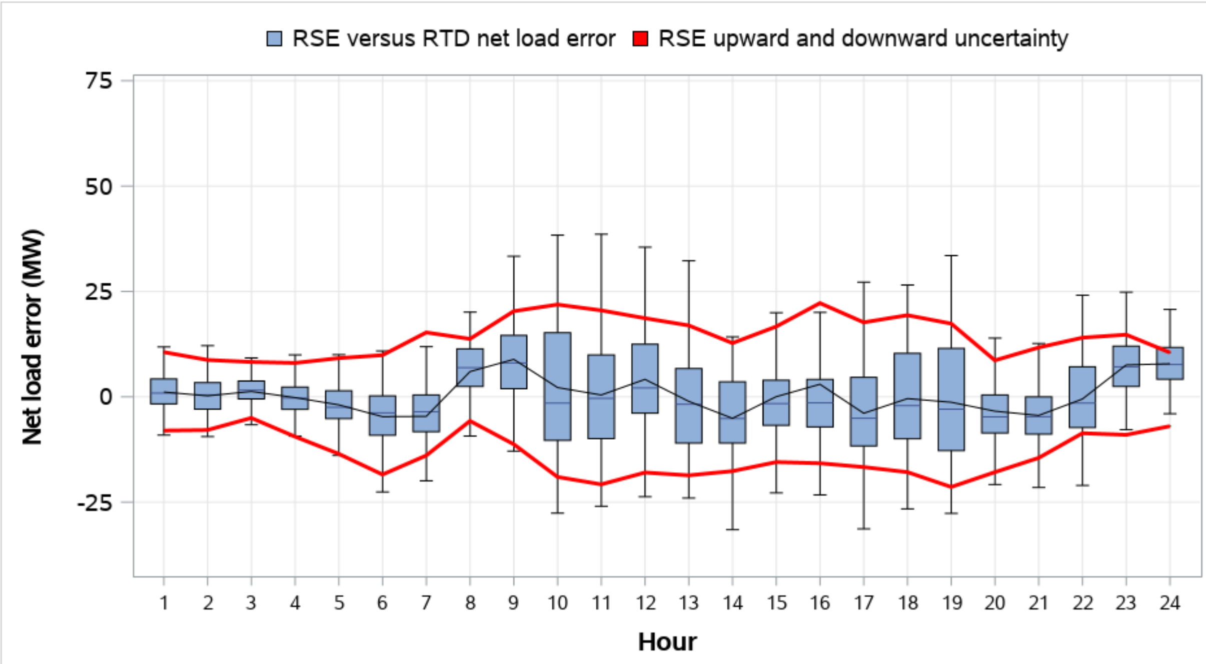


Figure 8.52 Tacoma Power distribution of RSE and RTD load and VER error (weekdays, April 2022)

