EIM Resource Sufficiency Evaluation Metrics Report covering December 2021

January 11, 2022

Prepared by: Department of Market Monitoring

California Independent System Operator

1 Report overview

As part of the Energy Imbalance 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 December 2021 and is organized as follows:

- Section 2 provides an overview of the flexible ramp sufficiency and bid-range capacity tests.
- Section 3 provides existing summary metrics.
- Section 4 provides metrics for key time periods.
- Section **Error! Reference source not found.** reviews input differences between the resource sufficiency evaluation and latest 15-minute market run.
- Section 6 provides a discussion on the net load uncertainty used in the tests.
- Section 7 summarizes resource sufficiency evaluation issues identified by DMM or the ISO in 2021.

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.

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 ramp sufficiency test, and the bid range capacity test.

The market software automatically limits transfers into a balancing area from other energy imbalance market 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. In previous reports, this was referred to as the *sufficiency* test.
- **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, 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 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 EIM 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*.

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

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

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]

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.

5 Net load uncertainty is reduced by the diversity benefit similar to the flexibility test. Unlike the flexibility 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.

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 3.1 through Figure 3.4 show the number of 15-minute intervals in which each EIM 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 energy imbalance market areas are limited.

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 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 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.

[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.

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

	2020			2021											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arizona PS	—	—	9	5	10	—	—	8	—	5	8	5	—	9	1
BANC	2	1	—	—	—	3	—	—	—	7	—	1	—	—	—
California ISO	—	—	—	—	—	—	—	—	4	6	1	5	—	—	—
Idaho Power	—	—	—	—	—	—	—	—	—	13	25	3	—	—	—
LADWP							—	—	2	—	—	—	8	5	2
NorthWestern									9	36	18	6	253	34	7
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	14	11
Portland GE	—	—	—	—	4	—	11	—	21	25	30	41	13	6	11
Powerex	2	3	—	4	1	—	—	—	1	1	—	2	15	6	6
PSC New Mexico							—	—	—	11	—	5	—	—	—
Puget Sound En	—	—	—	—	2	17	29	18	45	16	21	17	29	18	10
Salt River Proj.	3	2	—	—	215	—	2	4	19	90	76	56	3	20	—
Seattle City Light	—	—	—	—	—	—	—	—	—	—	1	14	4	—	4
Turlock ID						—	—	1	—	—	33	22	46	—	—

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

	2020			2021											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arizona PS	—	—	1387	2325	1443	—	—	48	—	92	45	97	—	80	20
BANC	20	5	—	—	—	13	—	—	—	53	—	6	—	—	—
California ISO	—	—	—	—	—	—	—	—	405	601	274	125	—	—	—
Idaho Power	—	—	—	—	—	—	—	—	—	17	34	6	—	—	—
LADWP							—	—	46	—	—	—	95	103	40
NorthWestern									25	24	61	9	38	31	14
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	15	85
Portland GE	—	—	—	—	268	—	42	—	34	46	36	38	31	32	15
Powerex	79	258	—	41	32	—	—	—	63	3	—	22	78	70	148
PSC New Mexico							—	—	—	129	—	57	—	—	—
Puget Sound En	—	—	—	—	21	68	28	49	50	58	74	46	33	54	39
Salt River Proj.	26	72	—	—	54	—	25	38	30	75	121	74	27	27	—
Seattle City Light	—	—	—	—	—	—	—	—	—	—	4	151	53	—	16
Turlock ID						—	—	1	—	—	7	7	8	—	—

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

	2020			2021											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arizona PS	24	19	19	15	13	7	—	19	—	1	—	7	—	10	1
BANC	4	—	4	—	—	—	—	—	—	—	—	—	—	—	—
California ISO	13	14	—	—	—	—	—	—	1	10	3	11	—	3	—
Idaho Power	—	—	—	—	4	—	—	—	—	—	—	—	—	—	1
LADWP							1	3	—	4	—	—	1	1	10
NorthWestern									18	108	20	46	247	14	14
NV Energy	41	24	—	4	13	11	12	20	27	12	15	4	8	1	1
PacifiCorp East	14	1	—	4	2	4	4	1	2	1	—	4	—	2	1
PacifiCorp West	3	1	3	1	5	3	4	1	—	1	2	—	—	16	7
Portland GE	3	3	5	10	15	3	7	7	8	14	5	—	1	—	5
Powerex	4	16	7	7	4	4	4	—	4	15	—	—	7	5	8
PSC New Mexico							11	1	3	15	—	2	—	2	—
Puget Sound En	5	—	—	—	—	—	—	4	2	1	1	—	—	2	—
Salt River Proj.	49	25	8	5	192	8	15	6	26	57	49	24	5	36	1
Seattle City Light	5	5	4	—	—	—	—	—	—	1	—	4	—	—	—
Turlock ID						—	—	9	—	—	—	2	5	—	—

