California ISO

EIM Resource Sufficiency Evaluation Metrics Report covering October 2021

November 12, 2021

Prepared by: Department of Market Monitoring

California Independent System Operator

1 Report overview

As part of the Energy Impact Market (EIM) resource sufficiency evaluation 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 October 2021. This report is organized as follows:

- Section 2 provides an overview of the flexible ramping sufficiency and bid-range capacity tests.
- Section 3 provides existing summary metrics.
- Section 4 provides existing metrics for key time periods.
- Section 5 provides a special discussion on the comparison between unloaded capacity and net EIM imports.
- Section 6 provides a special discussion on the net load uncertainty used in the tests.

This report includes two recommendations:

- As discussed in Section 5, DMM has been reviewing cases in which optimized net EIM imports significantly exceeded the unloaded capacity within the ISO balancing area, but the ISO area still passed the bid-range capacity test. Detailed examination of these cases highlights differences in specific market conditions and inputs that drive these outcomes. DMM recommends that the ISO and stakeholders review some of the differences highlighted in Section 5 to potentially improve the accuracy of the test.
- As discussed in Section 6, the uncertainty component currently used in both the flexible ramping sufficiency test and bid-range capacity test is pulled from the 15-minute market flexible ramping product uncertainty calculations. DMM recommends that any uncertainty calculation used in the resource sufficiency evaluation be developed separately from that of the flexible ramping product.

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

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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 energy imbalance market, 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 ramping sufficiency test, and the bid range capacity test.

If a balancing area fails either of the following two tests, transfers into that balancing area from other energy imbalance market areas are automatically limited by the market software:

- **The flexible ramping sufficiency test (referred to as the sufficiency test by the ISO)** requires that each balancing area has 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 ramping sufficiency test or bid range capacity test in the upward direction, energy imbalance market 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 ramping sufficiency test

The flexible ramping sufficiency test requires that each balancing area has 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 ramping sufficiency test. As shown in Equation 1, the requirement for the flexible ramping 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*.

Equation 1. Flexible Ramping Sufficiency Test Formulation

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

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

[2] If an area fails either test in the upward direction, net EIM imports during the hour cannot exceed the more lenient 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.

Finally, as shown in Equation 1, the reduction in the sufficiency 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 ramping sufficiency test is calculated from the historical net load error observation. The 2.5th percentile of historical net load error observations is used for the downward requirement and the 97.5th 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*.

Equation 2. Bid Range Capacity Test Formulation

$$Requirement = \underbrace{Load}_{\text{Load forecast}} + \underbrace{Export_{base} - Import_{base} - Generation_{base}}_{\text{Intertie and generation base schedules}} + \underbrace{Intertie\ Deviation}_{\text{Additional requirement to account for historical intertie deviation}} + \underbrace{Uncertainty}_{\text{Net load uncertainty, net diversity benefit (effective June 16, 2021)}}$$

As also shown in Equation 2, two additional components are added to the requirement in order to account for both (1) historical intertie deviations and (2) net load uncertainty (beginning June 16).[5]

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

5 Net load uncertainty is reduced by the diversity benefit similar to the sufficiency test. Unlike the sufficiency test, credits (net EIM exports in the upward test and net EIM imports in the downward test) are not used in the capacity test. This is to prevent double counting of internal capacity. For example, net EIM exports are supported by internal capacity, which is already accounted for in the capacity test by the generation base schedules and bid range.

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 ISO, the “base” schedules used in the requirement are the advisory schedules from the last binding 15-minute market run. For all other energy imbalance market 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:[6]

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

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.

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

3 Summary metrics

This section provides existing summary metrics on the resource sufficiency evaluation.[7]

Frequency and size of test failures

Figure 1 through Figure 4 show the number of 15-minute intervals in which each EIM area failed the upward capacity or sufficiency tests as well as the average shortfall of those test failures. Figure 5 through Figure 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 ramping sufficiency test and bid-range capacity test failures reported in Figures 1 through 8 are reported separately. As previously noted, if a balancing area fails either (or both) of these tests, then transfers between that are and the rest of the energy imbalance market areas are limited.

Figure 9 summarizes the overlap between failure of the upward capacity and sufficiency tests during the month. The black horizontal line (right axis) shows the number of 15-minute intervals with either a capacity or sufficiency test failure for each energy imbalance market 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 10 shows the same information for the downward direction. Areas that did not fail either the capacity or sufficiency test during this period were omitted from the figure.

As shown in Figure 1, failures of the upward bid-range capacity test increased significantly in summer 2021 relative to summer 2020. This increase was driven by changes implemented by the ISO in 2021. First, the ISO corrected two errors effective February 4, 2021. These errors incorrectly accounted for resource derates/outages as well as mirror resources, making it easier to pass the bid-range capacity test.[8] Next, the ISO added net load uncertainty to the requirement of the bid-range capacity test on June 16, 2021. The impact of adding uncertainty is summarized in the following section.

As shown in these figures, NorthWestern Energy failed the upward capacity and flex ramp sufficiency tests in a large number of intervals in October. These failures did not have any direct impact on the rest of the energy imbalance market because NorthWestern Energy did not offer incremental import capacity in the energy imbalance market during this period, so that upward leaning was not possible.

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7 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.

8 For additional information on these errors and the impact on bid-range capacity test failures, see DMM's May report: http://www.caiso.com/Documents/Report-on-Resource-Sufficiency-Tests-in-the-Energy-Imbalance-Market-May-20-2021.pdf

Figure 1. Frequency of upward capacity test failures (number of intervals)

	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Arizona PS	—	—	—	—	9	5	10	—	—	8	—	5	8	5	—
BANC	1	—	2	1	—	—	—	3	—	—	—	7	—	1	—
California ISO	—	—	—	—	—	—	—	—	—	—	4	6	1	5	—
Idaho Power	—	—	—	—	—	—	—	—	—	—	—	13	25	3	—
LADWP									—	—	2	—	—	—	8
NorthWestern											9	36	18	6	253
NV Energy	—	—	3	6	—	—	9	—	1	14	22	15	6	7	8
PacifiCorp East	—	—	—	4	—	—	—	—	—	—	10	9	4	6	4
PacifiCorp West	—	—	—	4	—	—	—	2	—	1	4	7	2	3	2
Portland GE	—	—	—	—	—	—	4	—	11	—	21	25	30	41	13
Powerex	—	2	2	3	—	4	1	—	—	—	1	1	—	2	15
PSC New Mexico									—	—	—	11	—	5	—
Puget Sound En	—	—	—	—	—	—	2	17	29	18	45	16	21	17	29
Salt River Proj.	—	—	3	2	—	—	215	—	2	4	19	90	76	56	3
Seattle City Light	2	—	—	—	—	—	—	—	—	—	—	—	1	14	4
Turlock ID								—	—	1	—	—	33	22	46
	2020					2021									

Figure 2. Average shortfall of upward capacity test failures (MW)

	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Arizona PS	—	—	—	—	1387	2325	1443	—	—	48	—	92	45	97	—
BANC	3	—	20	5	—	—	—	13	—	—	—	53	—	6	—
California ISO	—	—	—	—	—	—	—	—	—	—	405	601	274	125	—
Idaho Power	—	—	—	—	—	—	—	—	—	—	—	17	34	6	—
LADWP									—	—	46	—	—	—	95
NorthWestern											25	24	61	9	38
NV Energy	—	—	23	15	—	—	26	—	15	27	82	55	25	42	57
PacifiCorp East	—	—	—	1214	—	—	—	—	—	—	73	40	38	63	79
PacifiCorp West	—	—	—	2228	—	—	—	12	—	4	10	26	16	36	2
Portland GE	—	—	—	—	—	—	268	—	42	—	34	46	36	38	31
Powerex	—	85	79	258	—	41	32	—	—	—	63	3	—	22	78
PSC New Mexico									—	—	—	129	—	57	—
Puget Sound En	—	—	—	—	—	—	21	68	28	49	50	58	74	46	33
Salt River Proj.	—	—	26	72	—	—	54	—	25	38	30	75	121	74	27
Seattle City Light	2	—	—	—	—	—	—	—	—	—	—	—	4	151	53
Turlock ID								—	—	1	—	—	7	7	8
	2020					2021									

Figure 3. Frequency of upward sufficiency test failures (number of intervals)

	Aug 2020	Sep 2020	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mar 2021	Apr 2021	May 2021	Jun 2021	Jul 2021	Aug 2021	Sep 2021	Oct 2021
Arizona PS	—	10	24	19	19	15	13	7	—	19	—	1	—	7	—
BANC	7	1	4	—	4	—	—	—	—	—	—	—	—	—	—
California ISO	32	14	13	14	—	—	—	—	—	—	1	10	3	11	—
Idaho Power	5	—	—	—	—	—	4	—	—	—	—	—	—	—	—
LADWP									1	3	—	4	—	—	1
NorthWestern											18	108	20	46	247
NV Energy	212	74	41	24	—	4	13	11	12	20	27	12	15	4	8
PacifiCorp East	5	2	14	1	—	4	2	4	4	1	2	1	—	4	—
PacifiCorp West	4	4	3	1	3	1	5	3	4	1	—	1	2	—	—
Portland GE	5	17	3	3	5	10	15	3	7	7	8	14	5	—	1
Powerex	4	10	4	16	7	7	4	4	4	—	4	15	—	—	7
PSC New Mexico									11	1	3	15	—	2	—
Puget Sound En	12	—	5	—	—	—	—	—	—	4	2	1	1	—	—
Salt River Proj.	54	33	49	25	8	5	192	8	15	6	26	57	49	24	5
Seattle City Light	—	2	5	5	4	—	—	—	—	—	—	1	—	4	—
Turlock ID								—	—	9	—	—	—	2	5

Figure 4. Average shortfall of upward sufficiency test failures (MW)

	Aug 2020	Sep 2020	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mar 2021	Apr 2021	May 2021	Jun 2021	Jul 2021	Aug 2021	Sep 2021	Oct 2021
Arizona PS	—	232	56	60	716	913	1140	57	—	33	—	38	—	42	—
BANC	52	8	15	—	18	—	—	—	—	—	—	—	—	—	—
California ISO	710	1031	872	516	—	—	—	—	—	—	404	585	400	735	—
Idaho Power	19	—	—	—	—	—	8	—	—	—	—	—	—	—	—
LADWP									32	59	—	70	—	—	10
NorthWestern											45	36	18	25	31
NV Energy	77	94	82	99	—	87	56	59	60	47	39	45	36	94	82
PacifiCorp East	33	95	64	20	—	62	26	61	67	47	53	44	—	21	—
PacifiCorp West	74	38	58	17	15	27	20	21	18	8	—	2	33	—	—
Portland GE	20	20	11	31	27	30	33	77	105	20	36	33	19	—	11
Powerex	664	48	64	115	65	82	64	26	69	—	137	111	—	—	50
PSC New Mexico									21	58	19	112	—	47	—
Puget Sound En	31	—	27	—	—	—	—	—	—	47	24	6	24	—	—
Salt River Proj.	69	46	56	49	52	20	64	27	75	27	69	61	53	50	32
Seattle City Light	—	10	9	6	4	—	—	—	—	—	—	7	—	14	—
Turlock ID								—	—	6	—	—	—	2	18

Figure 5. Frequency of downward capacity test failures (number of intervals)

	2020					2021									
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Arizona PS	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
BANC	—	—	4	4	—	—	1	2	—	—	—	—	—	—	—
California ISO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Idaho Power	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
LADWP									—	—	2	—	—	—	5
NorthWestern											—	—	—	—	29
NV Energy	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
PacifiCorp East	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PacifiCorp West	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Portland GE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Powerex	1	—	1	—	—	—	—	—	1	—	8	3	—	24	9
PSC New Mexico									—	—	—	—	—	—	7
Puget Sound En	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Salt River Proj.	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—
Seattle City Light	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—
Turlock ID								—	—	8	6	1	6	5	20

Figure 6. Average shortfall of downward capacity test failures (MW)

	2020					2021									
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Arizona PS	—	—	—	—	—	—	—	—	—	8	—	—	—	—	—
BANC	—	—	831	341	—	—	1	6	—	—	—	—	—	—	—
California ISO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Idaho Power	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
LADWP									—	—	16	—	—	—	30
NorthWestern											—	—	—	—	55
NV Energy	—	—	—	—	—	—	—	—	—	—	26	—	—	—	—
PacifiCorp East	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PacifiCorp West	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Portland GE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Powerex	29	—	13	—	—	—	—	—	8	—	350	33	—	144	51
PSC New Mexico									—	—	—	—	—	—	22
Puget Sound En	—	—	—	—	—	—	—	—	—	—	—	—	—	—	33
Salt River Proj.	—	—	—	—	—	—	—	—	11	—	29	—	—	—	—
Seattle City Light	—	—	—	—	—	—	—	—	—	—	—	8	8	5	—
Turlock ID								—	—	4	4	3	8	2	5

Figure 7. Frequency of downward sufficiency test failures (number of intervals)

	Aug 2020	Sep 2020	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mar 2021	Apr 2021	May 2021	Jun 2021	Jul 2021	Aug 2021	Sep 2021	Oct 2021
Arizona PS	—	4	57	27	75	64	61	129	55	8	4	—	4	2	3
BANC	—	—	4	8	—	—	17	10	—	—	—	—	—	—	—
California ISO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Idaho Power	—	—	1	1	—	—	—	—	—	1	—	—	—	—	—
LADWP									—	—	2	—	—	—	2
NorthWestern											10	18	11	33	68
NV Energy	24	64	16	39	32	6	163	42	15	127	58	88	74	48	34
PacifiCorp East	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PacifiCorp West	—	—	—	—	—	—	—	2	—	—	4	—	—	—	—
Portland GE	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
Powerex	2	2	2	—	—	12	—	42	6	27	36	12	6	29	12
PSC New Mexico									39	—	1	—	—	4	11
Puget Sound En	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Salt River Proj.	1	3	3	5	23	33	43	35	5	2	5	—	2	1	2
Seattle City Light	5	5	3	2	4	—	—	—	—	—	—	6	—	—	—
Turlock ID								3	4	16	—	—	1	—	18

Figure 8. Average shortfall of downward sufficiency test failures (MW)

	Aug 2020	Sep 2020	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mar 2021	Apr 2021	May 2021	Jun 2021	Jul 2021	Aug 2021	Sep 2021	Oct 2021
Arizona PS	—	36	73	44	55	63	94	52	73	38	26	—	50	27	36
BANC	—	—	63	98	—	—	16	13	—	—	—	—	—	—	—
California ISO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Idaho Power	—	—	5	10	—	—	—	—	—	9	—	—	—	—	—
LADWP									—	—	14	—	—	—	5
NorthWestern											259	14	29	17	25
NV Energy	71	87	30	31	32	150	49	56	64	74	65	141	70	83	39
PacifiCorp East	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PacifiCorp West	—	—	—	—	—	—	—	9	—	—	140	—	—	—	—
Portland GE	—	—	—	—	—	10	—	—	—	—	—	—	—	—	—
Powerex	54	47	71	—	—	95	—	64	26	38	199	83	44	121	101
PSC New Mexico									124	—	12	—	—	102	56
Puget Sound En	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Salt River Proj.	118	92	58	26	33	57	45	55	47	65	44	—	25	100	22
Seattle City Light	8	7	25	20	88	—	—	—	—	—	—	2	—	—	—
Turlock ID								2	6	7	—	—	4	—	16

Figure 9. Upward capacity/sufficiency test failure intervals by concurrence (October, 2021)

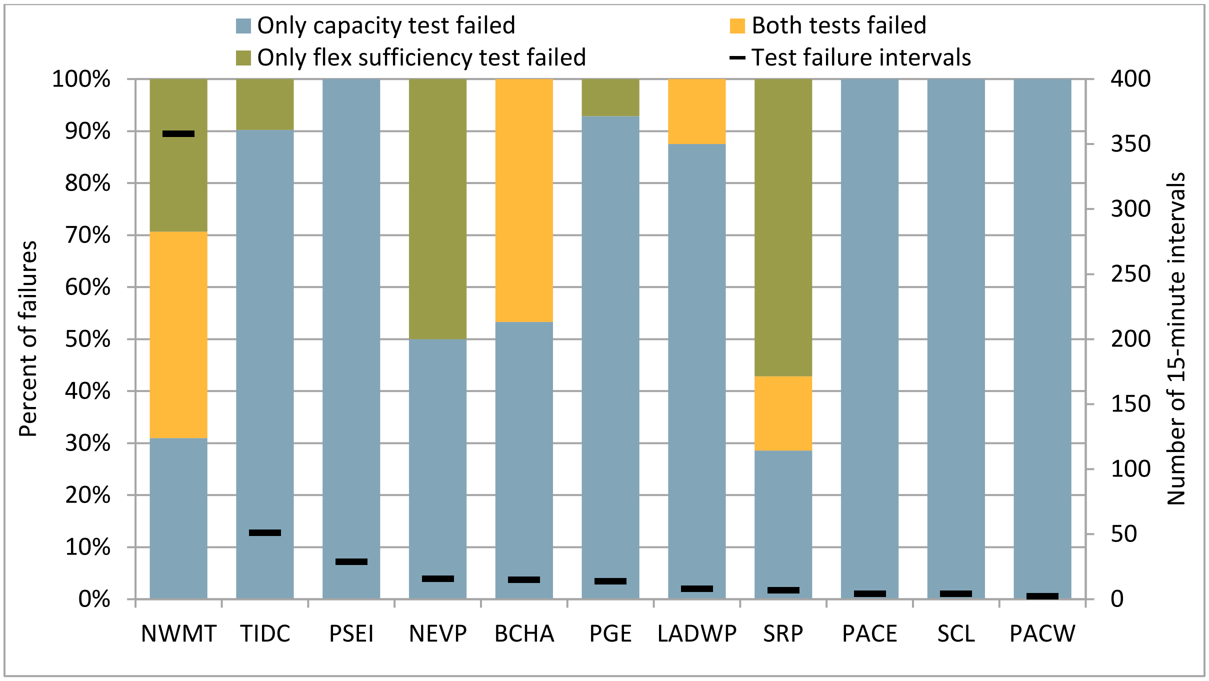
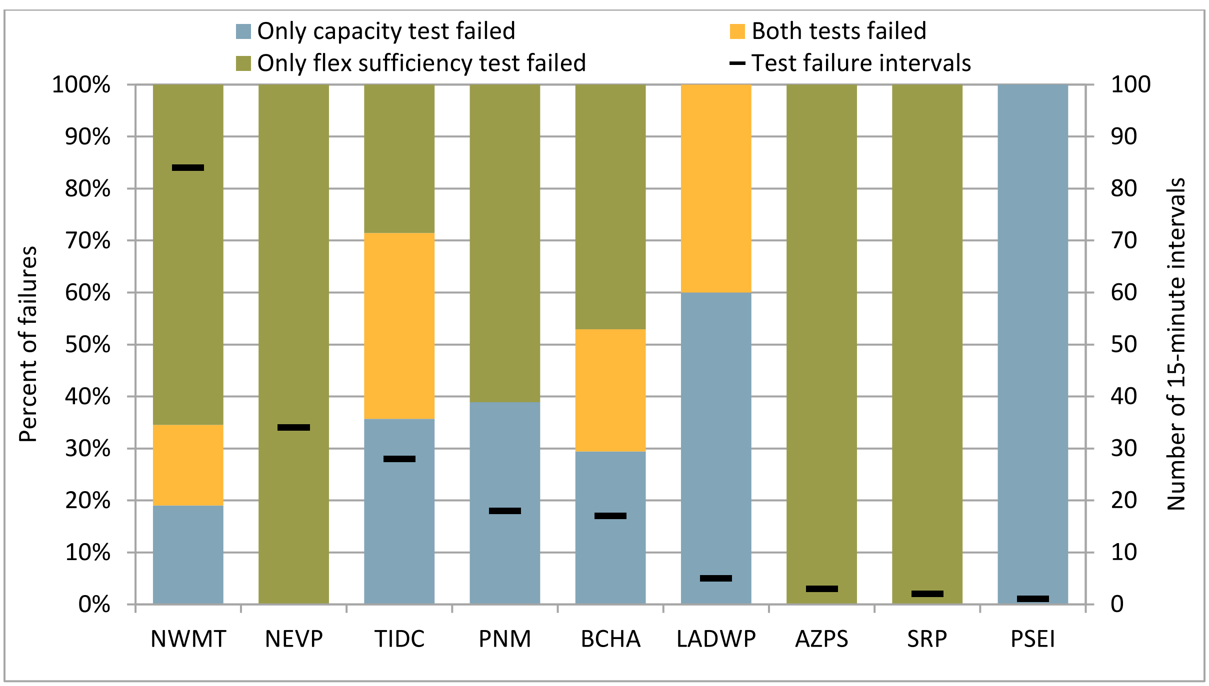


Figure 10. Downward capacity/sufficiency test failure intervals by concurrence (October, 2021)



Impact of adding uncertainty to the capacity test

On June 16, the 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. The uncertainty component is net of the diversity benefit, similar to that already in effect for the flexible ramping sufficiency test.[9]

Figure 11 shows the impact of this change by showing actual capacity test failure intervals that would have passed the test without the additional uncertainty component. Figure 12 shows the same information, except without intervals in which the sufficiency test also failed in that interval. Since the outcome of failing either the capacity or the sufficiency test is the same, this Figure 12 summarizes additional intervals in which energy imbalance market transfers were capped as a result of the addition of the uncertainty component.

Figure 11. Additional capacity test failures with implemented uncertainty (15-minute intervals)

	Upward capacity test					Downward capacity test				
	Jun*	Jul	Aug	Sep	Oct	Jun*	Jul	Aug	Sep	Oct
Arizona PS	—	3	7	2	—	—	—	—	—	—
BANC	—	3	—	1	—	—	—	—	—	—
California ISO	3	2	1	5	—	—	—	—	—	—
Idaho Power	—	13	21	3	—	—	—	—	—	—
LADWP	—	—	—	—	—	—	—	—	—	2
NorthWestern	4	30	12	6	192	—	—	—	—	15
NV Energy	3	9	6	5	6	—	—	—	—	—
PacifiCorp East	7	9	4	4	4	—	—	—	—	—
PacifiCorp West	4	7	2	2	2	—	—	—	—	—
Portland GE	17	20	25	34	13	—	—	—	—	—
Powerex	1	1	—	2	9	4	3	—	4	5
PSC New Mexico	—	3	—	2	—	—	—	—	—	7
Puget Sound En	7	8	10	8	19	—	—	—	—	1
Salt River Proj.	8	49	19	32	3	—	—	—	—	—
Seattle City Light	—	—	1	6	—	—	—	—	1	—
Turlock ID	—	—	9	10	18	4	—	1	2	3

*June 16-30, 2021 only (implementation of uncertainty in the capacity test)

9 The diversity benefit reflects that system-level flexible ramping needs are typically smaller than the sum of the individual balancing area flexible ramping needs because of reduced uncertainty across a larger footprint. The diversity benefit is a prorated discounted based on this proportion.