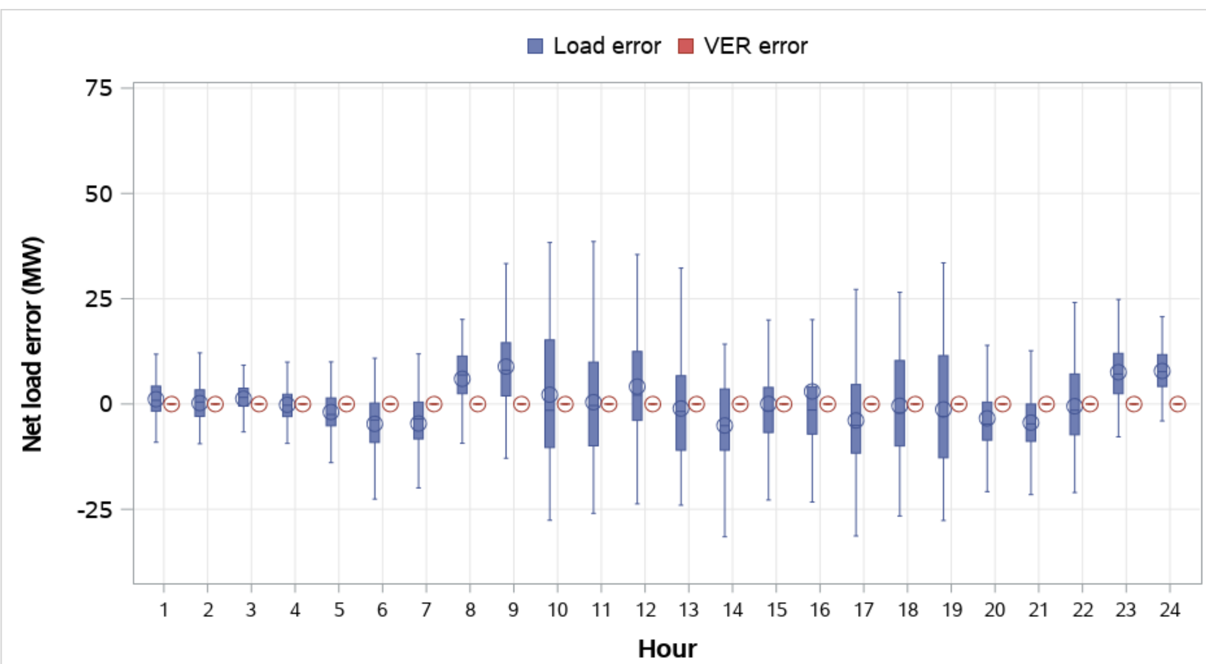


Figure 8.53 Turlock Irrigation District average uncertainty by component (weekdays, April 2022)

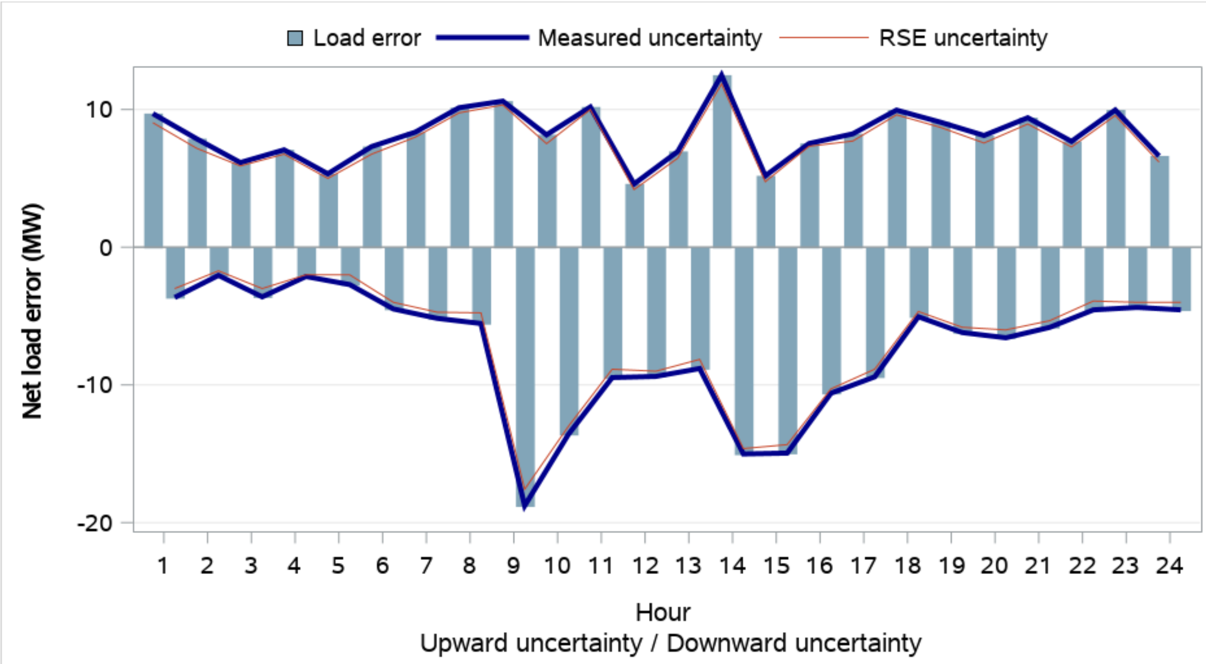


Figure 8.54 Turlock Irrigation District distribution of RSE and RTD net load error and comparison to RSE uncertainty (weekdays, April 2022)