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

	2020			2021											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arizona PS	56	60	716	913	1140	57	—	33	—	38	—	42	—	45	33
BANC	15	—	18	—	—	—	—	—	—	—	—	—	—	—	—
California ISO	872	516	—	—	—	—	—	—	404	585	400	735	—	540	—
Idaho Power	—	—	—	—	8	—	—	—	—	—	—	—	—	—	5
LADWP							32	59	—	70	—	—	10	11	97
NorthWestern									45	36	18	25	31	27	12
NV Energy	82	99	—	87	56	59	60	47	39	45	36	94	82	110	31
PacifiCorp East	64	20	—	62	26	61	67	47	53	44	—	21	—	57	10
PacifiCorp West	58	17	15	27	20	21	18	8	—	2	33	—	—	74	67
Portland GE	11	31	27	30	33	77	105	20	36	33	19	—	11	—	18
Powerex	64	115	65	82	64	26	69	—	137	111	—	—	50	88	41
PSC New Mexico							21	58	19	112	—	47	—	69	—
Puget Sound En	27	—	—	—	—	—	—	47	24	6	24	—	—	82	—
Salt River Proj.	56	49	52	20	64	27	75	27	69	61	53	50	32	65	10
Seattle City Light	9	6	4	—	—	—	—	—	—	7	—	14	—	—	—
Turlock ID						—	—	6	—	—	—	2	18	—	—

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

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

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

	2020			2021											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arizona PS	—	—	—	—	—	—	—	8	—	—	—	—	—	63	—
BANC	831	341	—	—	1	6	—	—	—	—	—	—	—	—	—
California ISO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Idaho Power	—	—	—	—	—	—	—	—	—	—	—	—	—	38	—
LADWP							—	—	16	—	—	—	30	—	—
NorthWestern									—	—	—	—	55	—	—
NV Energy	—	—	—	—	—	—	—	—	26	—	—	—	—	—	—
PacifiCorp East	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PacifiCorp West	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Portland GE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Powerex	13	—	—	—	—	—	8	—	350	33	—	144	51	7	—
PSC New Mexico							—	—	—	—	—	—	22	65	—
Puget Sound En	—	—	—	—	—	—	—	—	—	—	—	—	33	—	—
Salt River Proj.	—	—	—	—	—	—	11	—	29	—	—	—	—	—	8
Seattle City Light	—	—	—	—	—	—	—	—	—	8	8	5	—	18	10
Turlock ID						—	—	4	4	3	8	2	5	1	3

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

	2020			2021											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arizona PS	57	27	75	64	61	129	55	8	4	—	4	2	3	15	11
BANC	4	8	—	—	17	10	—	—	—	—	—	—	—	—	4
California ISO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Idaho Power	1	1	—	—	—	—	—	1	—	—	—	—	—	8	1
LADWP							—	—	2	—	—	—	2	—	—
NorthWestern									10	18	11	33	68	4	1
NV Energy	16	39	32	6	163	42	15	127	58	88	74	48	34	11	13
PacifiCorp East	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PacifiCorp West	—	—	—	—	—	2	—	—	4	—	—	—	—	1	—
Portland GE	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Powerex	2	—	—	12	—	42	6	27	36	12	6	29	12	1	4
PSC New Mexico							39	—	1	—	—	4	11	20	4
Puget Sound En	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
Salt River Proj.	3	5	23	33	43	35	5	2	5	—	2	1	2	1	2
Seattle City Light	3	2	4	—	—	—	—	—	—	6	—	—	—	1	1
Turlock ID						3	4	16	—	—	1	—	18	3	5