Figure 12. Additional capacity test failures with implemented uncertainty excluding sufficiency test failures (15-minute intervals)

	Upward capacity test					Downward capacity test				
	Jun*	Jul	Aug	Sep	Oct	Jun*	Jul	Aug	Sep	Oct
Arizona PS	—	3	7	2	—	—	—	—	—	—
BANC	—	3	—	1	—	—	—	—	—	—
California ISO	3	2	—	2	—	—	—	—	—	—
Idaho Power	—	13	21	3	—	—	—	—	—	—
LADWP	—	—	—	—	—	—	—	—	—	2
NorthWestern	2	9	9	—	105	—	—	—	—	13
NV Energy	2	9	6	5	6	—	—	—	—	—
PacifiCorp East	7	8	4	4	4	—	—	—	—	—
PacifiCorp West	4	6	2	2	2	—	—	—	—	—
Portland GE	17	19	25	34	13	—	—	—	—	—
Powerex	1	1	—	2	6	3	1	—	2	4
PSC New Mexico	—	1	—	2	—	—	—	—	—	7
Puget Sound En	7	8	10	8	19	—	—	—	—	1
Salt River Proj.	5	34	15	27	2	—	—	—	—	—
Seattle City Light	—	—	1	3	—	—	—	—	1	—
Turlock ID	—	—	9	10	18	4	—	1	2	1

*June 16-30, 2021 only (implementation of uncertainty in the capacity test)

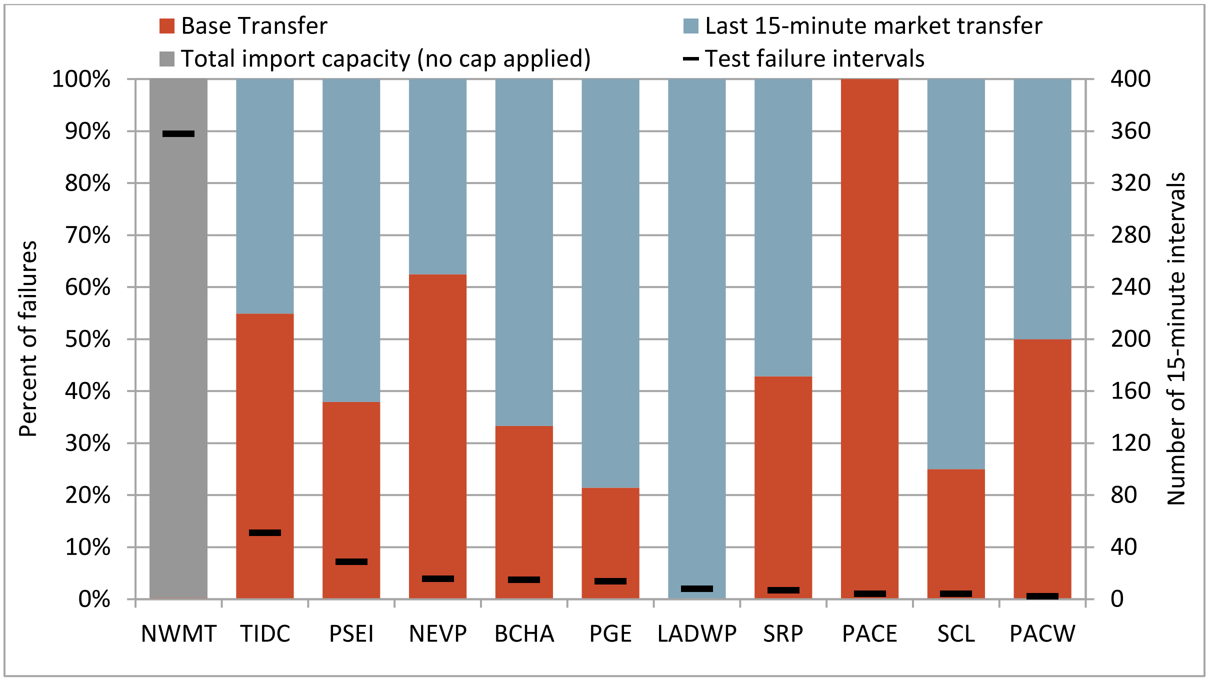
Transfer consequences of failing resource sufficiency evaluation

This section summarizes current consequences of failing the bid-range capacity or flexible ramping sufficiency tests in terms of the import limit that is imposed when a balancing area fails either of these tests in the upward direction. As part of the stakeholder initiative on resource sufficiency evaluation enhancements, the ISO is considering additional or alternative consequences for failing these tests.

When either test is failed 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 13 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 sufficiency test failure. The bars (left axis) show the percent of failure intervals in which the EIM 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.

Since no incremental import capacity above base schedules was offered into the NorthWestern Energy area (NWMT) during test failure intervals, these failures did not affect transfers into this area from the rest of the energy imbalance market.

Figure 13. Upward capacity/sufficiency test failure intervals by source of import limit (October 2021)



As a change from previous reports, the metrics below summarize *incremental* EIM import limits above base transfers (fixed bilateral transactions between EIM entities). From this perspective, the incremental EIM 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. The incremental EIM import limits therefore shows the incremental flexibility that is available through the energy imbalance market after a resource sufficiency evaluation failure.

Figure 14 and Figure 15 summarizes the incremental import limits that were imposed after failing either test by level for both September and October 2021. The black horizontal line (right axis) shows the number of 15-minute intervals with an import limit imposed after a test failure.[10] Areas without any upward test failures or imposed import limits during the month were excluded.

Figure 16 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.

10 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 14. Upward capacity/sufficiency test failure intervals by incremental import limit (September 2021)

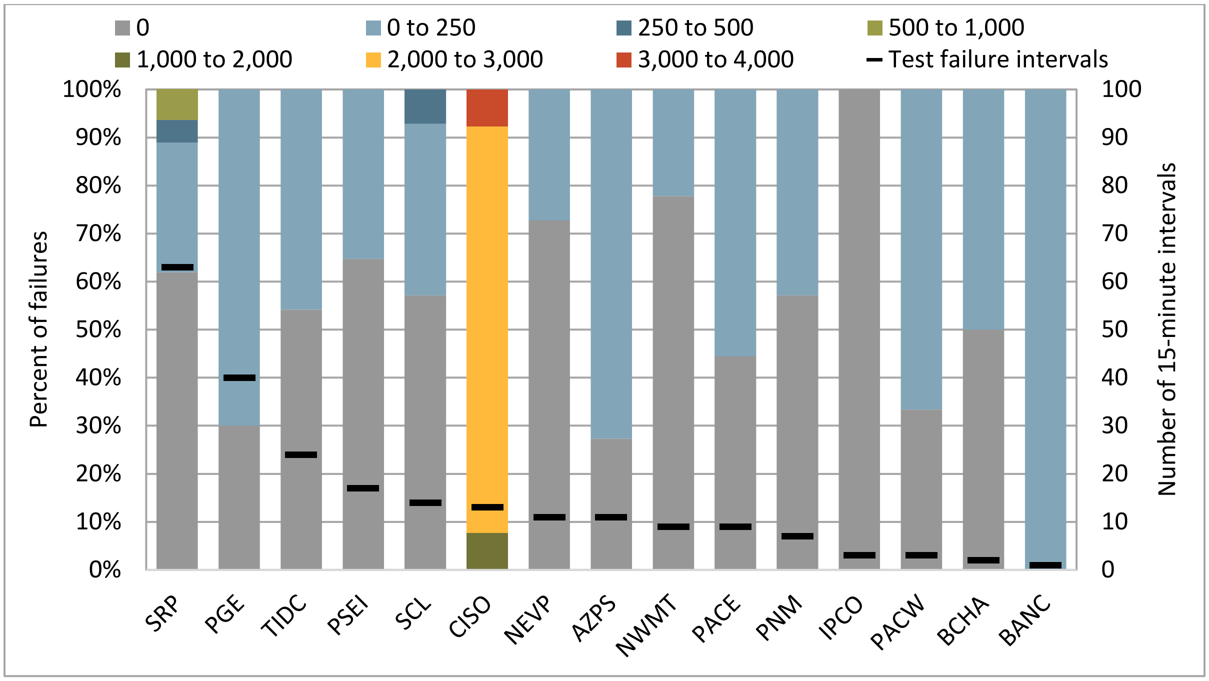


Figure 15. Upward capacity/sufficiency test failure intervals by incremental import limit (October 2021)

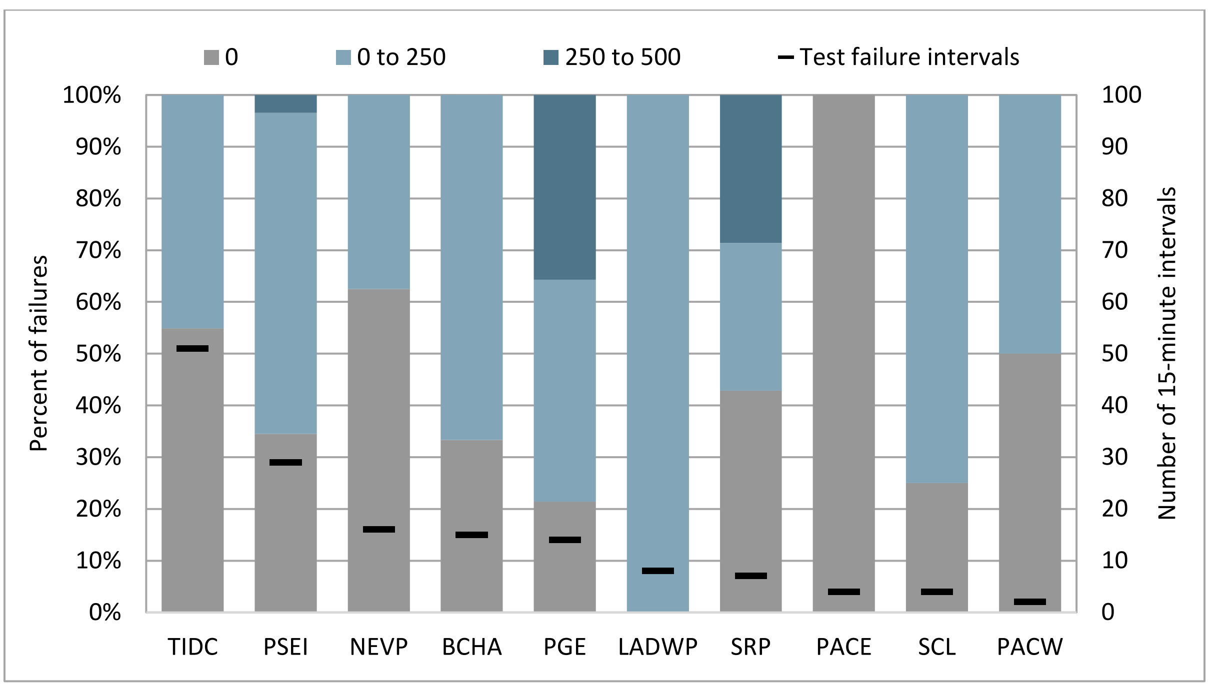
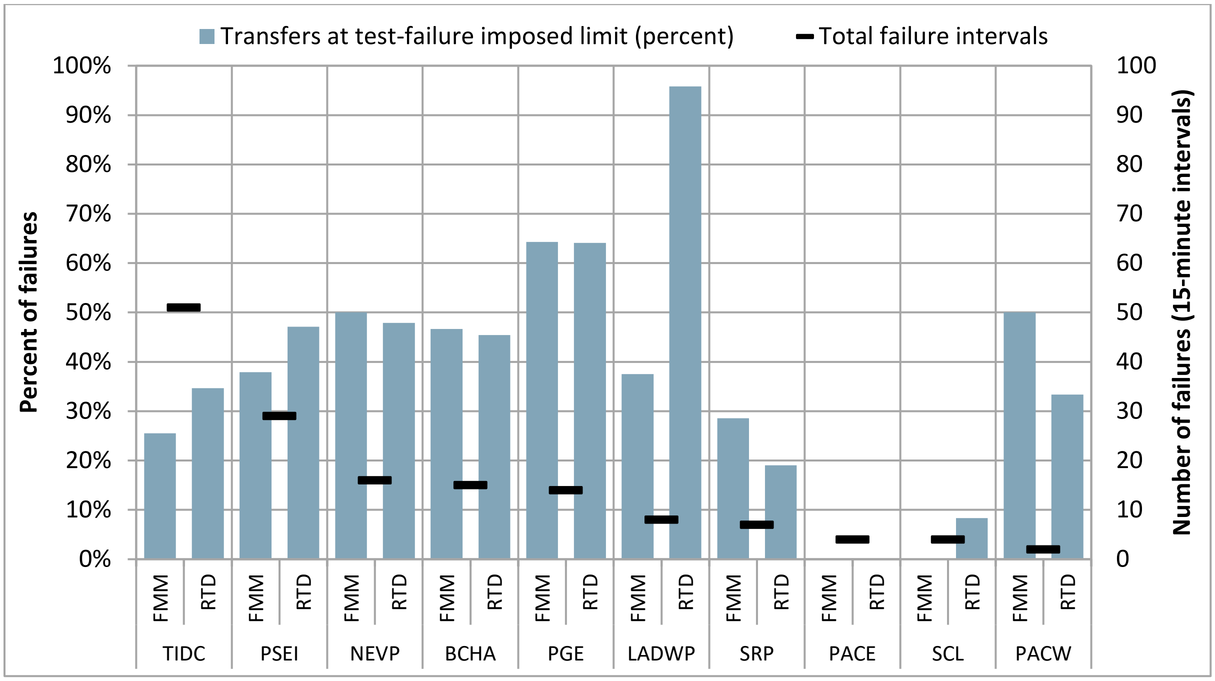


Figure 16. Percent of upward test failure intervals with market transfers at the imposed cap (October 2021)



Imbalance conformance in the energy imbalance market

Operators in every area of the 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 flexible ramping sufficiency tests. However, they can impact test results indirectly in at least several ways.

- The flexible ramping 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.[11] 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 ISO 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 sufficiency test is that energy imbalance market 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

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

can increase transfers into the balancing area resulting in higher transfer limits following a failure than would have occurred otherwise.

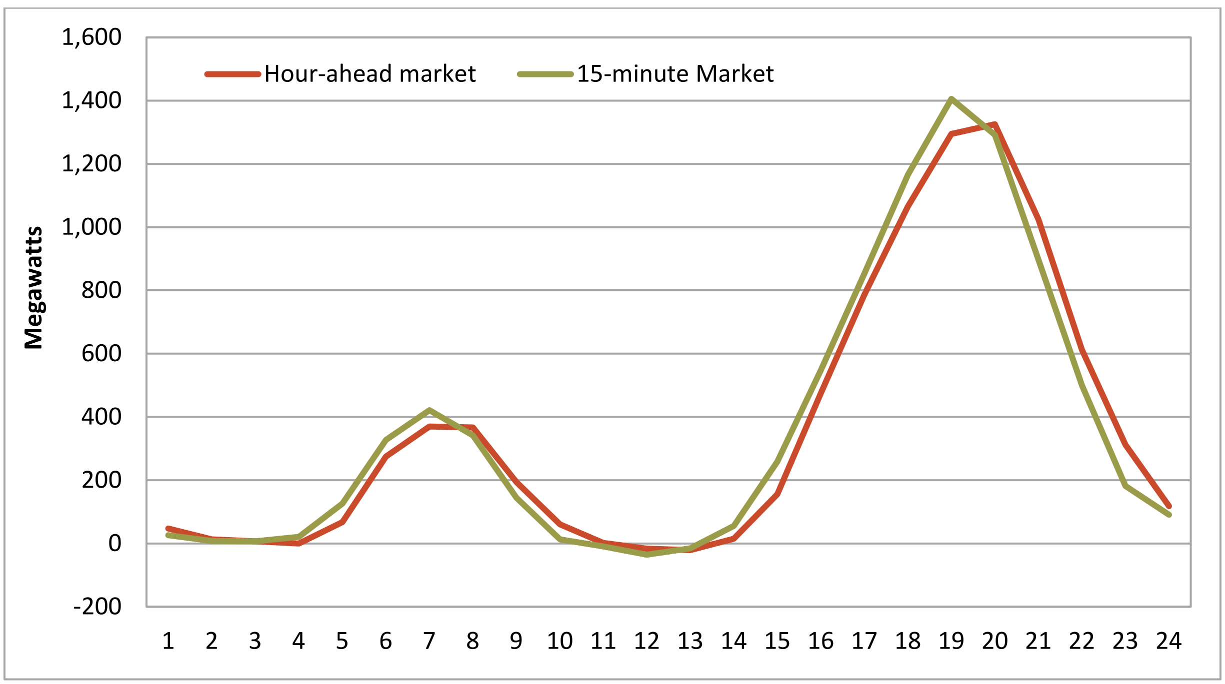
In the resource sufficiency evaluation enhancements initiative, the ISO does not propose to incorporate load conformance into the tests but plans to revisit this in a second phase.[12]

Figure 17 summarizes average hour-ahead and 15-minute market imbalance conformance adjustments entered by operators in the ISO during the month. Figure 18 shows the hourly distribution of 15-minute market imbalance conformance.

Figure 19 shows the same information for each of the EIM entities with substantial imbalance conformance and Figure 20 shows adjustments as a percent of total load.[13]

Table 1 summarizes the average frequency and size of 15-minute and 5-minute market imbalance conformance for all balancing authority areas.

Figure 17. Average ISO hour-ahead and 15-minute market imbalance conformance (October 2021)



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

13 EIM 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 18. Distribution of ISO 15-minute market imbalance conformance (October 2021)

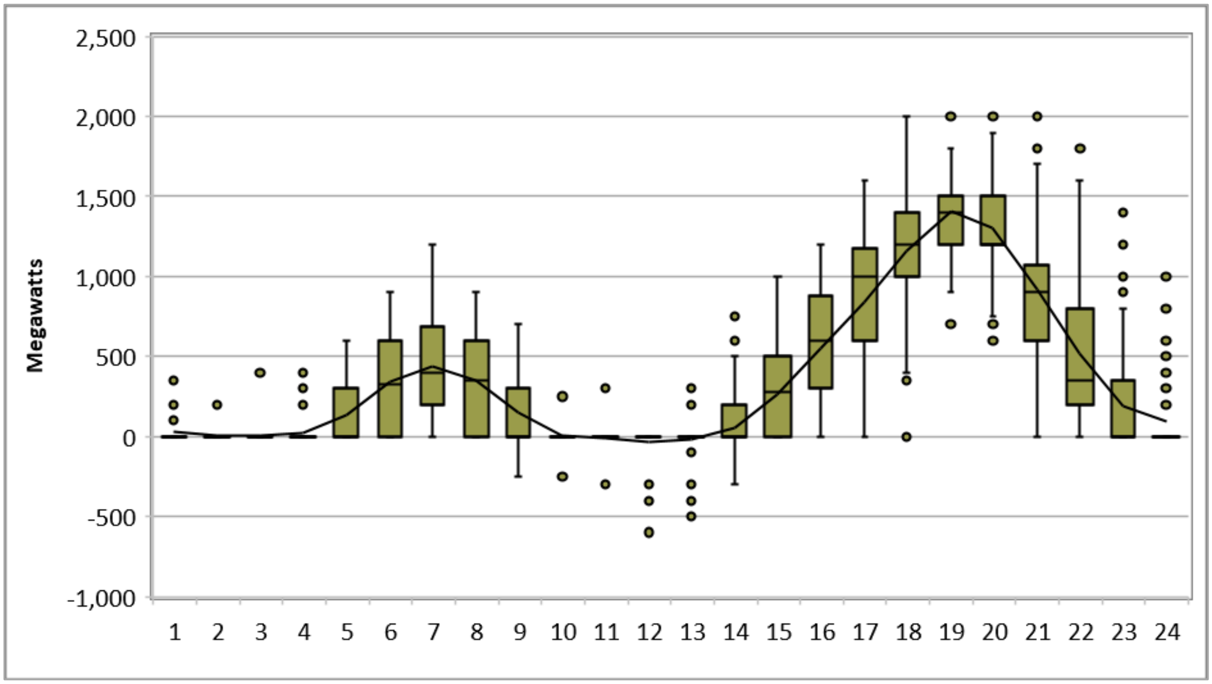


Figure 19. Average hourly non-ISO 15-minute market imbalance conformance (October 2021)

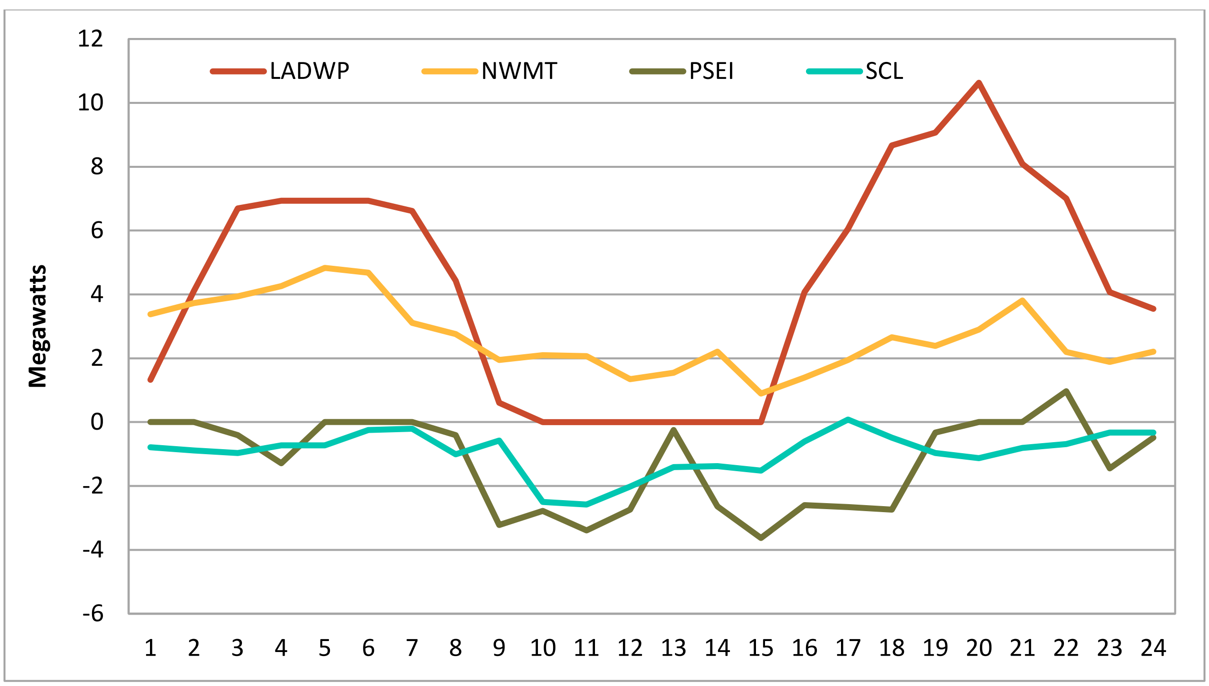


Figure 20. Average hourly 15-minute market imbalance conformance *as a percent of load* (October 2021)