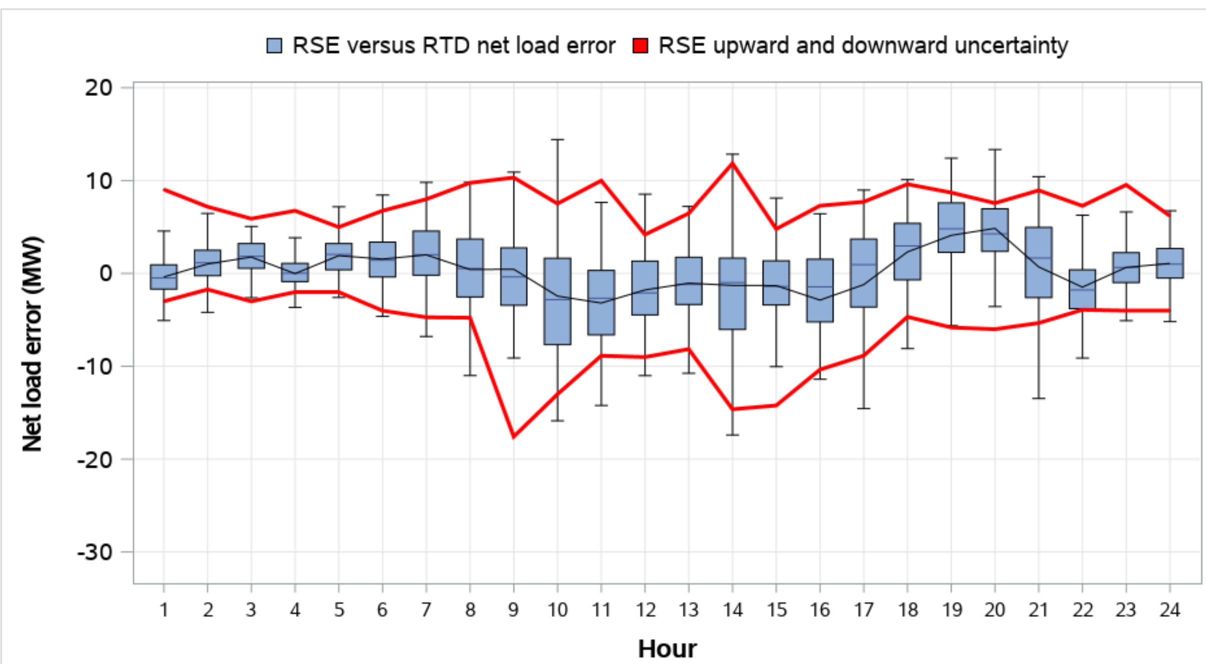
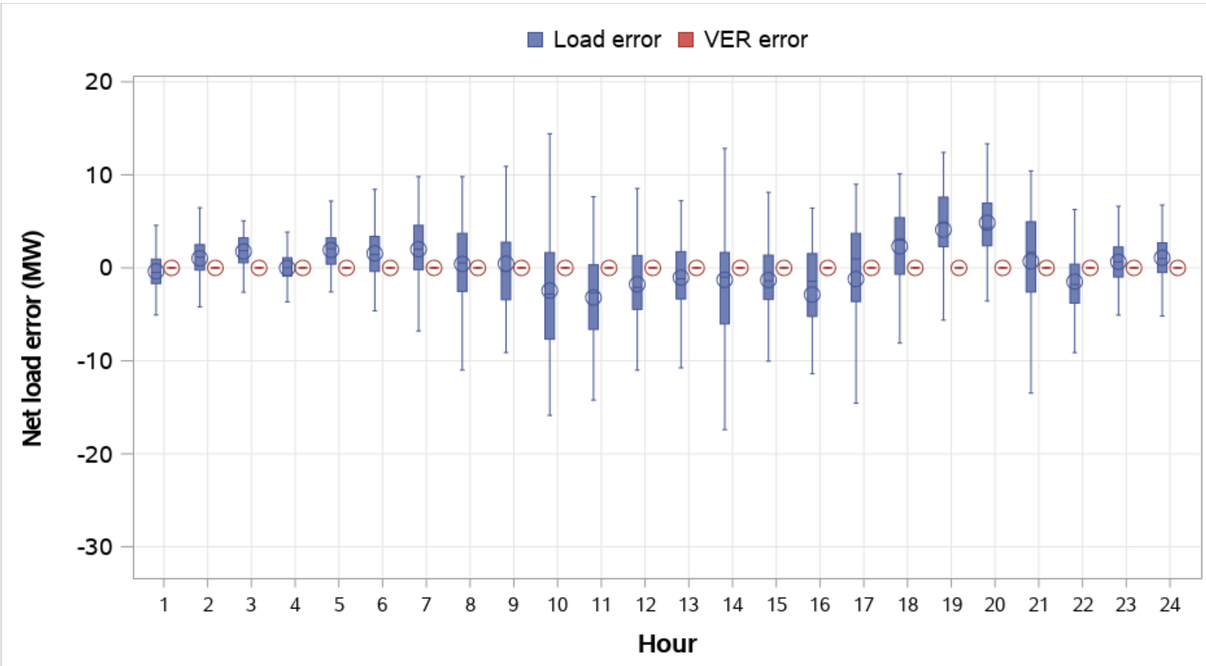