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

	2020			2021											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arizona PS	73	44	55	63	94	52	73	38	26	—	50	27	36	81	51
BANC	63	98	—	—	16	13	—	—	—	—	—	—	—	—	71
California ISO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Idaho Power	5	10	—	—	—	—	—	9	—	—	—	—	—	31	40
LADWP							—	—	14	—	—	—	5	—	—
NorthWestern									259	14	29	17	25	21	7
NV Energy	30	31	32	150	49	56	64	74	65	141	70	83	39	34	24
PacifiCorp East	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PacifiCorp West	—	—	—	—	—	9	—	—	140	—	—	—	—	32	—
Portland GE	—	—	—	10	—	—	—	—	—	—	—	—	—	—	—
Powerex	71	—	—	95	—	64	26	38	199	83	44	121	101	16	163
PSC New Mexico							124	—	12	—	—	102	56	41	223
Puget Sound En	—	—	—	—	—	—	—	—	—	—	—	—	—	16	—
Salt River Proj.	58	26	33	57	45	55	47	65	44	—	25	100	22	4	11
Seattle City Light	25	20	88	—	—	—	—	—	—	2	—	—	—	2	3
Turlock ID						2	6	7	—	—	4	—	16	3	94

Figure 3.9. Upward capacity/flexibility test failure intervals by concurrence (December 2021)

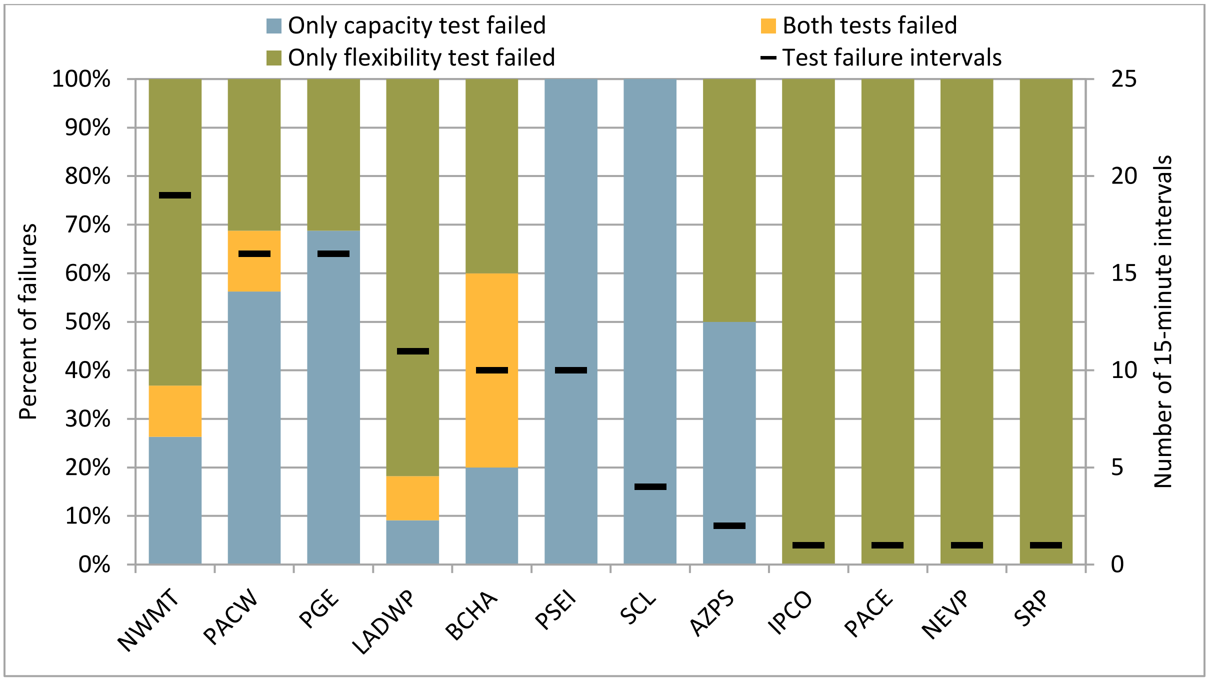
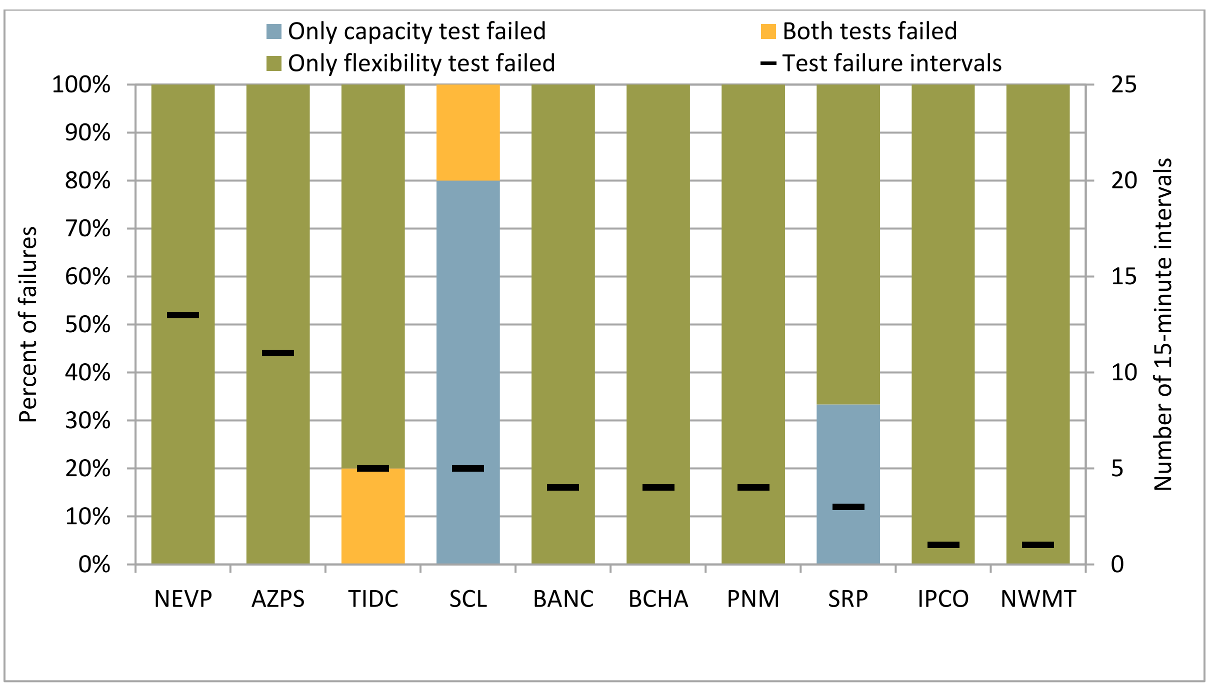