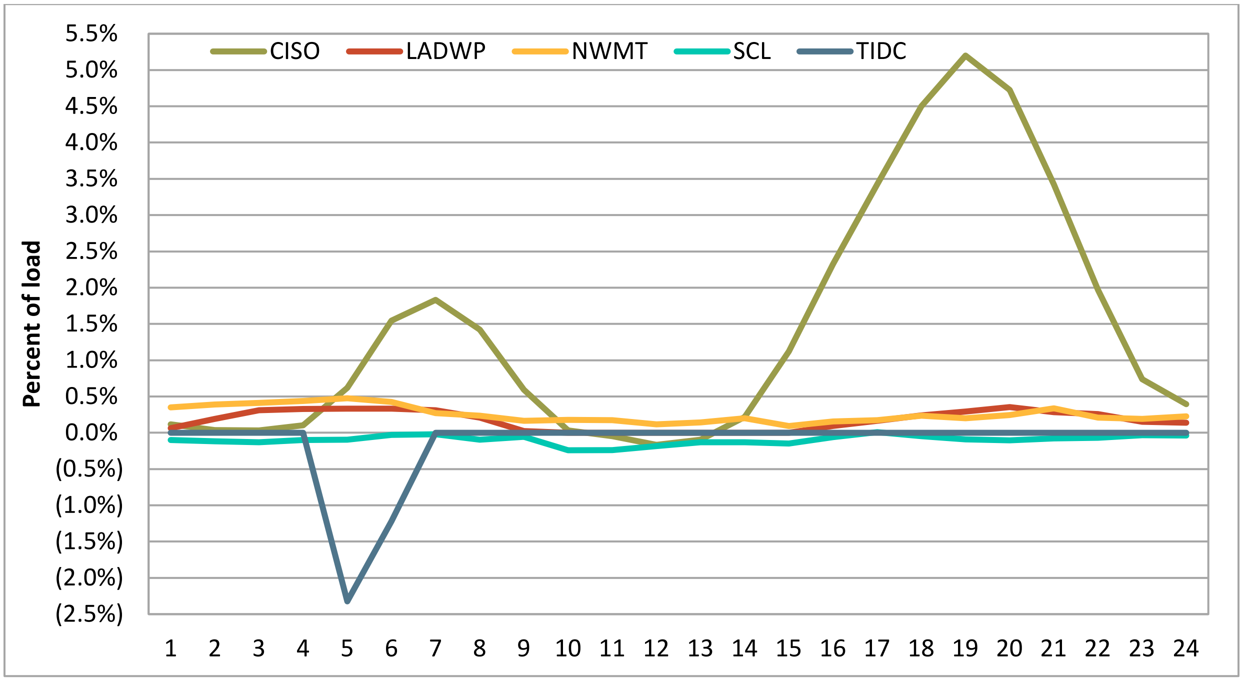


Table 1. Average frequency and size of imbalance conformance (October 2021)

	Positive imbalance conformance			Negative imbalance conformance			Average hourly adjustment MW
	Percent of intervals	Average MW	Percent of total load	Percent of intervals	Average MW	Percent of total load	
Arizona Public Service							
15-minute market	0.1%	38	1.4%	1%	-101	3.3%	-1
5-minute market	19%	116	3.8%	41%	-69	2.3%	-5
BANC							
15-minute market	0.3%	43	2.0%	0.1%	-30	1.8%	0
5-minute market	1%	37	2.0%	0.4%	-40	2.3%	0
California ISO							
15-minute market	46%	789	3.2%	2%	-261	1.3%	360
5-minute market	29%	246	1.0%	38%	-250	1.1%	-24
Idaho Power							
15-minute market	0.5%	50	2.8%	0%	N/A	N/A	0
5-minute market	15%	49	3.0%	3%	-41	2.8%	6
Los Angeles Dept. of Water and Power							
15-minute market	6%	74	2.8%	0.0%	-150	6.8%	4
5-minute market	23%	61	2.3%	5%	-40	1.6%	12
NorthWestern Energy							
15-minute market	17%	17	1.5%	1%	-20	1.6%	3
5-minute market	36%	17	1.6%	5%	-42	3.4%	4
NV Energy							
15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
5-minute market	8%	134	3.3%	8%	-125	3.4%	1
PacifiCorp East							
15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
5-minute market	12%	97	1.9%	35%	-105	2.2%	-25
PacifiCorp West							
15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
5-minute market	4%	60	2.7%	24%	-53	2.4%	-10
Portland General Electric							
15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
5-minute market	15%	26	1.1%	2%	-36	1.5%	3
Public Service Company of New Mexico							
15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
5-minute market	1%	87	6.5%	2%	-82	6.4%	-1
Puget Sound Energy							
15-minute market	1%	34	1.2%	3%	-46	1.6%	-1
5-minute market	1%	37	1.3%	54%	-39	1.5%	-21
Salt River Project							
15-minute market	0.1%	65	2.2%	0%	N/A	N/A	0
5-minute market	4%	50	1.4%	4%	-66	2.3%	-1
Seattle City Light							
15-minute market	1%	19	1.8%	6%	-19	1.9%	-1
5-minute market	4%	19	1.9%	64%	-21	2.2%	-13
Turlock Irrigation District							
15-minute market	0%	N/A	N/A	0.2%	-164	62%	0
5-minute market	0%	N/A	N/A	0.2%	-164	65%	0

4 Metrics for key time periods

This section is reserved for in these monthly report highlighting results and outcomes during specific periods of interest. However, during October the ISO did not fail any flexible ramping sufficiency or bid-range capacity test and there were no energy emergency alerts (EEA). DMM is seeking input on thresholds to produce other period specific and area specific metrics. This could include metrics on energy imbalance market transfers during test failures as well as metrics summarizing test components.

5 Unloaded capacity and EIM imports

This section includes a special discussion on the comparison between unloaded capacity within the ISO balancing are and net EIM imports. DMM has been reviewing cases in which optimized net EIM imports significantly exceeded the unloaded capacity within the ISO balancing area, but the ISO area still passed the bid-range capacity test. Detailed examination of these cases highlights differences in specific market conditions and inputs that drive these outcomes. DMM recommends that the ISO and stakeholders review some of the differences highlighted in this section to potentially improve the accuracy of the test.

Figure 21 shows this comparison during the peak load hours on July 9, 2021, a period in which the California ISO hit a Stage 2 Energy Emergency. The blue line shows the actual incremental unloaded capacity used in the bid-range capacity test to meet imbalance requirements. 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.

The green bars show advisory net EIM imports in the 15-minute market. These reflect the latest market results available at the time of the resource sufficiency evaluation for the upcoming hour.[14] These values can be interpreted as the imports balancing supply and demand in the advisory interval. [15] Figure 21 compares these advisory net EIM imports to the imbalance requirement used in the bid-range capacity test excluding the uncertainty components (yellow bars).

The energy imbalance (without EIM transfers) used in the bid-range capacity test can differ from the net EIM transfers from the last market run. The list below summarizes some of the differences between these two sets of market inputs that have been identified.

- **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 the large majority of the differences. Figure 22 illustrates this by comparing the net EIM imports with 15-minute market imbalance conformance adjustments entered by ISO operators for the same hours on July 9.

- **Non-participating pump load.** This is pumping load, which 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.

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

15 If there is a power balance shortage, this insufficiency would also need to be covered to meet load.

- **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 impact 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. There can therefore 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 EIM imports shown in the figure) and the binding resource sufficiency evaluation, which can impact some of the generation and load inputs.
- **Uncertainty.** The bid-range capacity test includes two components to account for intertie and net load uncertainty. The difference between the red and yellow bars in Figure 21 reflects this.

These differences mean that net EIM imports exceeded unloaded capacity without a test failure. Inspecting the components can also help flag potential accuracy issues. DMM plans to quantify and summarize these differences more thoroughly in a future report. DMM recommends that the ISO and stakeholders review some of these differences to potentially improve the accuracy of the test.

Figure 21. Unloaded capacity, net EIM imports, and imbalance requirement (July 9, 2021)

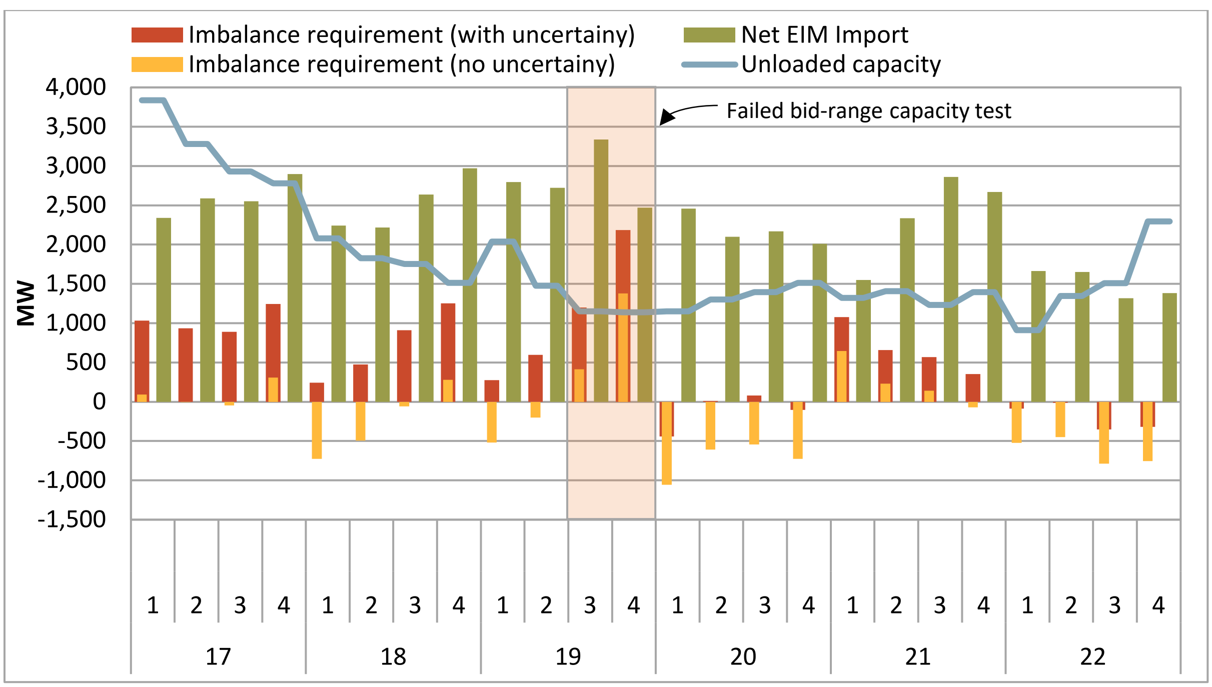
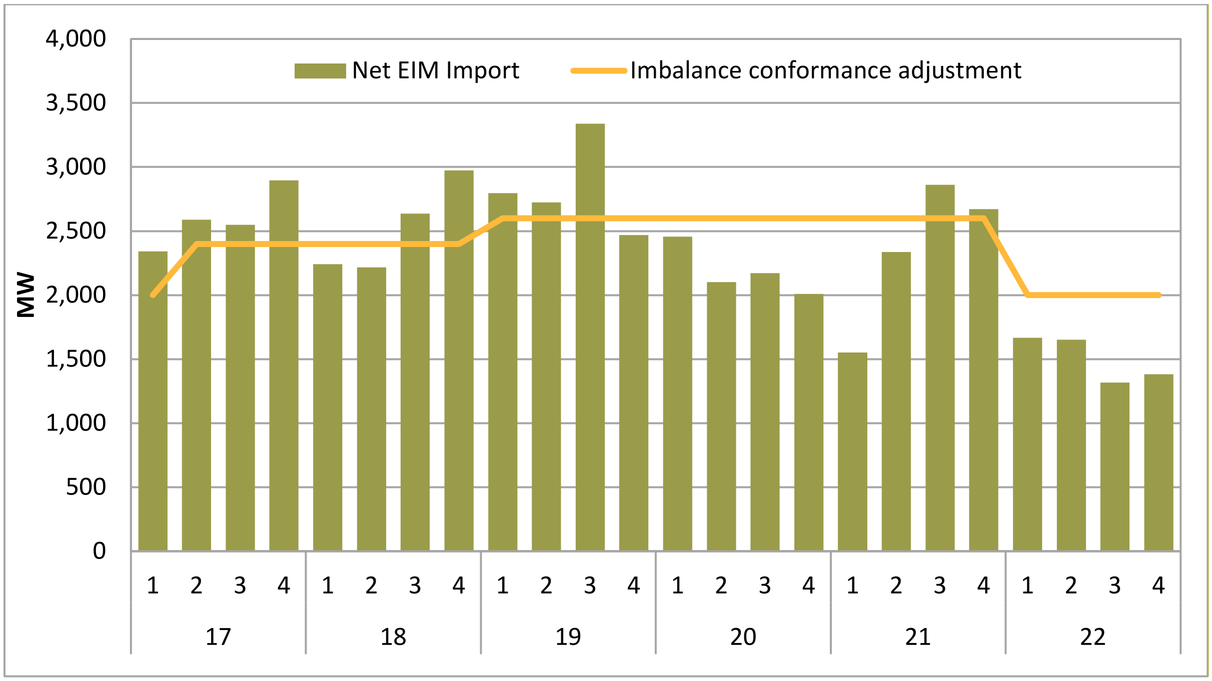


Figure 22. Net EIM imports and imbalance conformance adjustments (July 9, 2021)



6 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 ramping sufficiency test and 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 ramping sufficiency test and 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.[16] 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 ISO and stakeholders to consider whether the 95 percent confidence interval, or another, is most appropriate for the tests.[17]

Further, the resource sufficiency evaluation occurs in a different timeframe than the 15-minute minute market. Figure 23 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.[18]

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 flexible ramping product uncertainty calculation. In the later test intervals, the gap between the

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16 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 error are used as a separate observation in the distribution.

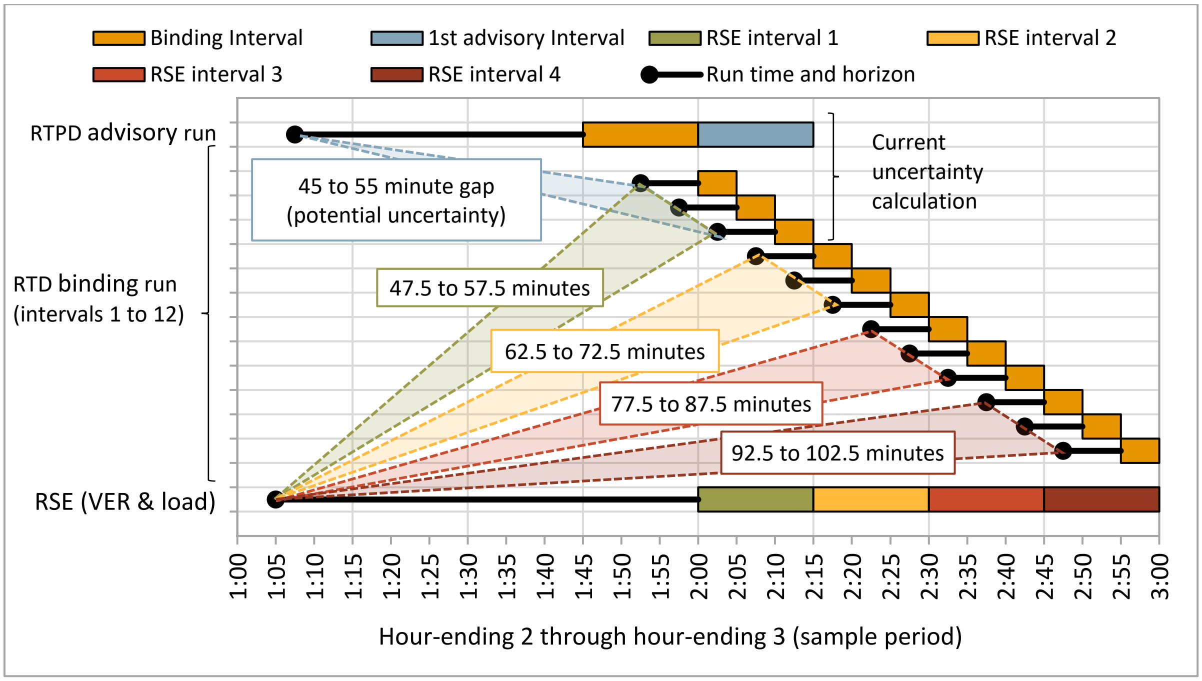
17 *Comments on EIM Resource Sufficiency Evaluation Enhancements Issue Paper*, September 8, 2021. http://www.caiso.com/Documents/DMM-Comments-on-EIM-Resource-Sufficiency-Evaluation-Enhancements-Issue-Paper-Sep-8-2021.pdf

18 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.

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 23. 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 24 summarizes the current source of net load error from either load, wind or solar error during October for the ISO. The figure shows the average weekday uncertainty during the month (from the 97.5th percentile of net load error observations for upward uncertainty and 2.5th 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 2.5th percentile and 97.5th percentile of net load errors, from the same hour of the last 40 weekday. 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 25 summarizes the difference between net load forecasts used in the bid range capacity test and those used in the 5-minute market for the ISO during October. 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 26 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 27 through Figure 71 provides the same information for all EIM entities.

Figure 24. California ISO average uncertainty by component (Weekdays, October 2021)

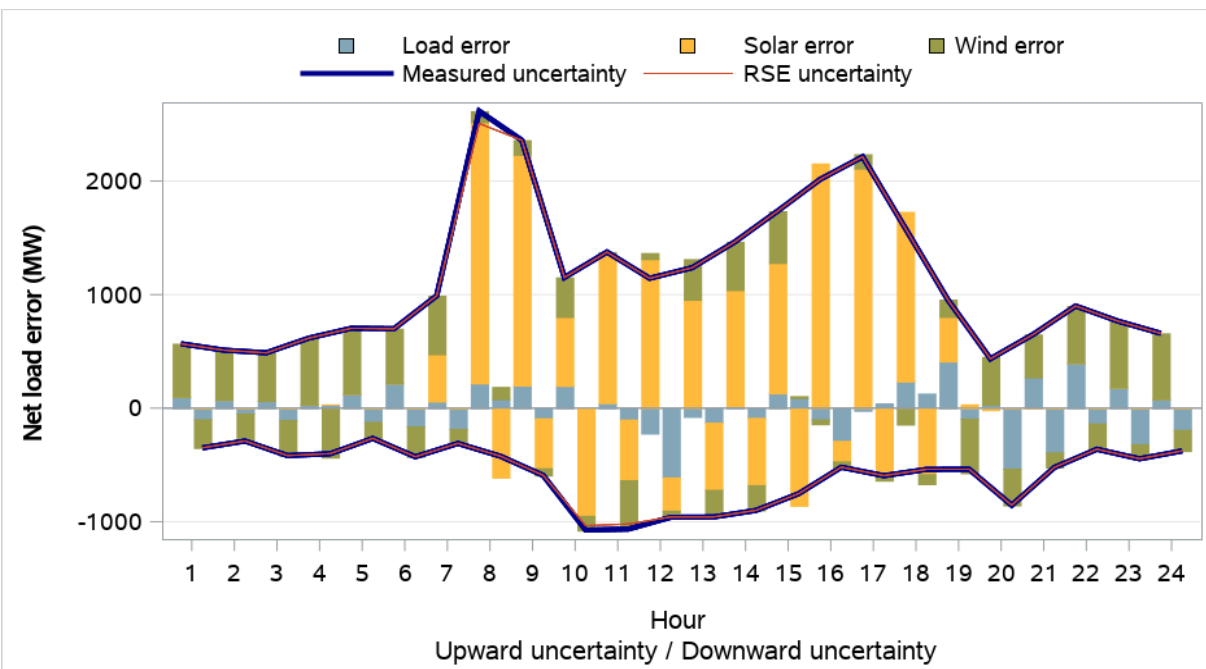


Figure 25. California ISO distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, October 2021)

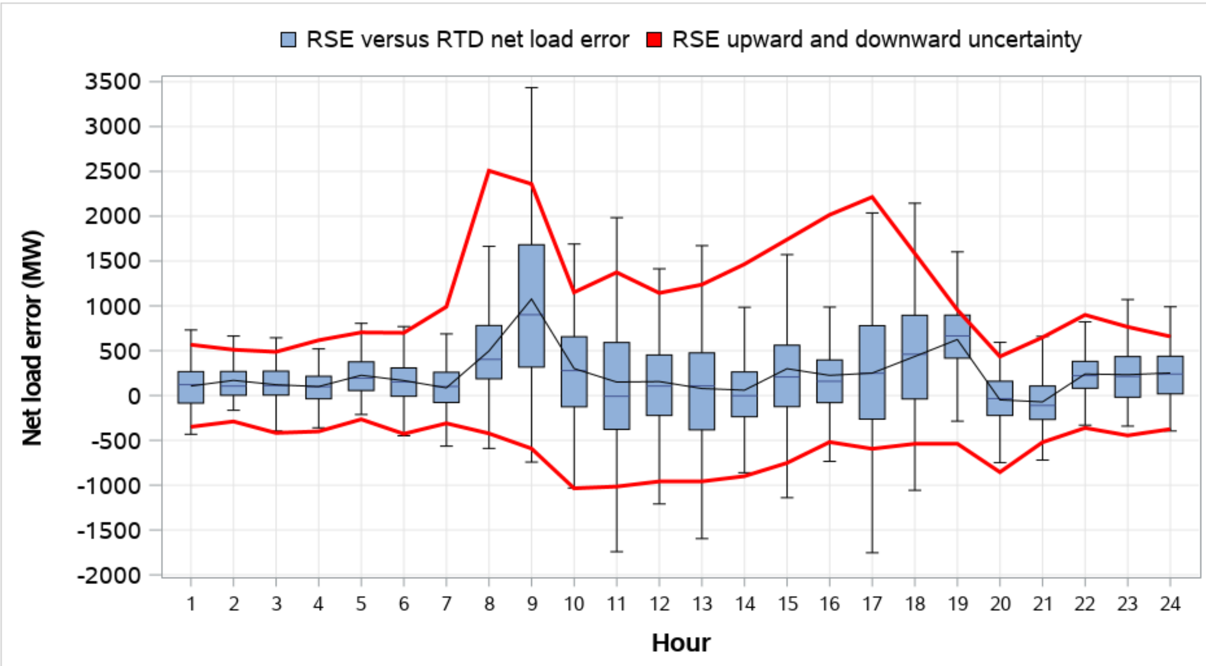


Figure 26. California ISO distribution of RSE and RTD load and VER error (Weekdays, October 2021)

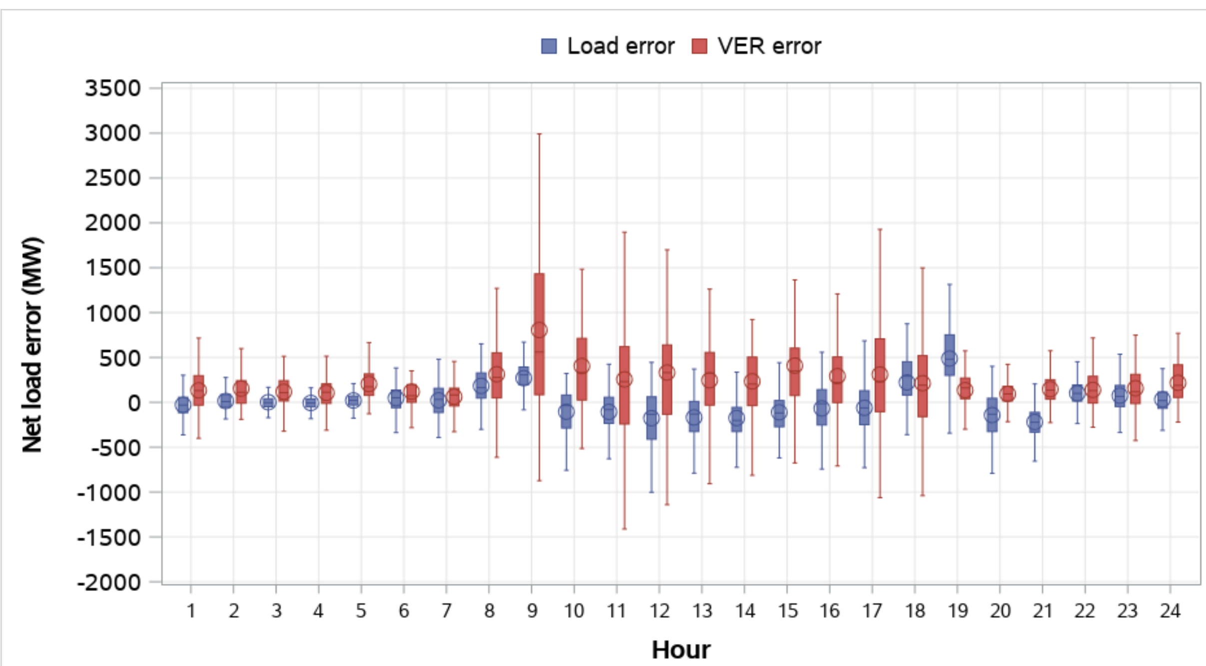


Figure 27. Arizona Public Service average uncertainty by component (Weekdays, October 2021)