Figure 8.55 Turlock Irrigation District distribution of RSE and RTD load and VER error (weekdays, April 2022)



9 Resource sufficiency evaluation implementation issues

This section summarizes resource sufficiency evaluation implementation issues identified by DMM or the CAISO in 2021. Most issues listed below have been resolved; however, the list does not include the two issues discussed in the CAISO's January 2021 workshop on the resource sufficiency evaluation and its application during the August 2020 heatwave; those issues were fixed effective February 4, 2021.[22]

1. **In some cases, upward capacity for multi-stage generation (MSG) resources was double-counted in the bid-range capacity test**. Upward capacity for MSG resources is calculated based on the highest configuration. The issue occurred when a de-rate on a configuration caused multiple configurations to be selected as the highest configuration and was fixed on June 10, 2021.

2. **De-rates and outages for variable energy resources (VERs) were not correctly accounted for.** Instead, upward capacity was included up to the forecast under these conditions. This issue impacted both the bid-range capacity test and the flexible ramp sufficiency test and was fixed on June 10, 2021.

3. **Under specific conditions, changes in base WEIM transfers from the previous hour to the current hour were double-counted in the flexible ramp sufficiency test.** This occurred when net import capability in the upward test (or net export capability for the downward test) was less than the combination of diversity benefits and credits. Diversity benefit and credits discount the requirement of the flexible ramp sufficiency test to the extent that the area has transfer capability. When the area's transfer capability set the discount toward the requirement, any change in base WEIM transfers were counted twice on both the requirement side as a discount as well as on the supply side as ramping capacity. Here, base WEIM transfers were incorrectly included in the net transfer capability calculation. This issue was fixed effective December 22, 2021.

4. **In some cases, each side of an auto-mirror resource was counted differently for both CAISO and non-CAISO balancing areas in the bid-range capacity test.** An update as part of summer 2021 enhancements allowed auto-mirroring for intertie transactions between CAISO and non-CAISO balancing areas. Here, the more granular 15-minute auto-mirror schedule, which accounts for intertie ramping between hours, was included in the capacity test for the non-CAISO balancing area; however, for CAISO's capacity test, the hourly block schedule is used. The issue has not yet been fixed.

5. **Downward intertie uncertainty incorrectly *reduced* the requirement for the downward bid-range capacity test.** Intertie uncertainty is calculated from historical observations between net imports and exports scheduled 40 minutes prior to the hour as well as the final tagged values at 20 minutes prior to the hour. Here, intertie deviation from higher imports or lower exports at 20 minutes prior to the hour incorrectly reduced the downward capacity requirement rather than add to it. This issue was fixed on September 23, 2021.

6. **Intertie uncertainty in the bid-range capacity test was incorrectly set to zero from the 28th day of the month to the end of each month.** This issue was fixed in September 2021.

[22] *Resource Sufficiency Evaluation*, January 13, 2021. http://www.caiso.com/InitiativeDocuments/Presentation-MarketEnhancements-Summer2021ReadinessJan13,2021Workshop.pdf