Figure 3.10. Downward capacity/flexibility test failure intervals by concurrence (December 2021)



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 ramp sufficiency test.[8]

Figure 3.11 shows the impact of this change by showing actual capacity test failure intervals that would have passed the test without the additional net load uncertainty component. Figure 3.12 shows the same information, except without intervals in which the flexibility test also failed in that interval. Since the outcome of failing either the capacity or the flexibility test is the same, this figure summarizes additional intervals in which energy imbalance market transfers were capped as a result of the addition of the uncertainty component.

As part of the stakeholder initiative on resource sufficiency evaluation enhancements, the ISO has proposed to remove *both* the net load and intertie uncertainty components from the capacity test[9]. These adders would be expected to return once the calculations are improved as part of the second phase of the initiative.

Figure 3.13 shows the impact of this proposal by showing actual capacity test failure intervals that would have passed the test with both the net load and intertie uncertainty adders removed from the requirement. Again, since the outcome of failing either the capacity or the flexibility test is the same, Figure 3.14 shows the same information except without intervals in which the flexibility test also failed in that interval; this highlights intervals in which energy imbalance market transfers were capped but would not have been under the proposal.

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8 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.

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

Figure 3.11. Additional capacity test failures with net load uncertainty (15-minute intervals)

	Upward capacity test						Downward capacity test					
	Jul	Aug	Sep	Oct	Nov	Dec	Jul	Aug	Sep	Oct	Nov	Dec
Arizona PS	3	7	2	—	5	1	—	—	—	—	1	—
BANC	3	—	1	—	—	—	—	—	—	—	—	—
California ISO	2	1	5	—	—	—	—	—	—	—	—	—
Idaho Power	13	21	3	—	—	—	—	—	—	—	4	—
LADWP	—	—	—	—	1	2	—	—	—	2	—	—
NorthWestern	30	12	6	192	30	7	—	—	—	15	—	—
NV Energy	9	6	5	6	—	—	—	—	—	—	—	—
PacifiCorp East	9	4	4	4	—	—	—	—	—	—	—	—
PacifiCorp West	7	2	2	2	14	5	—	—	—	—	—	—
Portland GE	20	25	34	13	4	11	—	—	—	—	—	—
Powerex	1	—	2	9	5	3	3	—	4	5	1	—
PSC New Mexico	3	—	2	—	—	—	—	—	—	7	—	—
Puget Sound En	8	10	8	19	13	8	—	—	—	1	—	—
Salt River Proj.	49	19	32	3	17	—	—	—	—	—	—	1
Seattle City Light	—	1	6	—	—	1	—	—	1	—	2	2
Turlock ID	—	9	10	18	—	—	—	1	2	3	3	1

Figure 3.12. Additional capacity test failures with net load uncertainty <u>excluding</u> flexibility test failures (15-minute intervals)

	Upward capacity test						Downward capacity test					
	Jul	Aug	Sep	Oct	Nov	Dec	Jul	Aug	Sep	Oct	Nov	Dec
Arizona PS	3	7	2	—	1	1	—	—	—	—	—	—
BANC	3	—	1	—	—	—	—	—	—	—	—	—
California ISO	2	—	2	—	—	—	—	—	—	—	—	—
Idaho Power	13	21	3	—	—	—	—	—	—	—	—	—
LADWP	—	—	—	—	1	1	—	—	—	2	—	—
NorthWestern	9	9	—	105	23	5	—	—	—	13	—	—
NV Energy	9	6	5	6	—	—	—	—	—	—	—	—
PacifiCorp East	8	4	4	4	—	—	—	—	—	—	—	—
PacifiCorp West	6	2	2	2	11	5	—	—	—	—	—	—
Portland GE	19	25	34	13	4	11	—	—	—	—	—	—
Powerex	1	—	2	6	1	2	1	—	2	4	1	—
PSC New Mexico	1	—	2	—	—	—	—	—	—	7	—	—
Puget Sound En	8	10	8	19	13	8	—	—	—	1	—	—
Salt River Proj.	34	15	27	2	14	—	—	—	—	—	—	1
Seattle City Light	—	1	3	—	—	1	—	—	1	—	2	2
Turlock ID	—	9	10	18	—	—	—	1	2	1	1	—

Figure 3.13. Additional capacity test failures with *both* net load and intertie uncertainty (15-minute intervals)

	Upward capacity test						Downward capacity test					
	Jul	Aug	Sep	Oct	Nov	Dec	Jul	Aug	Sep	Oct	Nov	Dec
Arizona PS	3	8	4	—	7	1	—	—	—	—	3	—
BANC	3	—	1	—	—	—	—	—	—	—	—	—
California ISO	2	1	5	—	—	—	—	—	—	—	—	—
Idaho Power	13	25	3	—	—	—	—	—	—	—	4	—
LADWP	—	—	—	1	5	2	—	—	—	4	—	—
NorthWestern	30	12	6	248	30	7	—	—	—	28	—	—
NV Energy	12	6	7	6	—	—	—	—	—	—	—	—
PacifiCorp East	9	4	5	4	—	—	—	—	—	—	—	—
PacifiCorp West	7	2	3	2	14	6	—	—	—	—	—	—
Portland GE	22	29	39	13	6	11	—	—	—	—	—	—
Powerex	1	—	2	10	5	3	3	—	7	6	1	—
PSC New Mexico	3	—	3	—	—	—	—	—	—	7	1	—
Puget Sound En	10	20	17	29	15	10	—	—	—	1	—	—
Salt River Proj.	72	54	52	3	20	—	—	—	—	—	—	1
Seattle City Light	—	1	6	—	—	1	—	1	1	—	3	2
Turlock ID	—	33	22	45	—	—	—	1	2	3	3	1

Figure 3.14. Additional capacity test failures with *both* net load and intertie uncertainty excluding flexibility test failures (15-minute intervals)