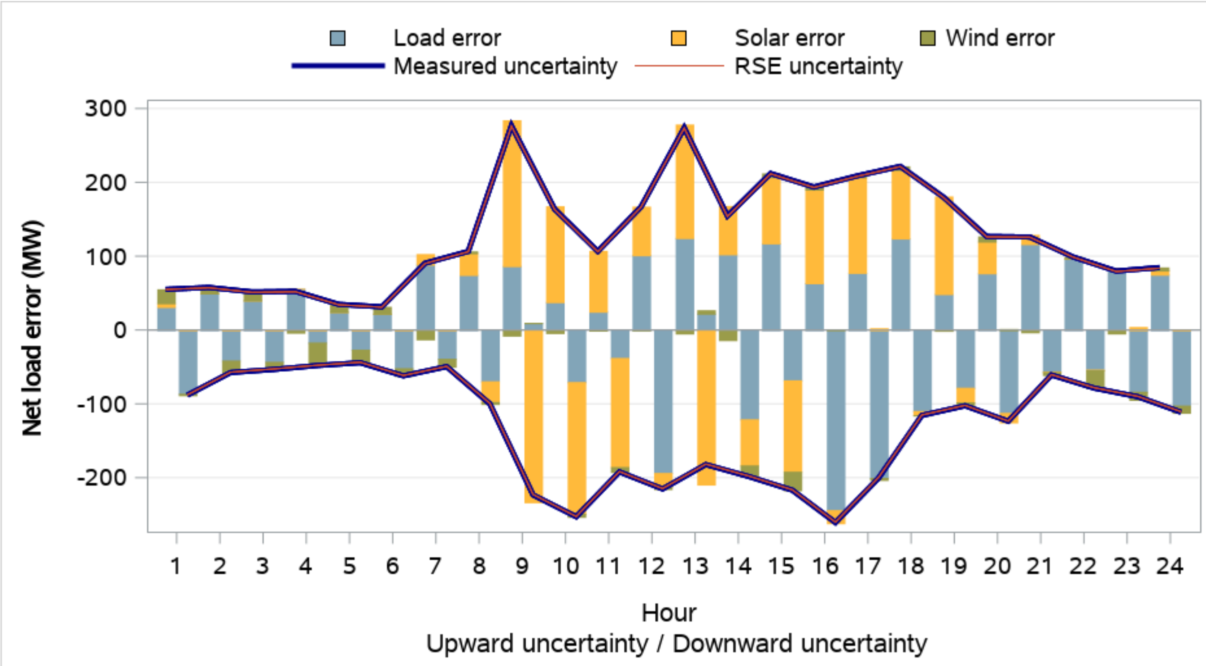


Figure 28. Arizona Public Service distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, October 2021)

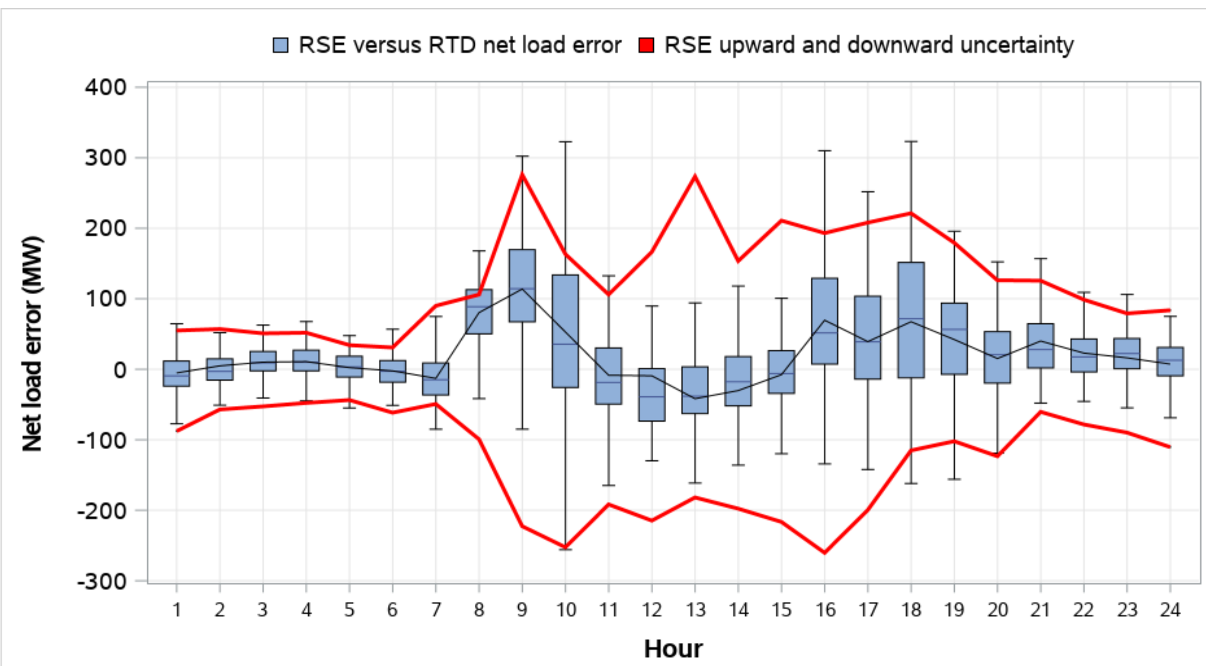


Figure 29. Arizona Public Service distribution of RSE and RTD load and VER error (Weekdays, October 2021)

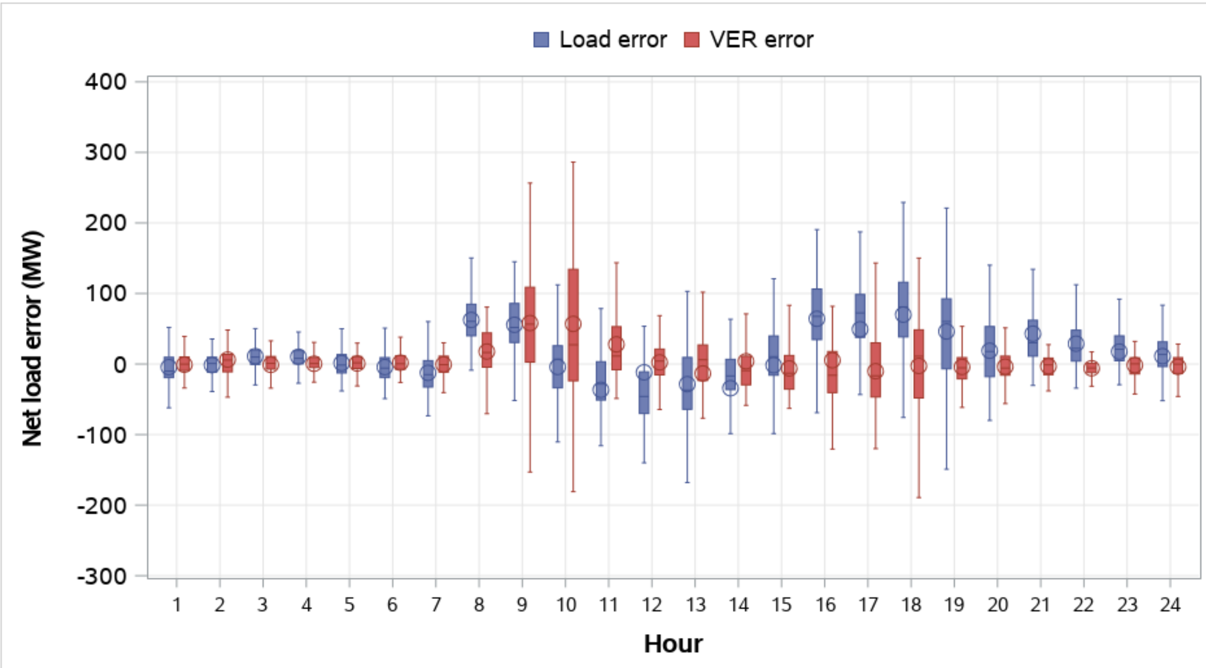


Figure 30. BANC average uncertainty by component (Weekdays, October 2021)

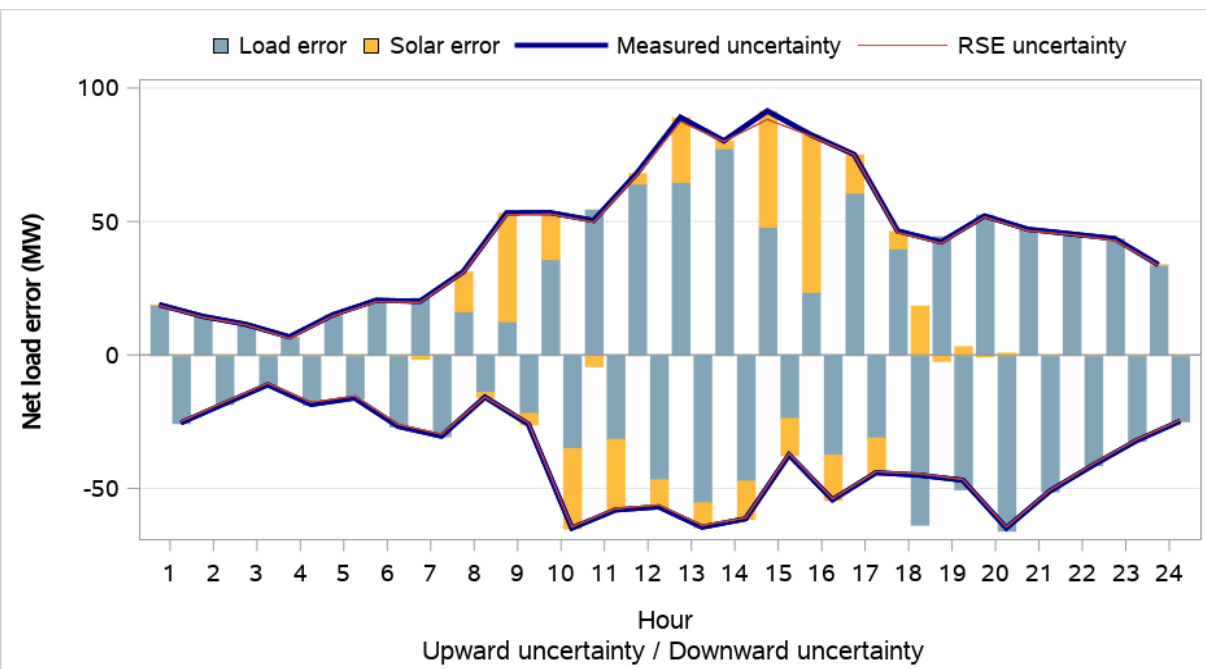


Figure 31. BANC distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, October 2021)

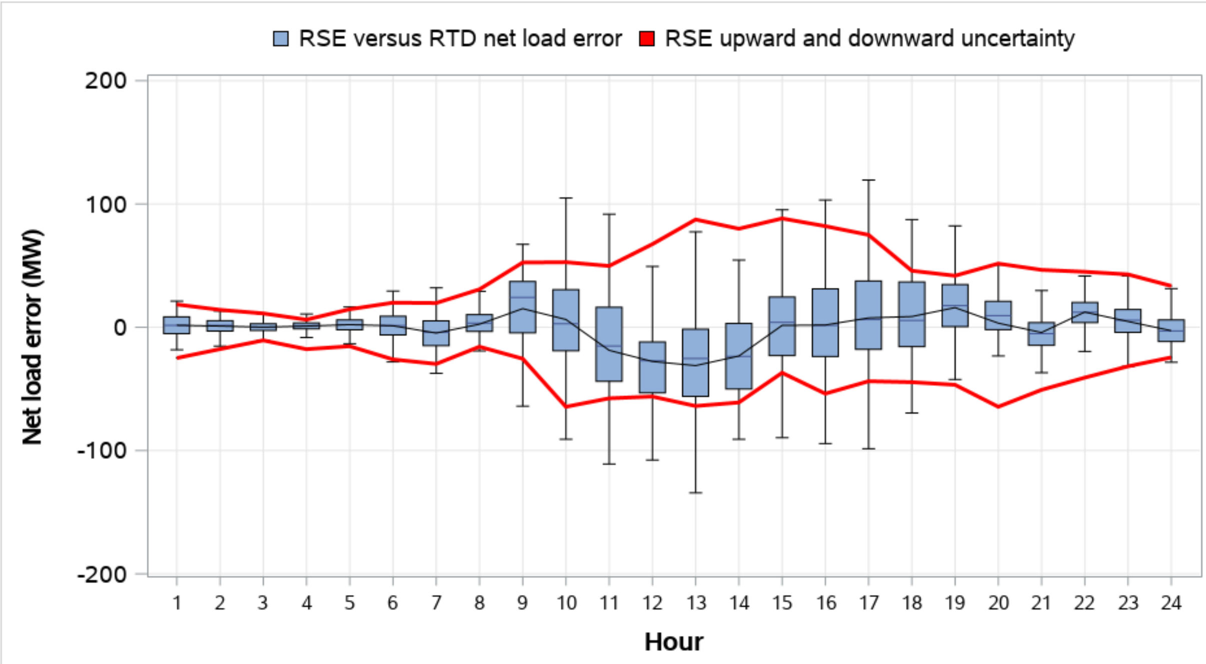


Figure 32. BANC distribution of RSE and RTD load and VER error (Weekdays, October 2021)

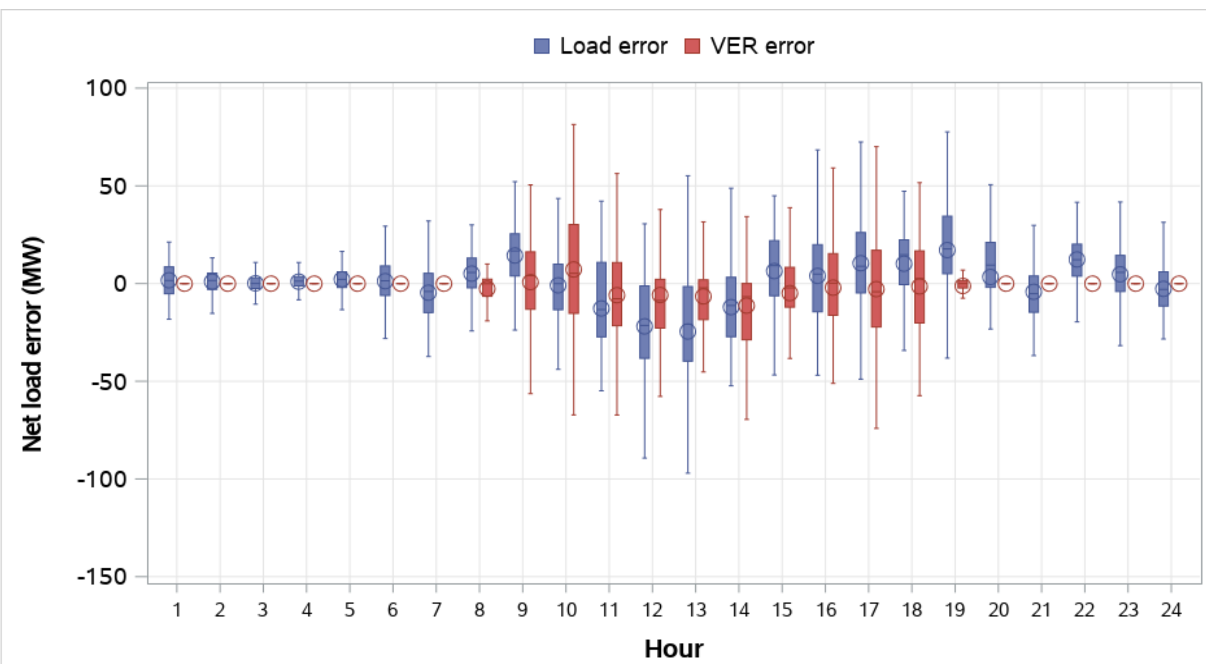


Figure 33. Idaho Power average uncertainty by component (Weekdays, October 2021)

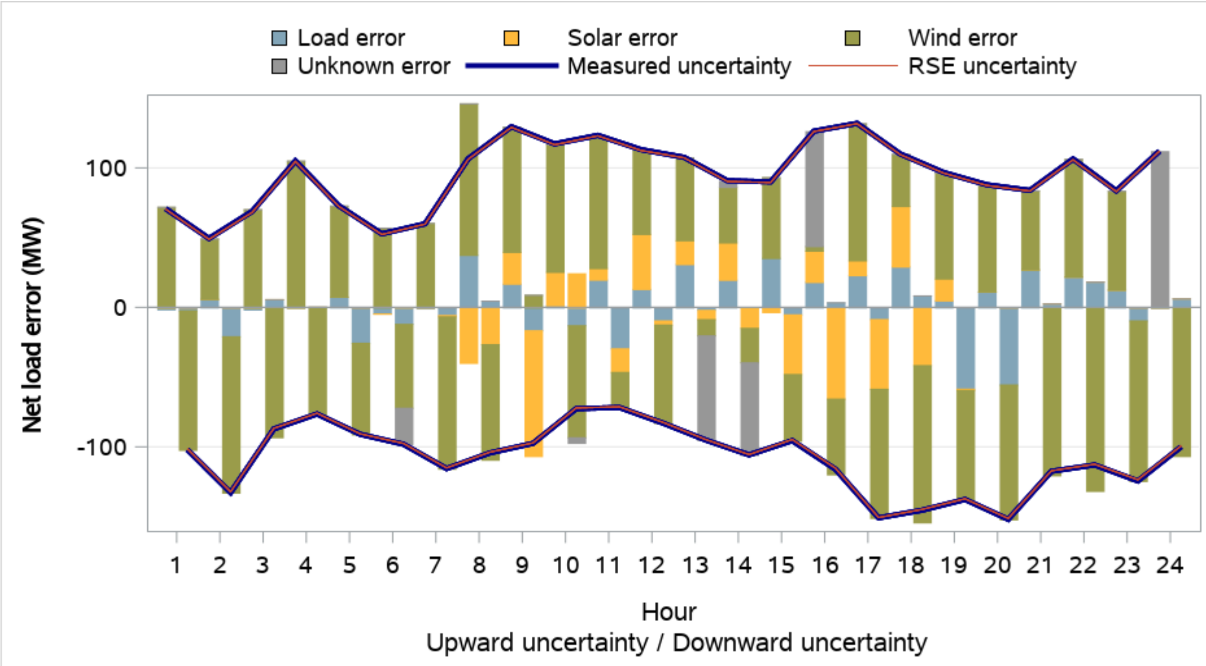


Figure 34. Idaho Power distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, October 2021)

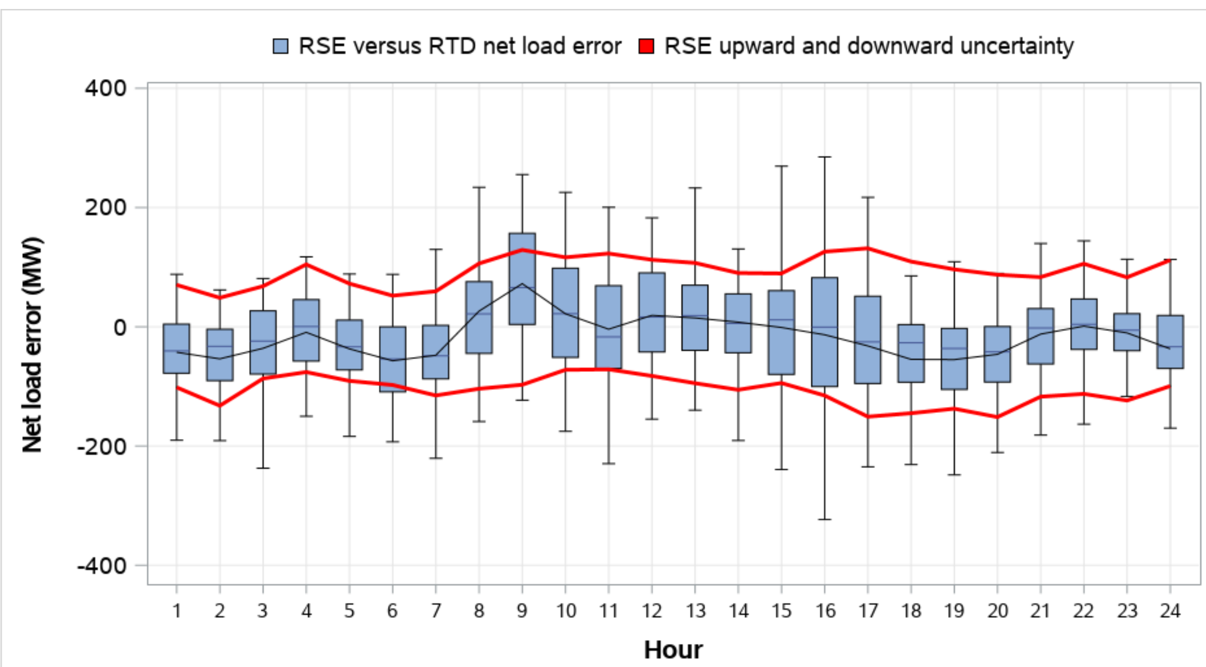


Figure 35. Idaho Power distribution of RSE and RTD load and VER error (Weekdays, October 2021)

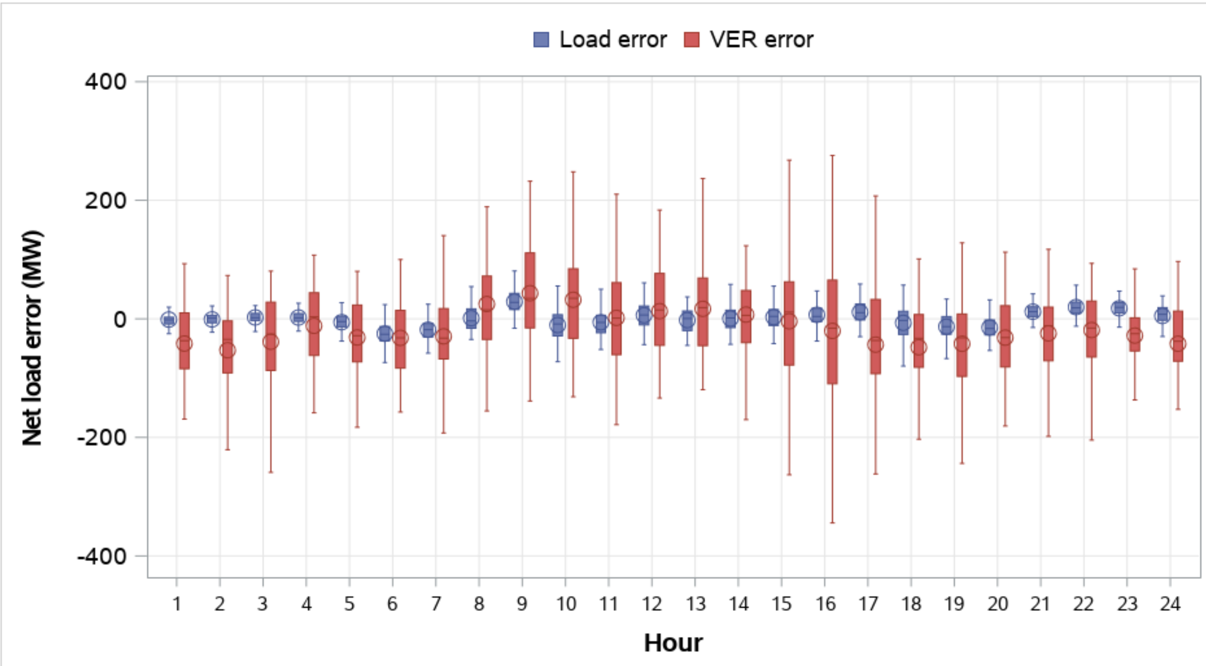


Figure 36. LADWP average uncertainty by component (Weekdays, October 2021)

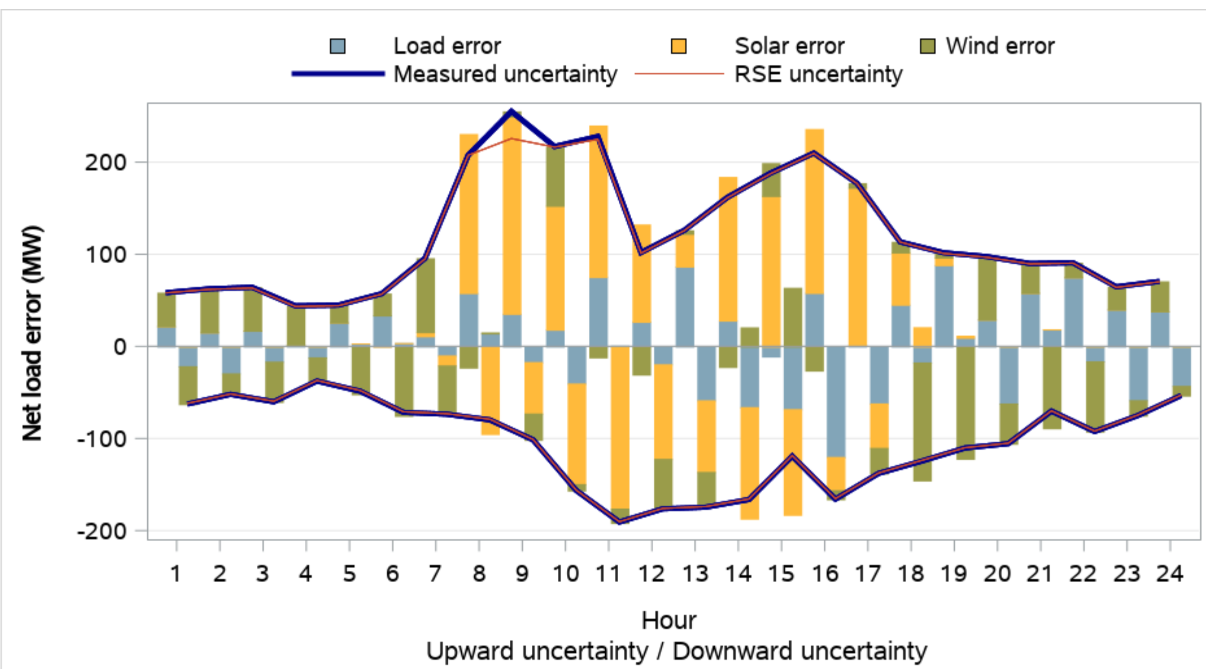


Figure 37. LADWP distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, October 2021)

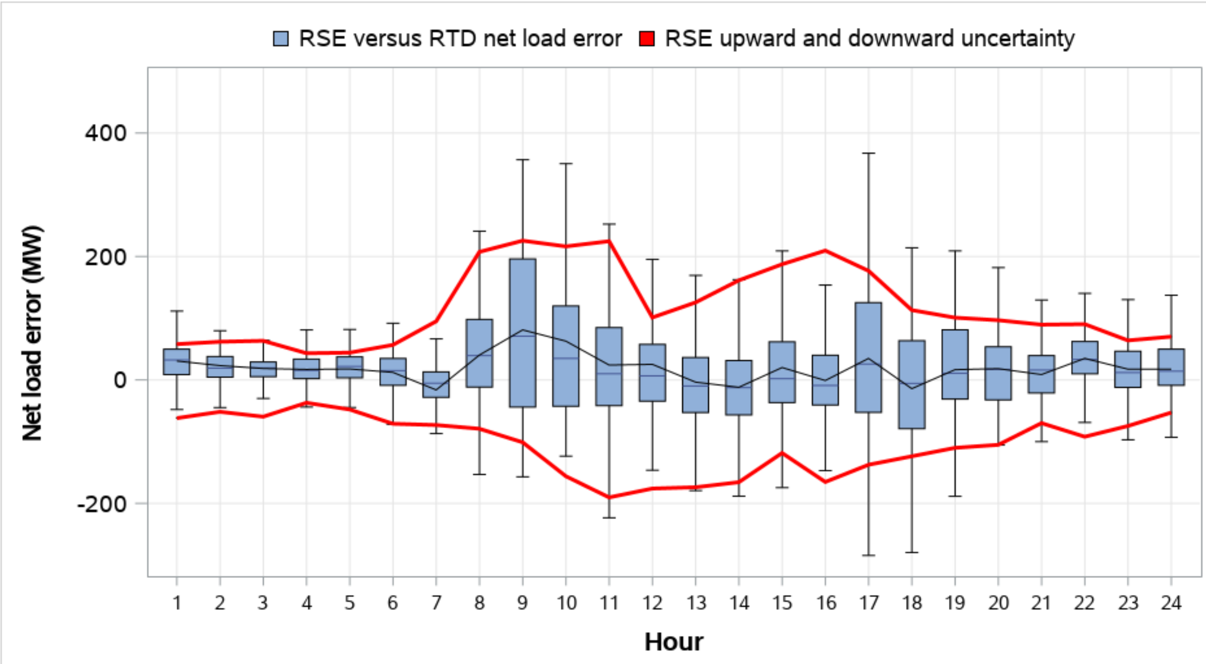


Figure 38. LADWP distribution of RSE and RTD load and VER error (Weekdays, October 2021)

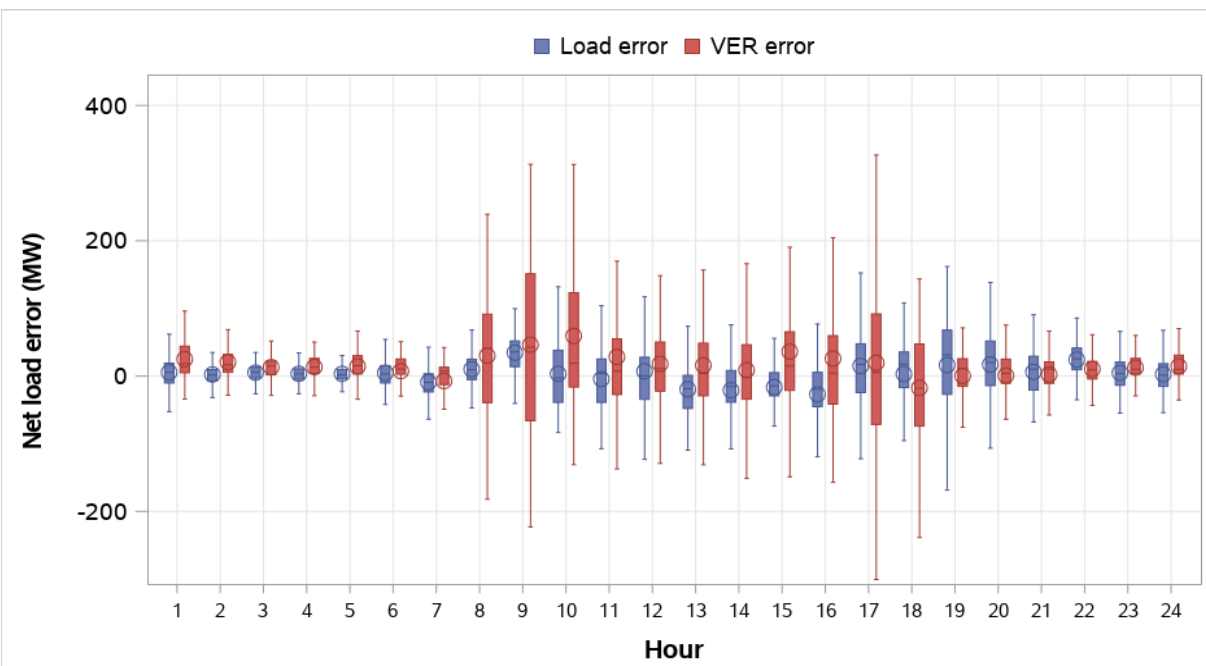


Figure 39. NorthWestern Energy average uncertainty by component (Weekdays, October 2021)

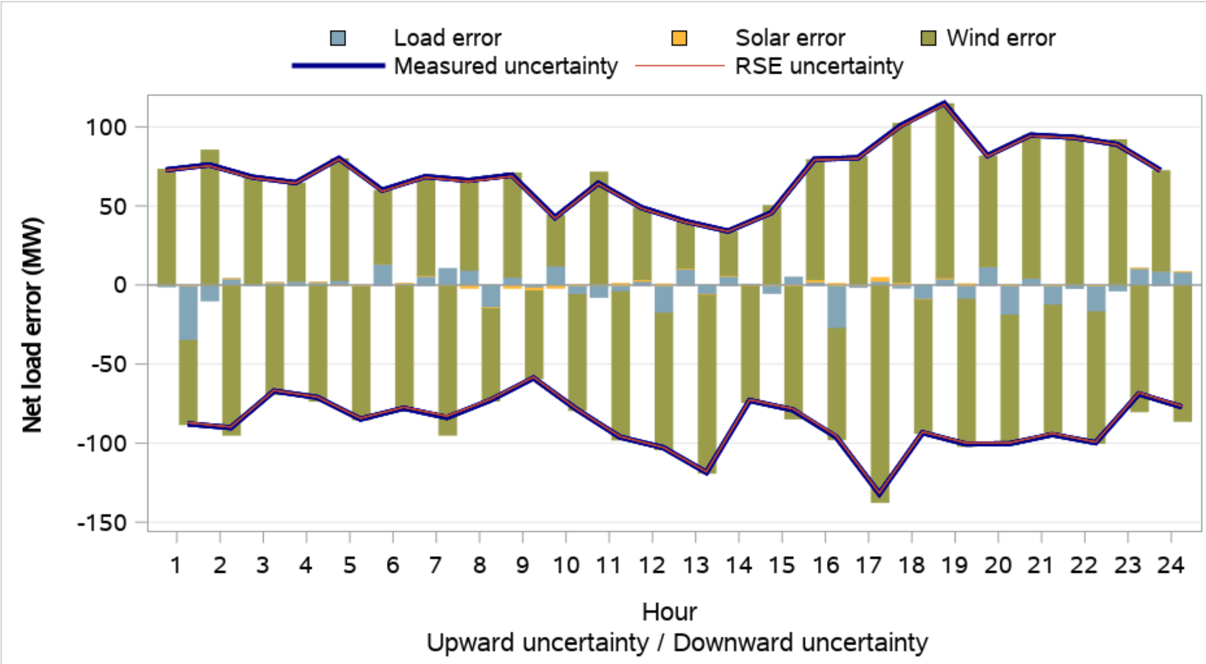


Figure 40. NorthWestern Energy distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, October 2021)

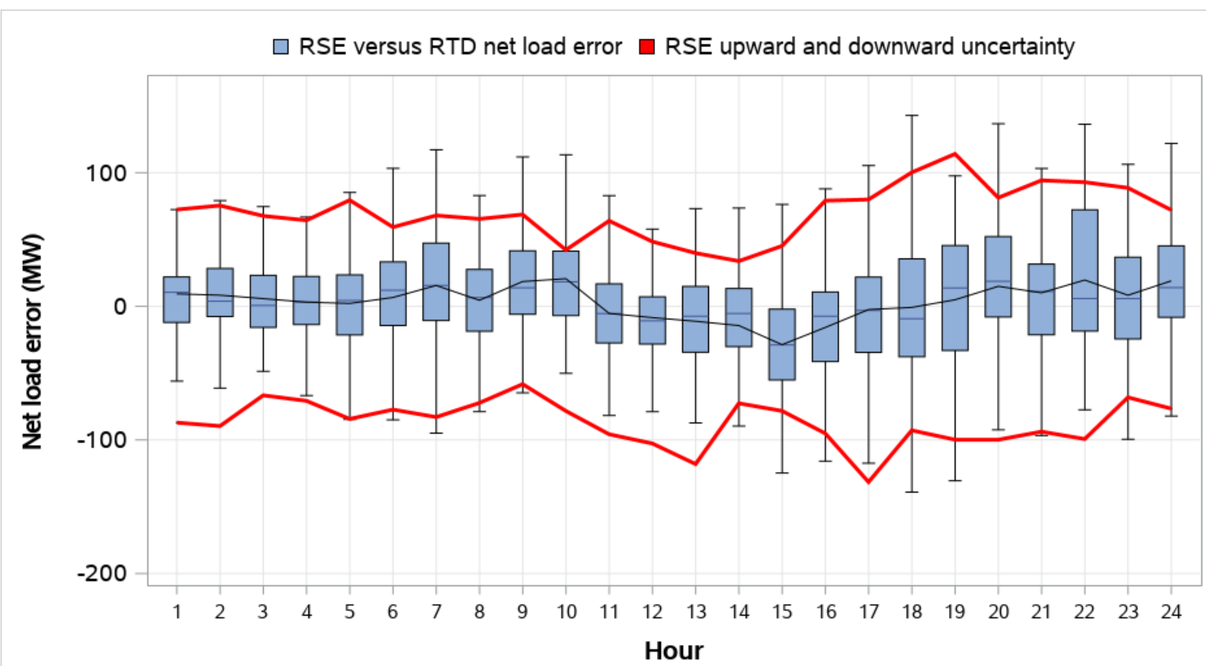


Figure 41. NorthWestern Energy distribution of RSE and RTD load and VER error (Weekdays, October 2021)

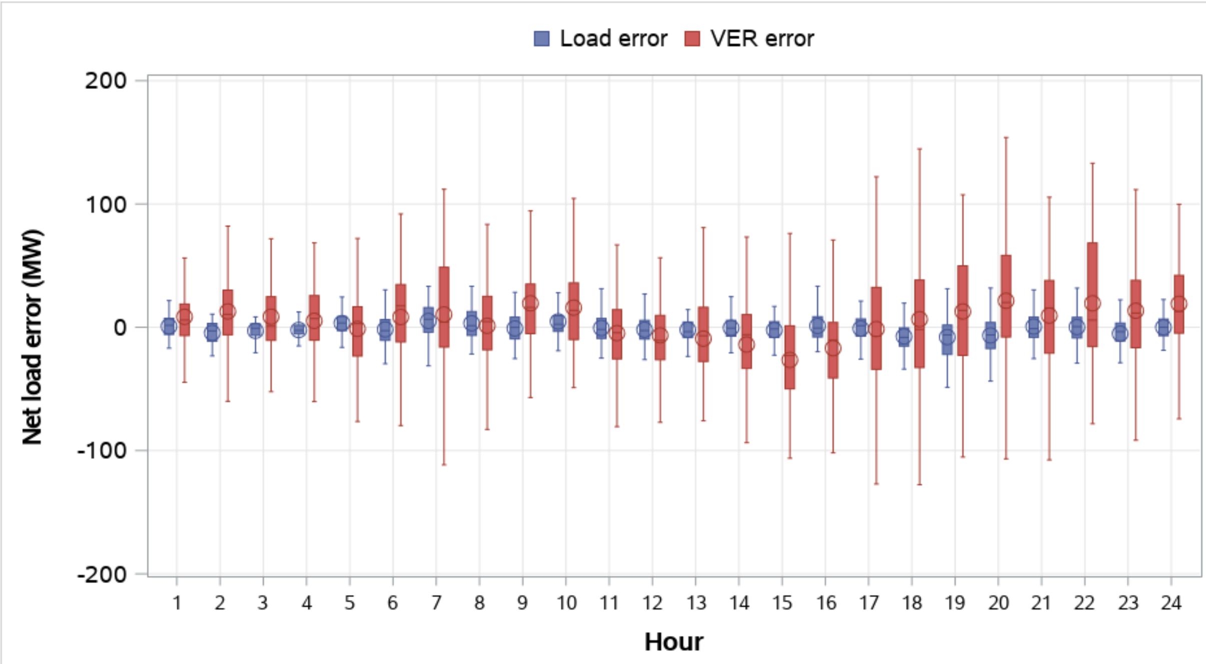


Figure 42. NV Energy average uncertainty by component (Weekdays, October 2021)

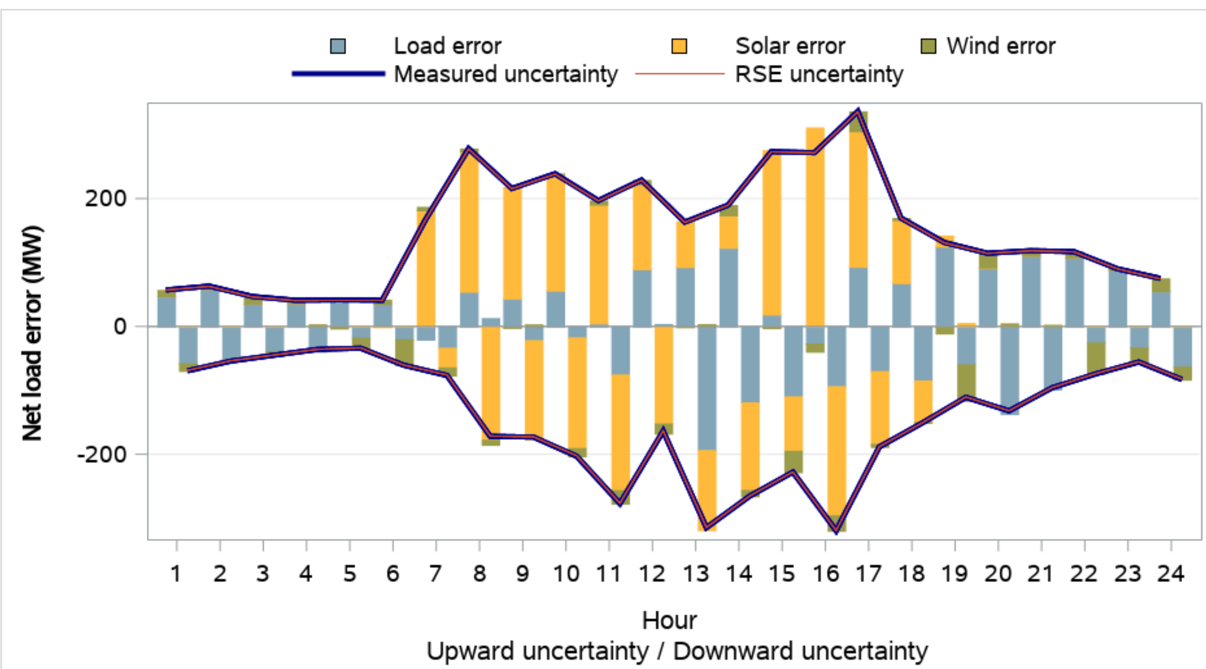


Figure 43. NV Energy distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, October 2021)

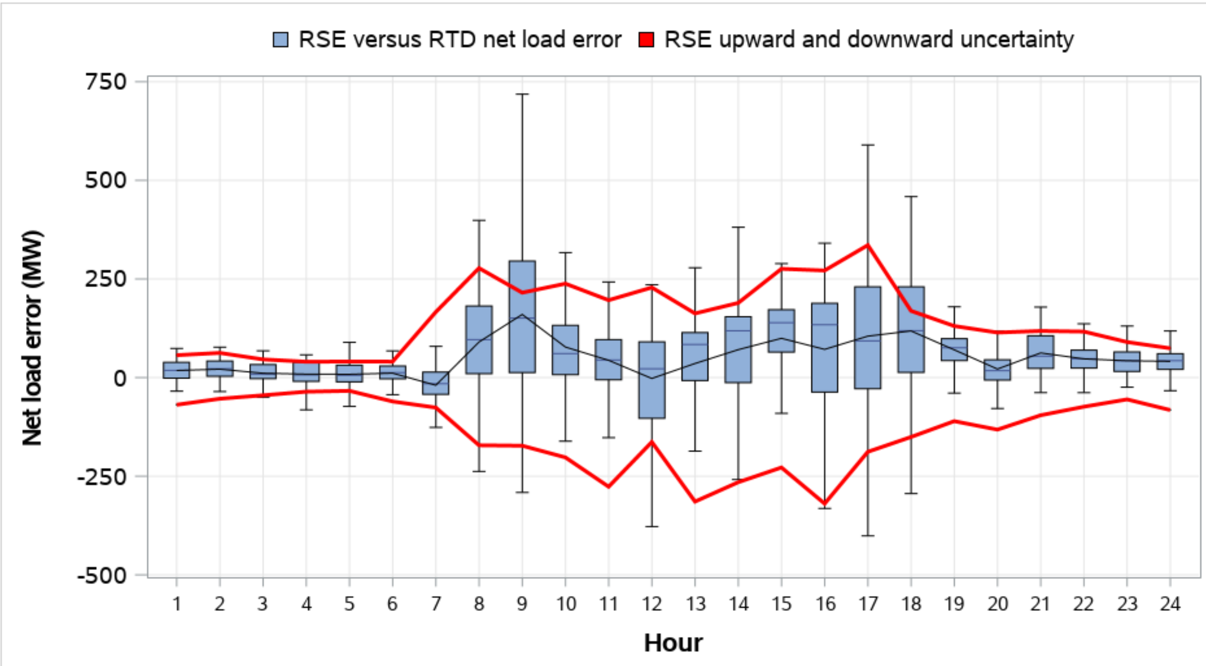


Figure 44. NV Energy distribution of RSE and RTD load and VER error (Weekdays, October 2021)

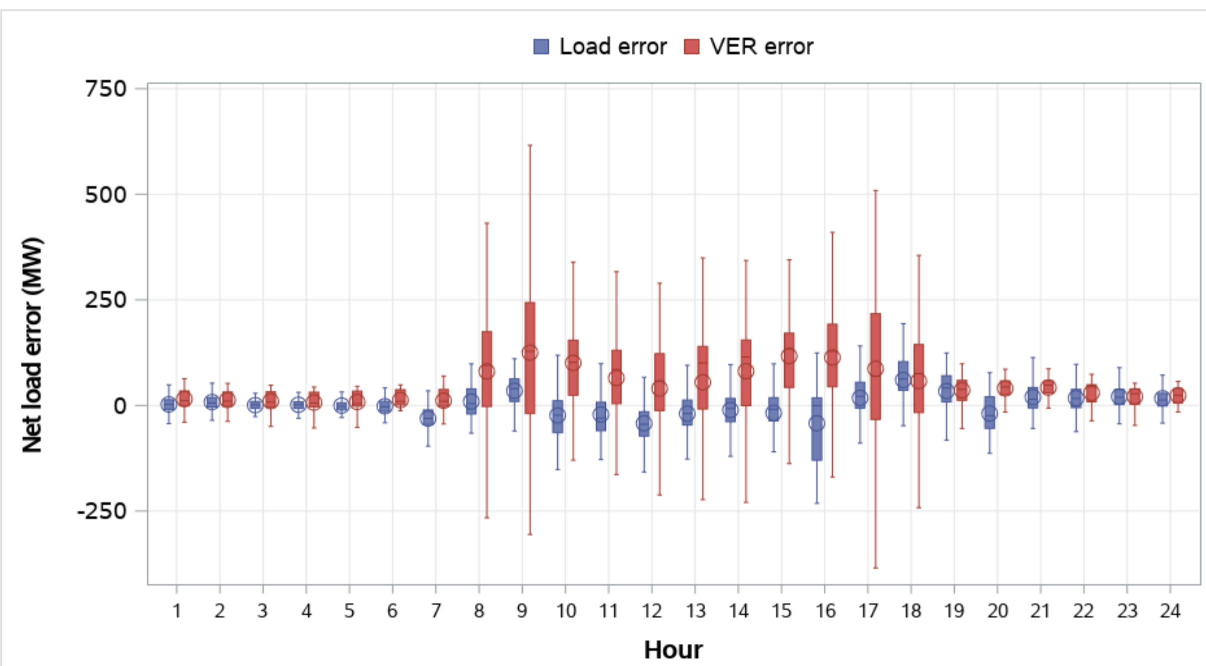


Figure 45. PacifiCorp East average uncertainty by component (Weekdays, October 2021)

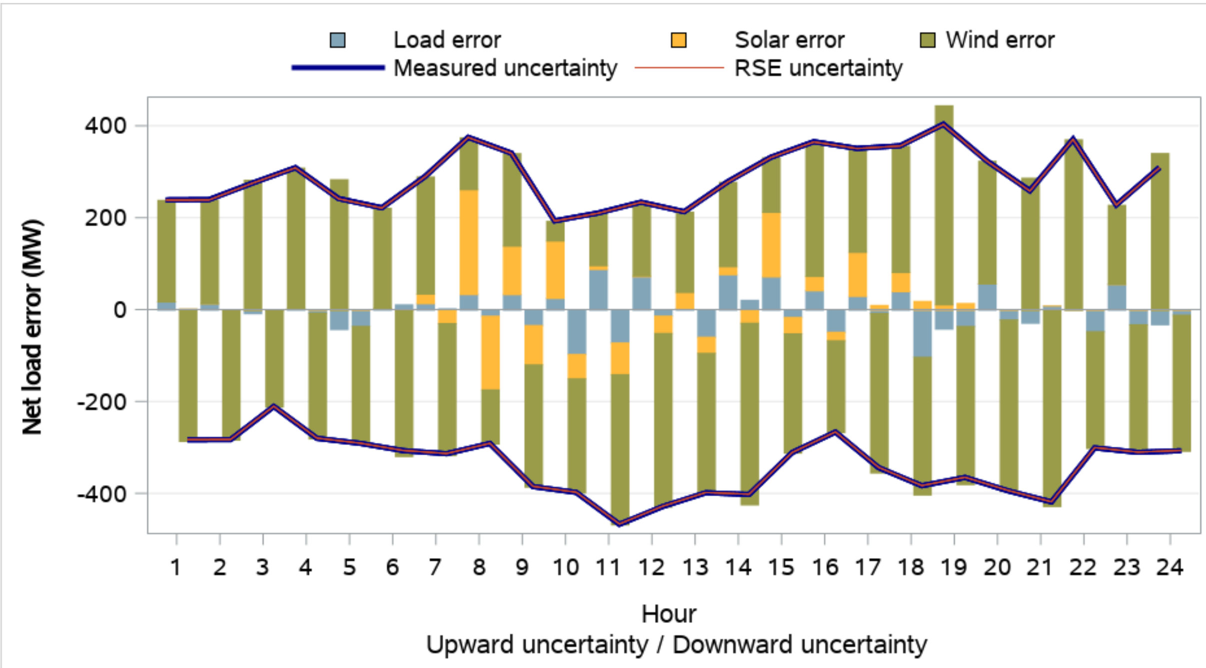


Figure 46. PacifiCorp East distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, October 2021)

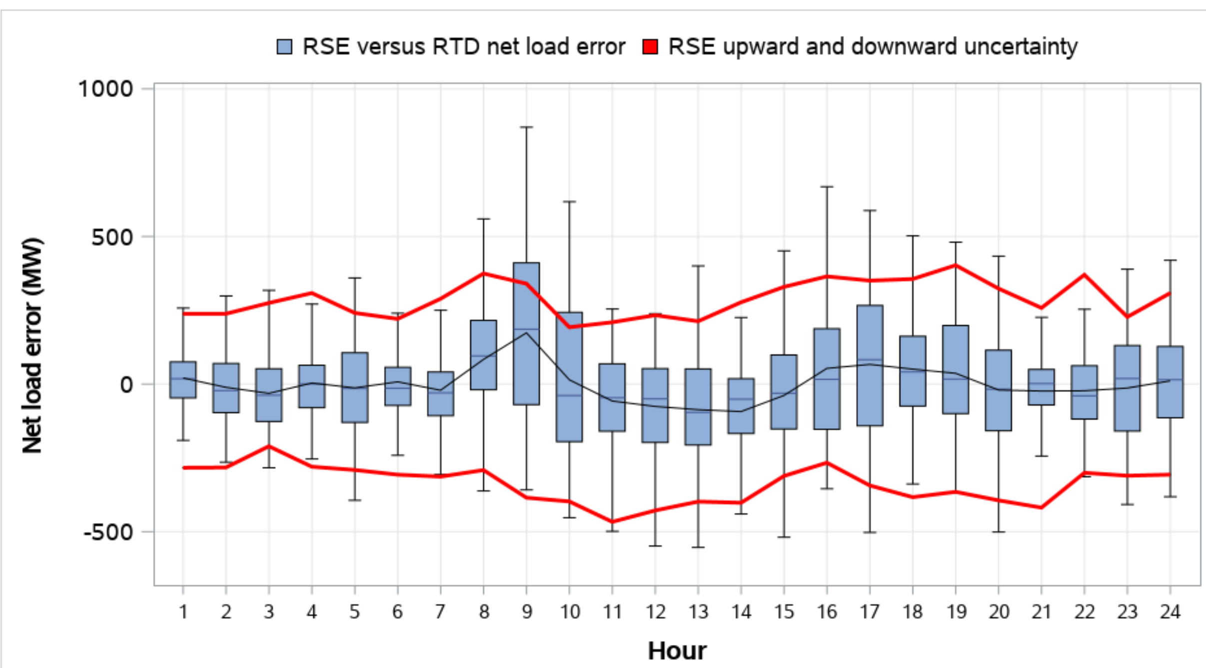


Figure 47. PacifiCorp East distribution of RSE and RTD load and VER error (Weekdays, October 2021)

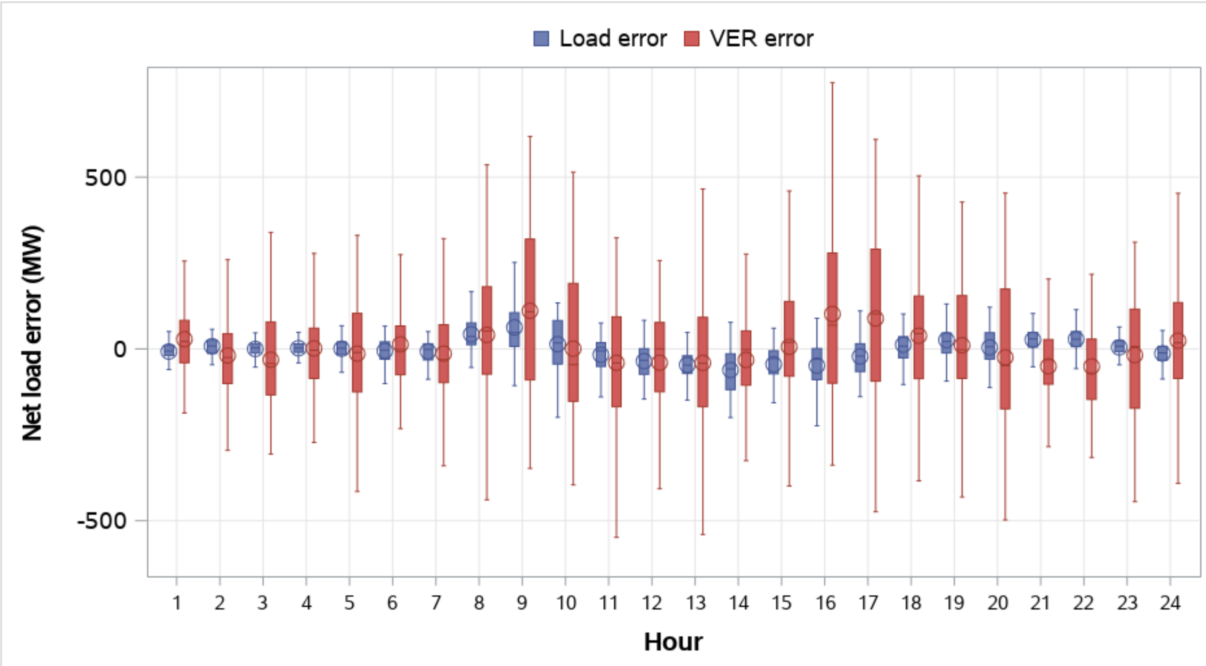


Figure 48. PacifiCorp West average uncertainty by component (Weekdays, October 2021)

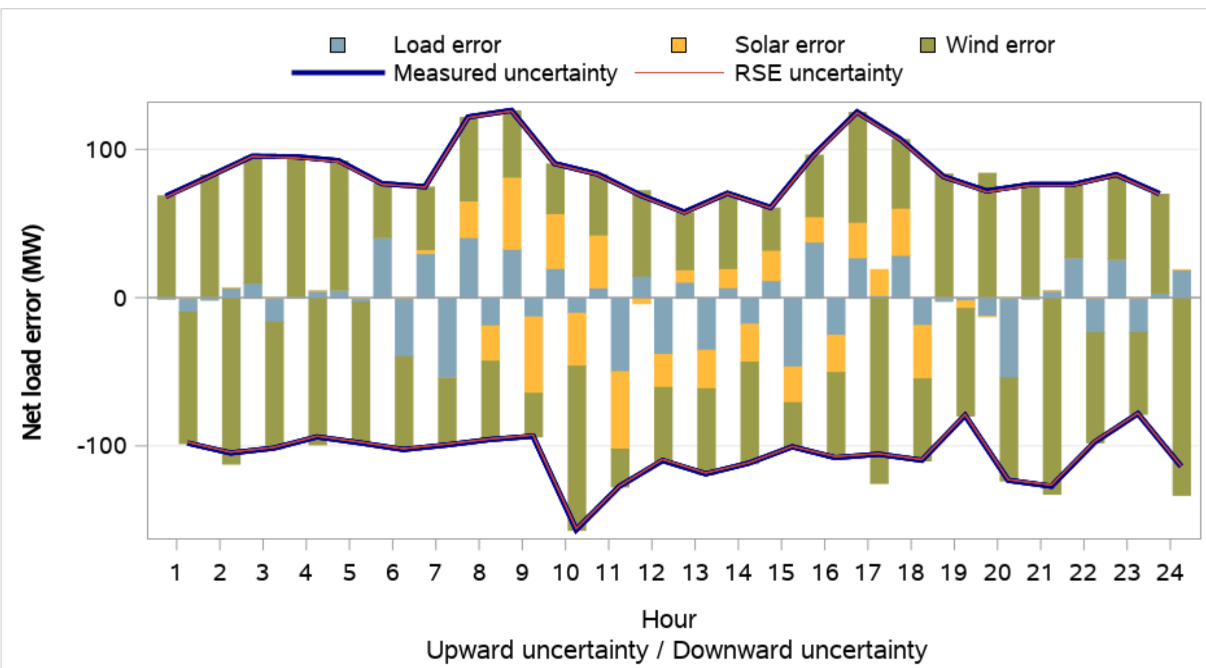


Figure 49. PacifiCorp West distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, October 2021)

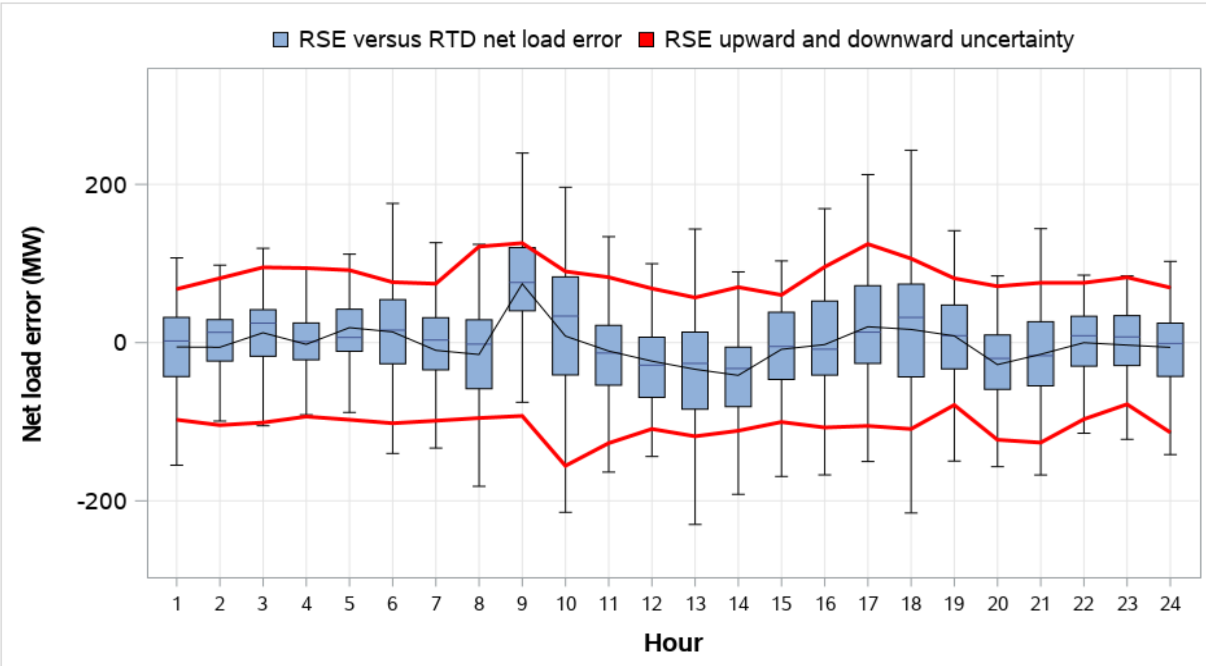


Figure 50. PacifiCorp West distribution of RSE and RTD load and VER error (Weekdays, October 2021)

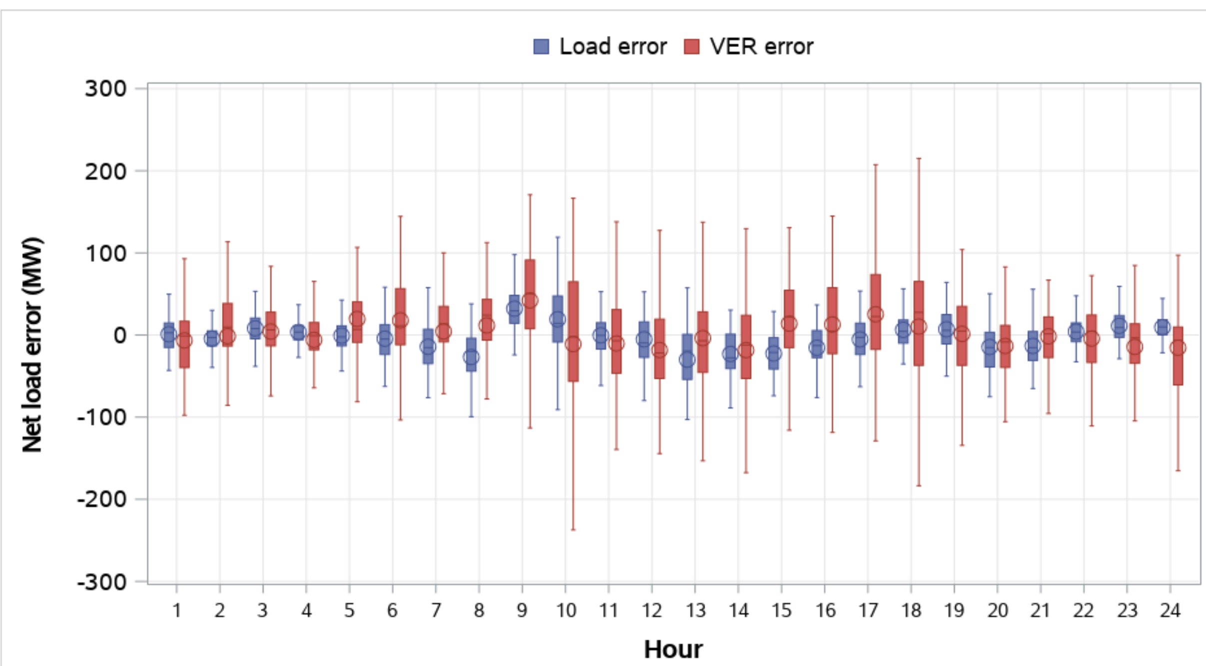


Figure 51. Portland General Electric average uncertainty by component (Weekdays, October 2021)

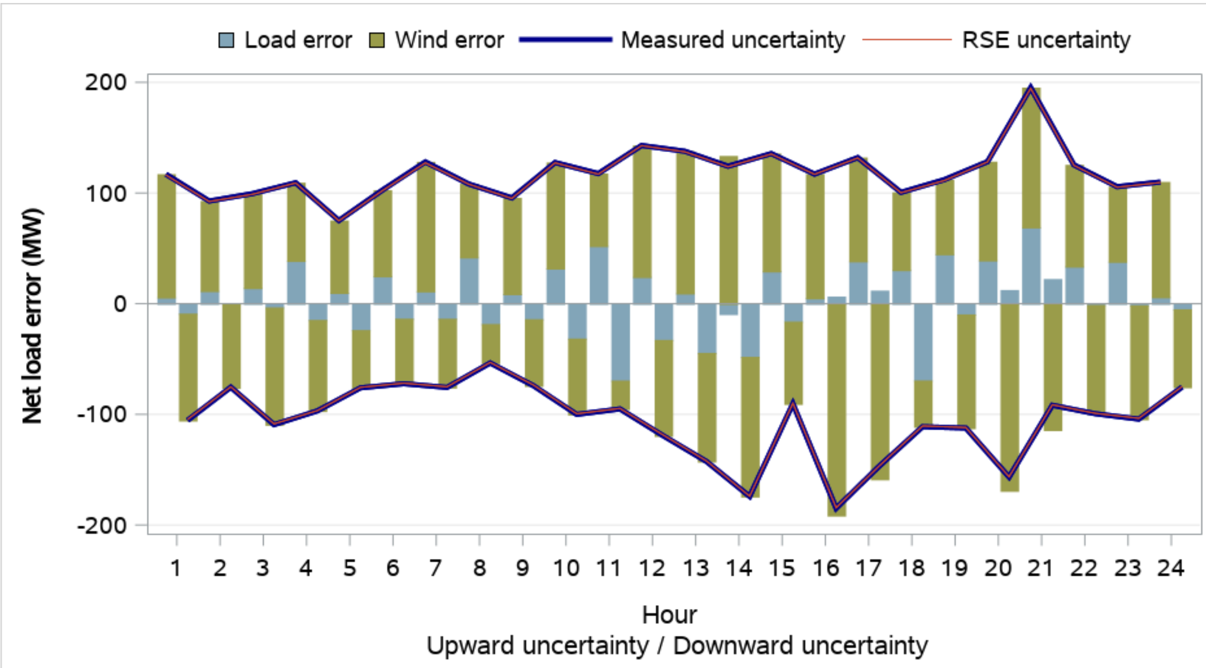


Figure 52. Portland General Electric distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, October 2021)

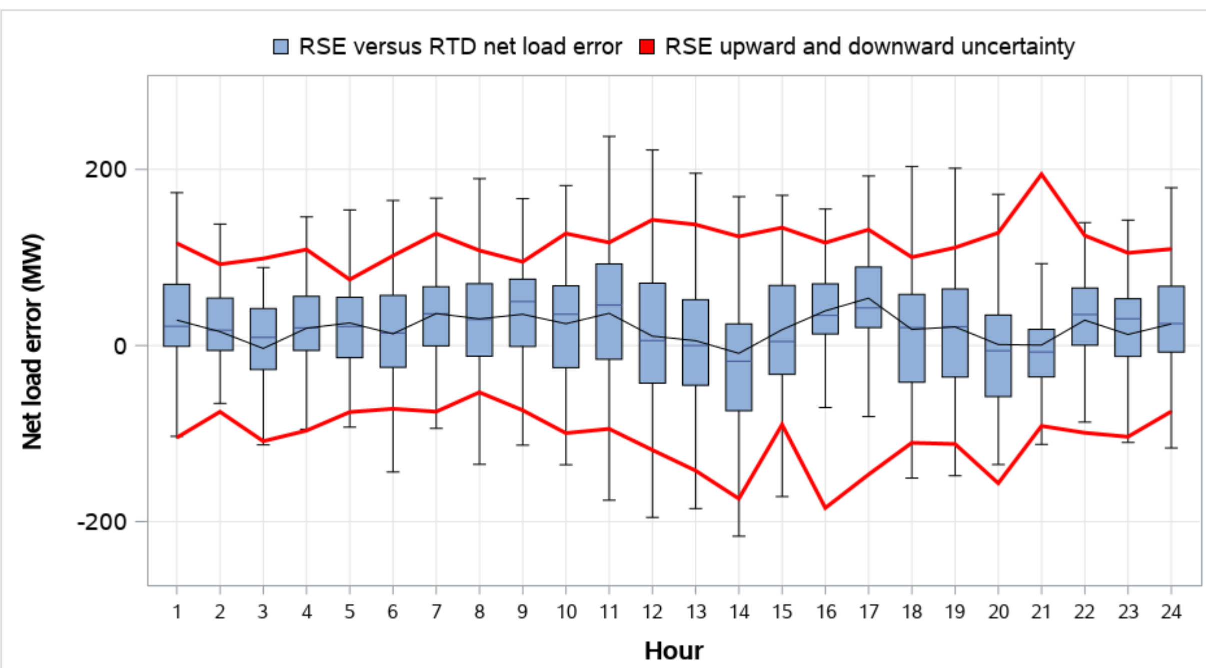


Figure 53. Portland General Electric distribution of RSE and RTD load and VER error (Weekdays, October 2021)

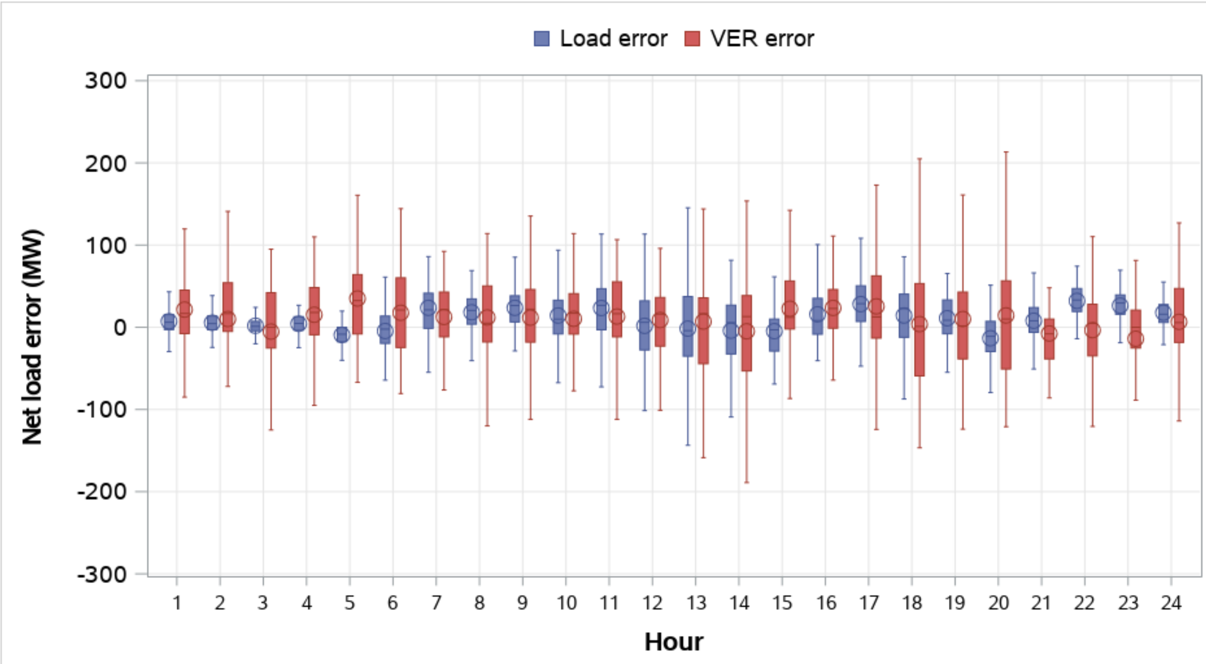


Figure 54. Powerex average uncertainty by component (Weekdays, October 2021)

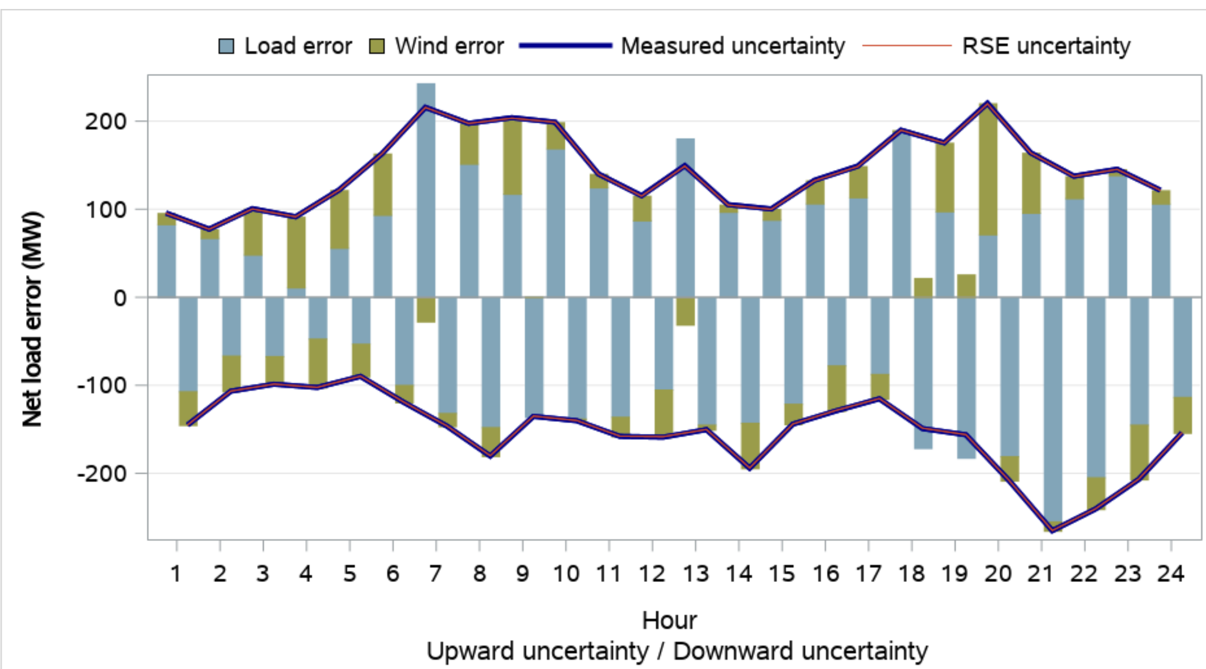


Figure 55. Powerex distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, October 2021)

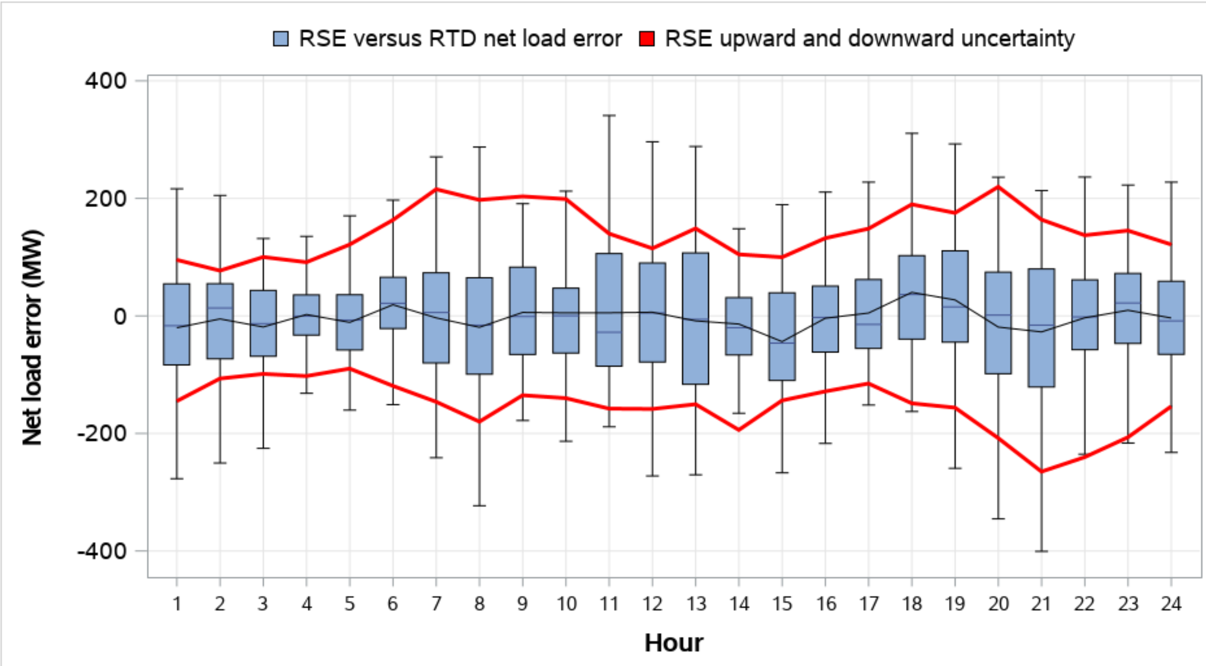


Figure 56. Powerex distribution of RSE and RTD load and VER error (Weekdays, October 2021)

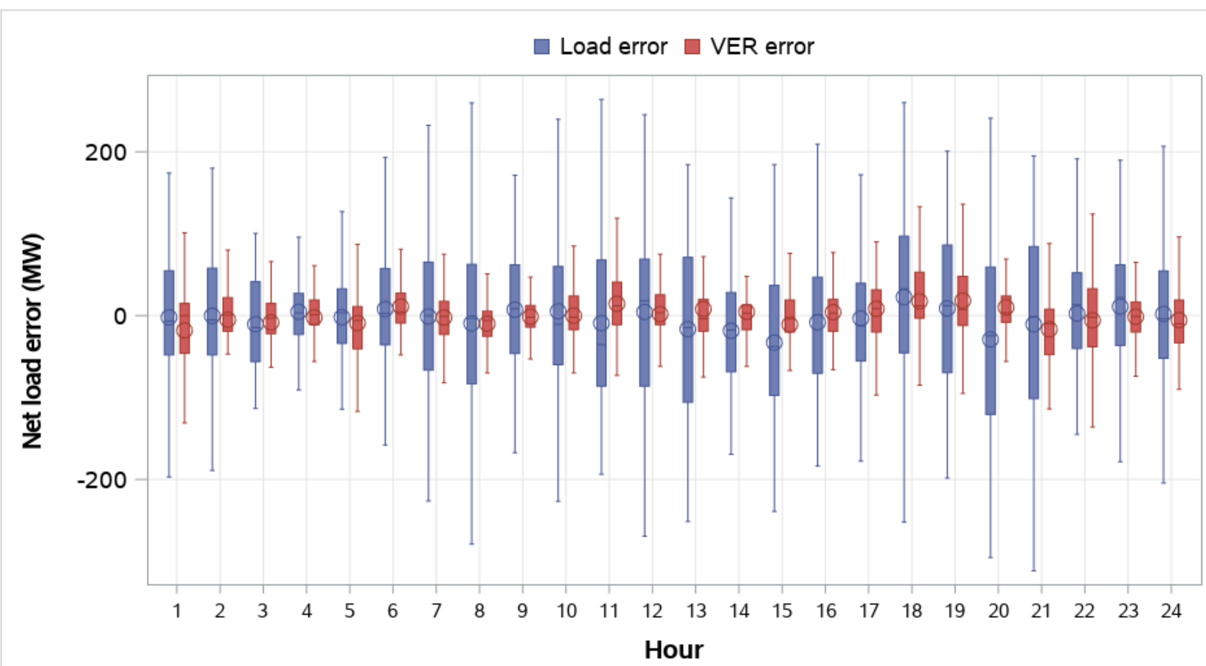


Figure 57. PNM average uncertainty by component (Weekdays, October 2021)

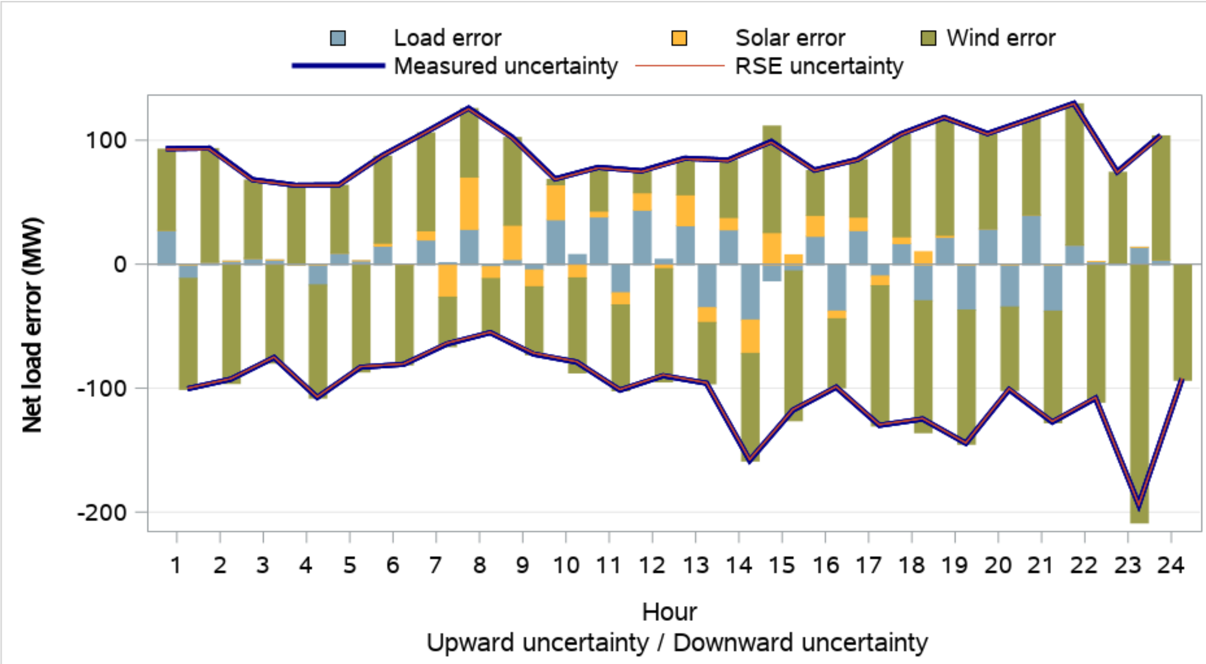


Figure 58. PNM distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, October 2021)

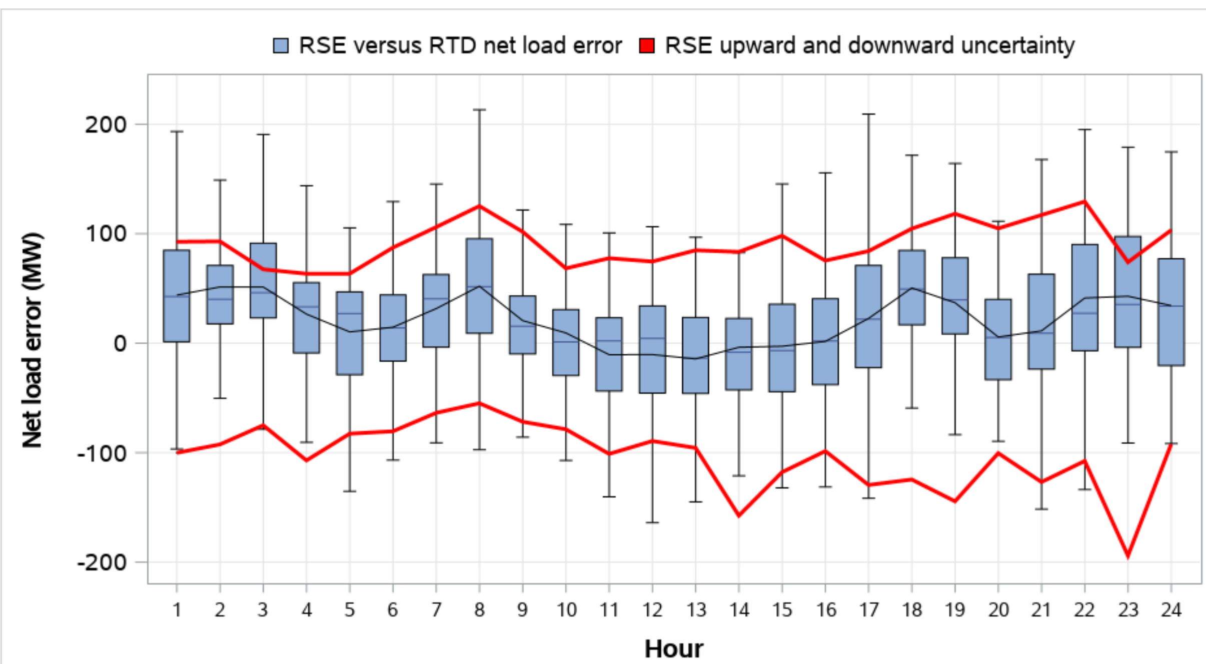


Figure 59. PNM distribution of RSE and RTD load and VER error (Weekdays, October 2021)

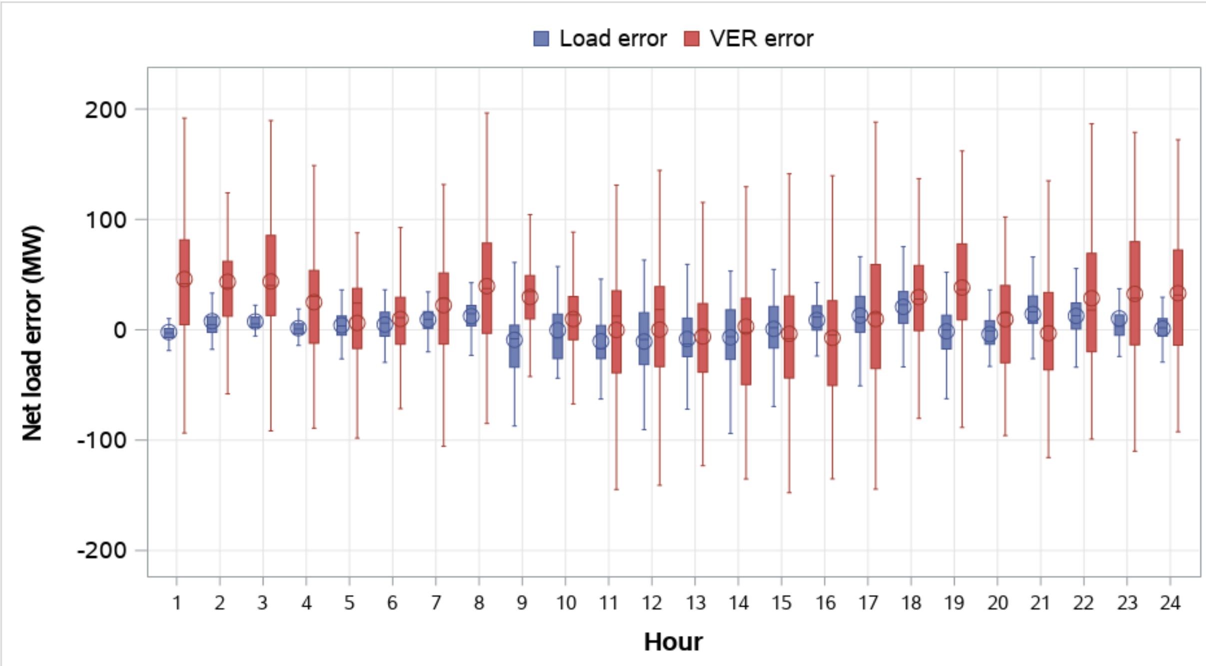


Figure 60. Puget Sound Energy average uncertainty by component (Weekdays, October 2021)

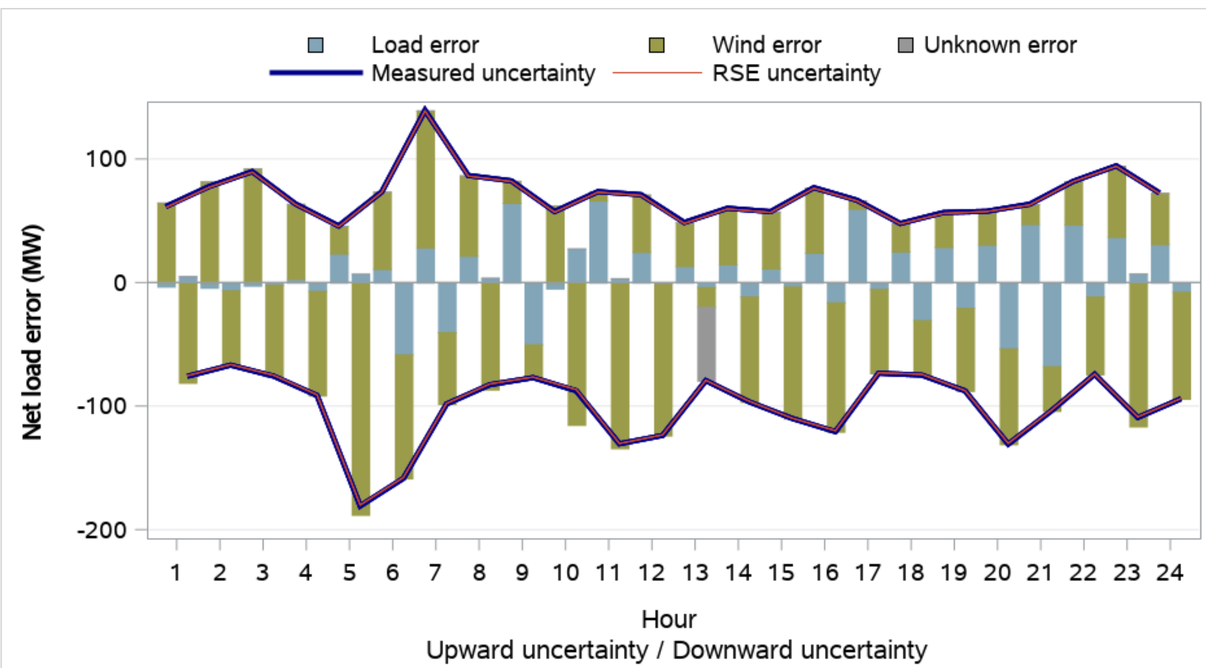


Figure 61. Puget Sound Energy distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, October 2021)

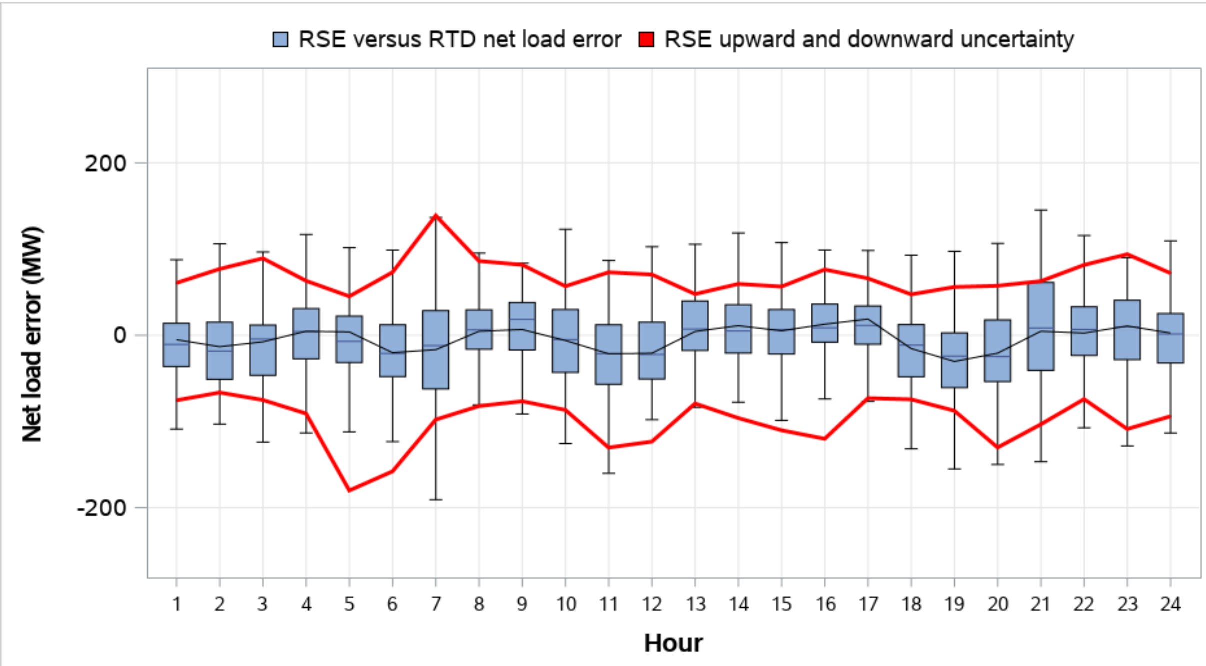


Figure 62. Puget Sound Energy distribution of RSE and RTD load and VER error (Weekdays, October 2021)

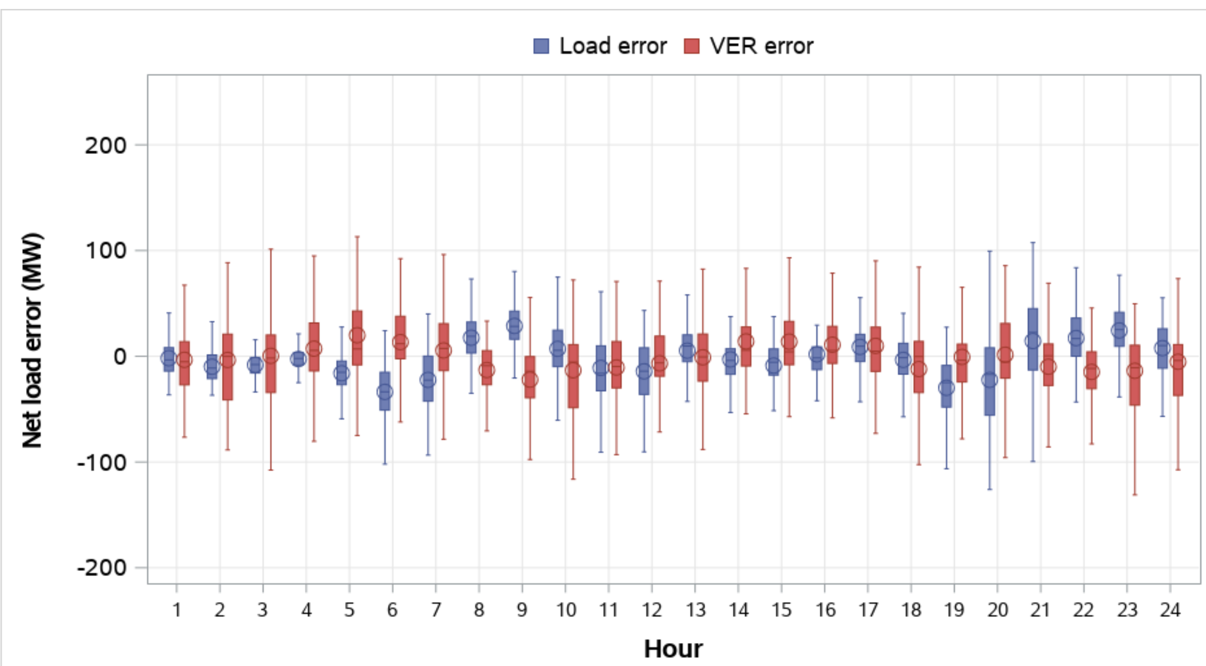


Figure 63. Salt River Project average uncertainty by component (Weekdays, October 2021)

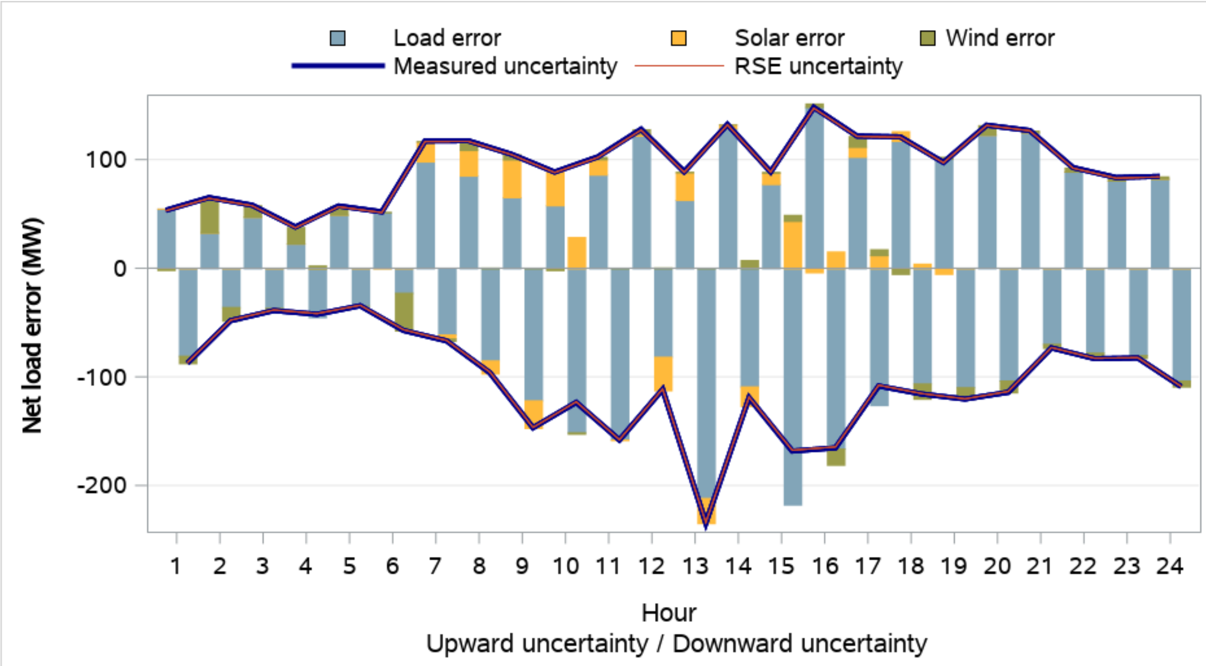


Figure 64. Salt River Project distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, October 2021)

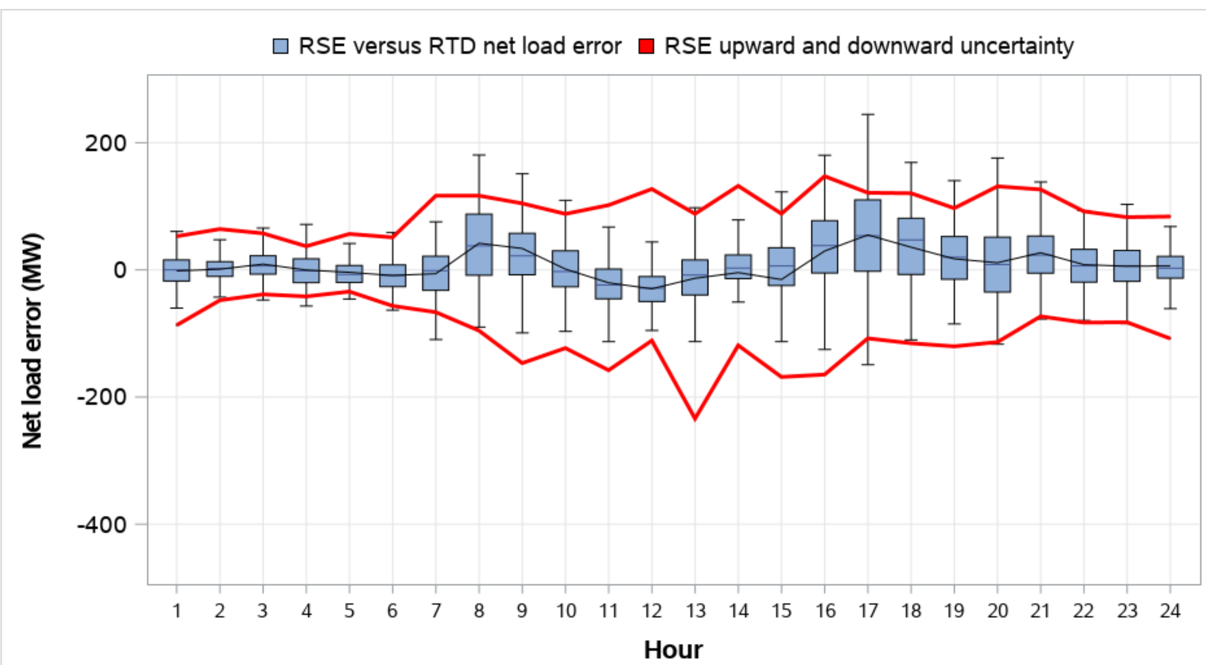


Figure 65. Salt River Project distribution of RSE and RTD load and VER error (Weekdays, October 2021)

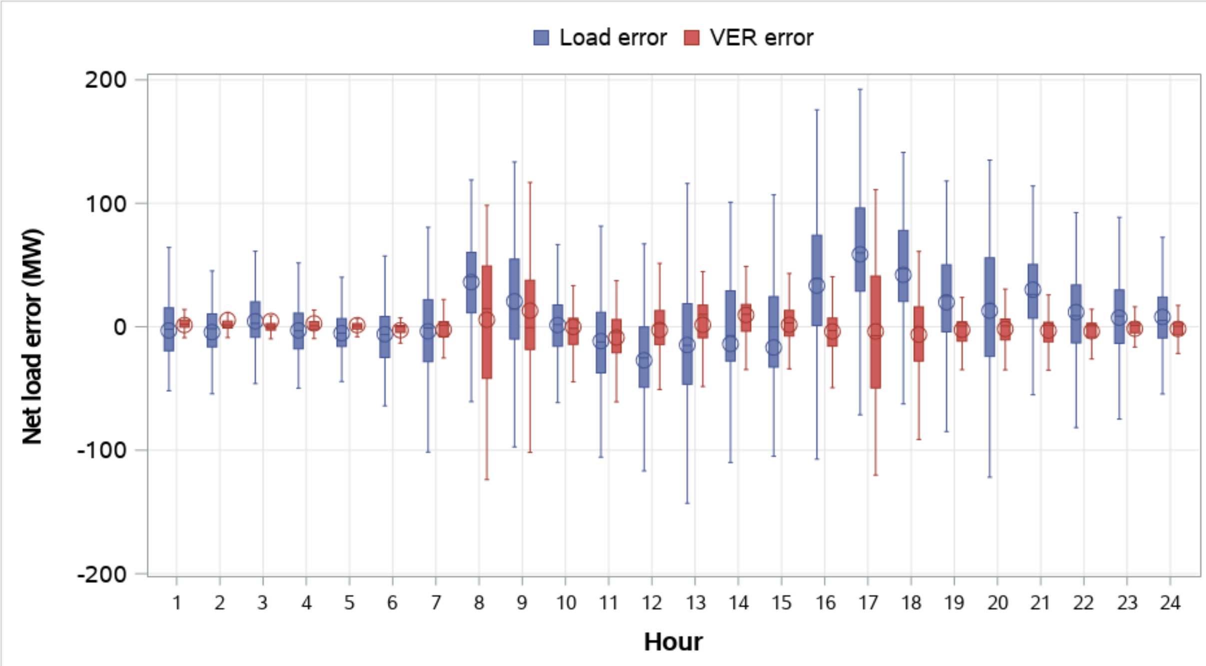


Figure 66. Seattle City Light average uncertainty by component (Weekdays, October 2021)

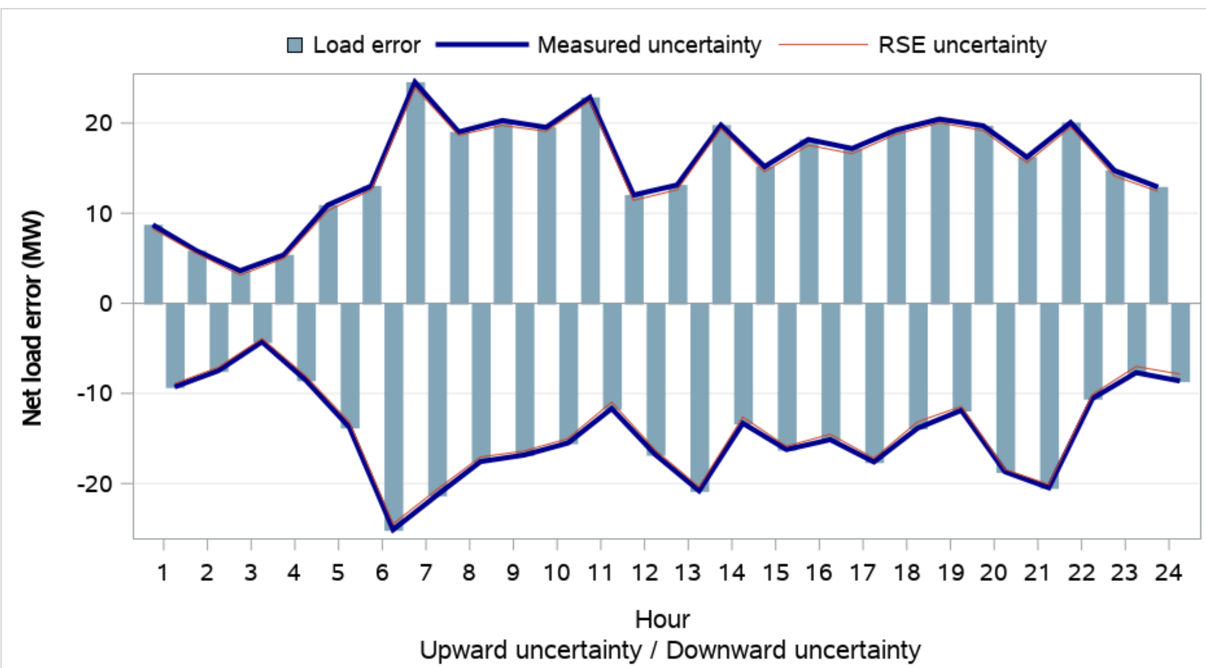


Figure 67. Seattle City Light distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, October 2021)

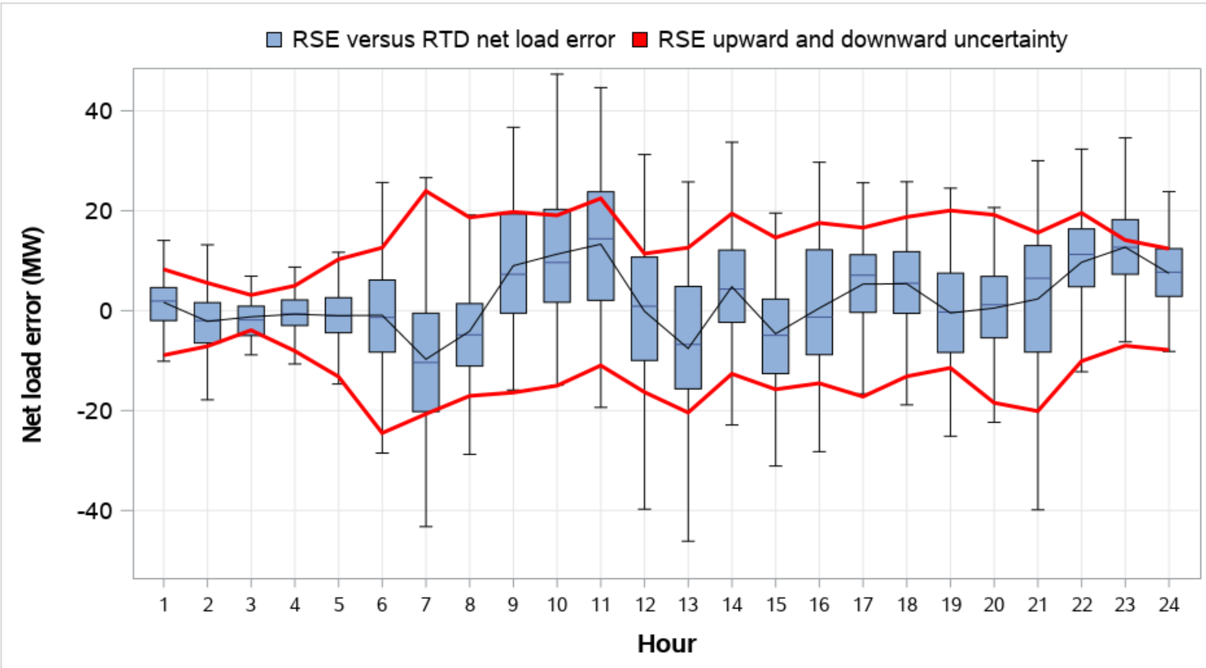


Figure 68. Seattle City Light distribution of RSE and RTD load and VER error (Weekdays, October 2021)

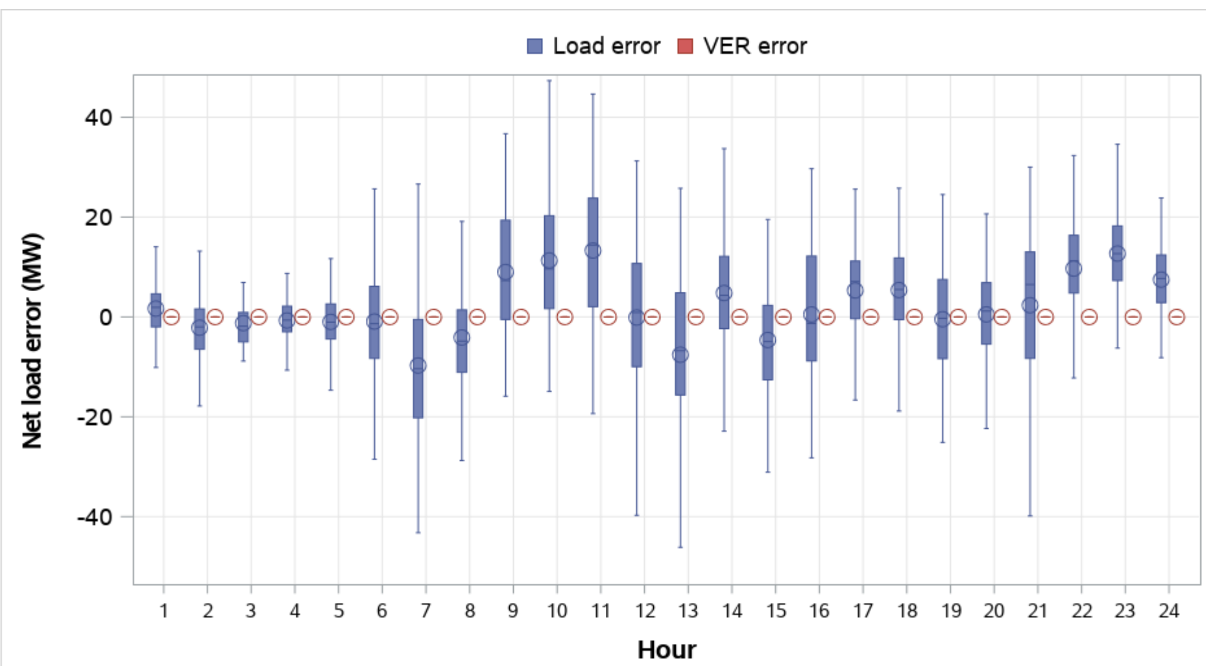


Figure 69. Turlock Irrigation District average uncertainty by component (Weekdays, October 2021)

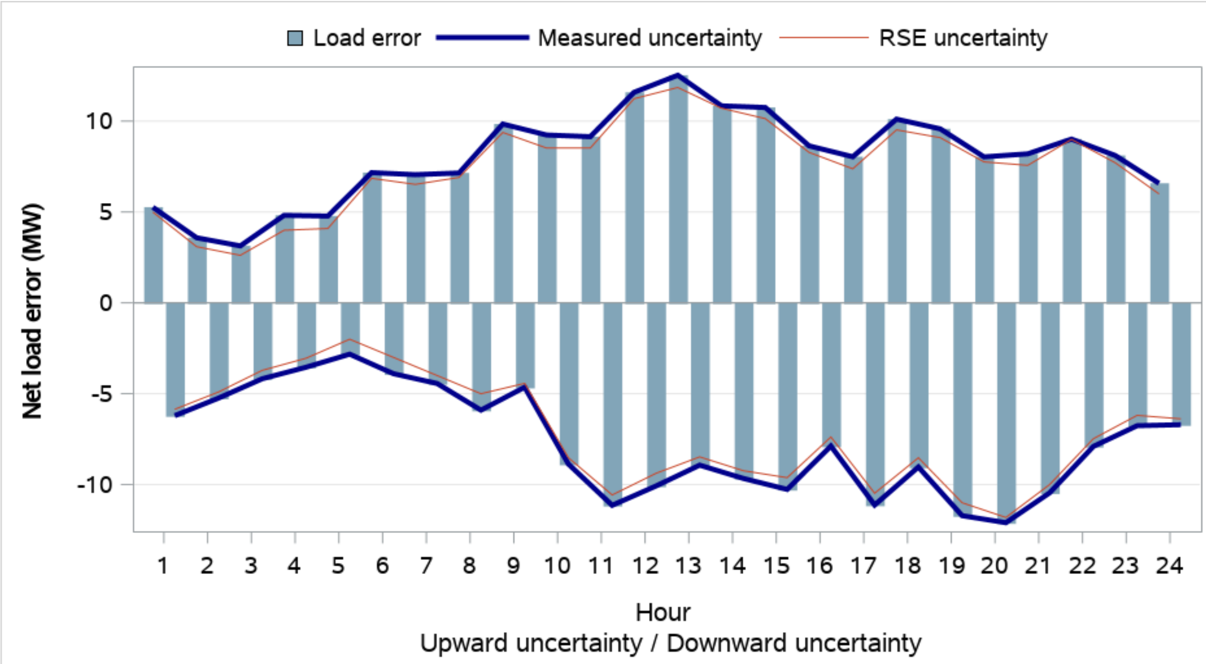


Figure 70. Turlock Irrigation District distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, October 2021)

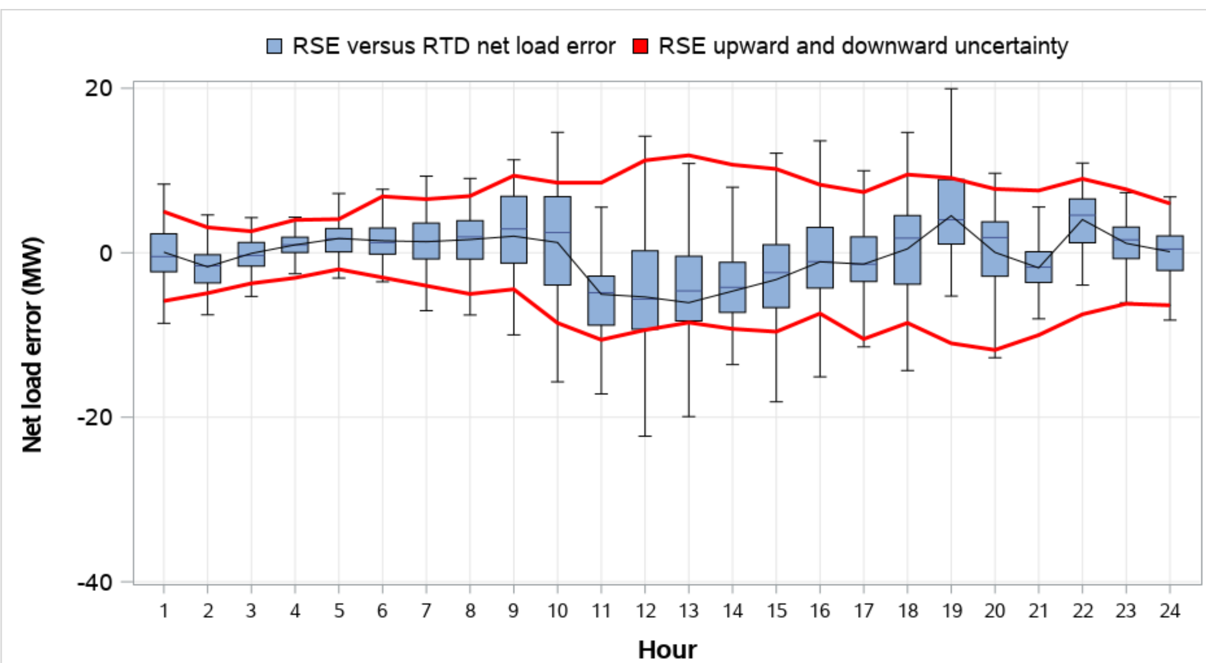


Figure 71. Turlock Irrigation District distribution of RSE and RTD load and VER error (Weekdays, October 2021)