	Upward capacity test						Downward capacity test					
	Jul	Aug	Sep	Oct	Nov	Dec	Jul	Aug	Sep	Oct	Nov	Dec
Arizona PS	3	8	4	—	3	1	—	—	—	—	1	—
BANC	3	—	1	—	—	—	—	—	—	—	—	—
California ISO	2	—	2	—	—	—	—	—	—	—	—	—
Idaho Power	13	25	3	—	—	—	—	—	—	—	—	—
LADWP	—	—	—	1	5	1	—	—	—	3	—	—
NorthWestern	9	9	—	111	23	5	—	—	—	16	—	—
NV Energy	10	6	7	6	—	—	—	—	—	—	—	—
PacifiCorp East	8	4	5	4	—	—	—	—	—	—	—	—
PacifiCorp West	6	2	3	2	11	5	—	—	—	—	—	—
Portland GE	21	29	39	13	6	11	—	—	—	—	—	—
Powerex	1	—	2	7	1	2	1	—	2	5	1	—
PSC New Mexico	1	—	3	—	—	—	—	—	—	7	1	—
Puget Sound En	10	20	17	29	15	10	—	—	—	1	—	—
Salt River Proj.	45	34	39	2	15	—	—	—	—	—	—	1
Seattle City Light	—	1	3	—	—	1	—	1	1	—	3	2
Turlock ID	—	33	22	45	—	—	—	1	2	1	1	—

Transfer consequences of failing resource sufficiency evaluation

This section summarizes current consequences of failing the bid-range capacity or flexible ramp 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 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 3.15 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 EIM import limit was capped by either the base transfer or the last 15-minute market transfer.

Figure 3.15. Upward capacity/flexibility test failure intervals by source of import limit (December 2021)

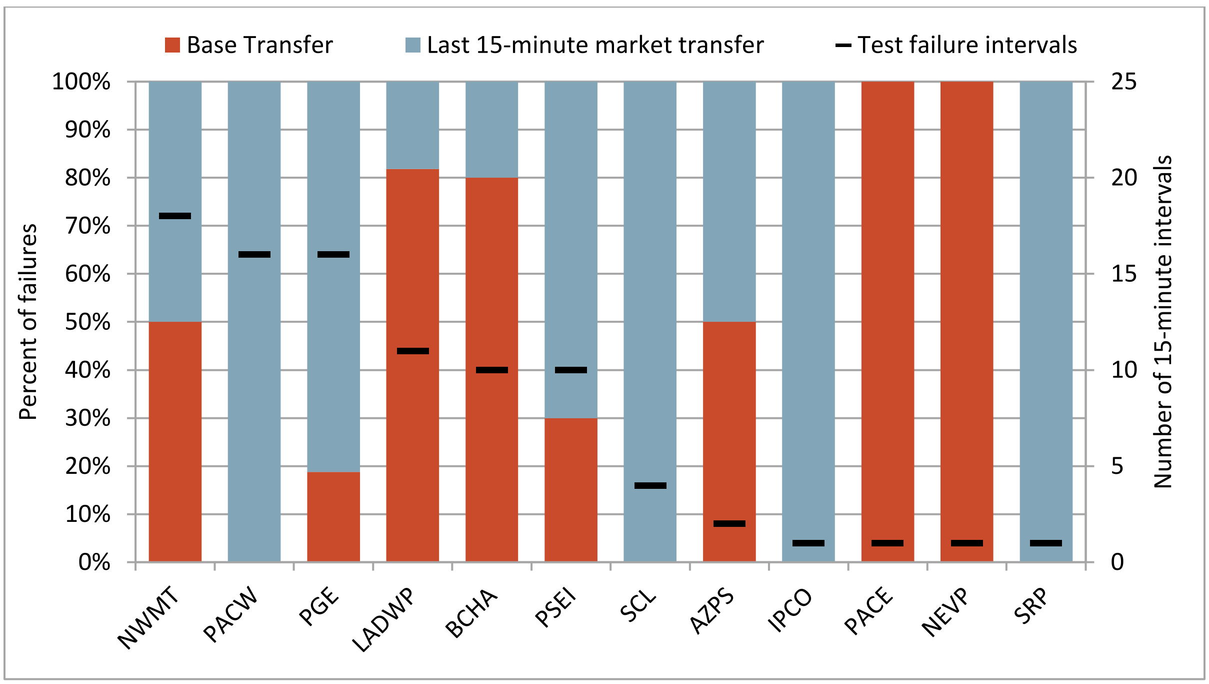
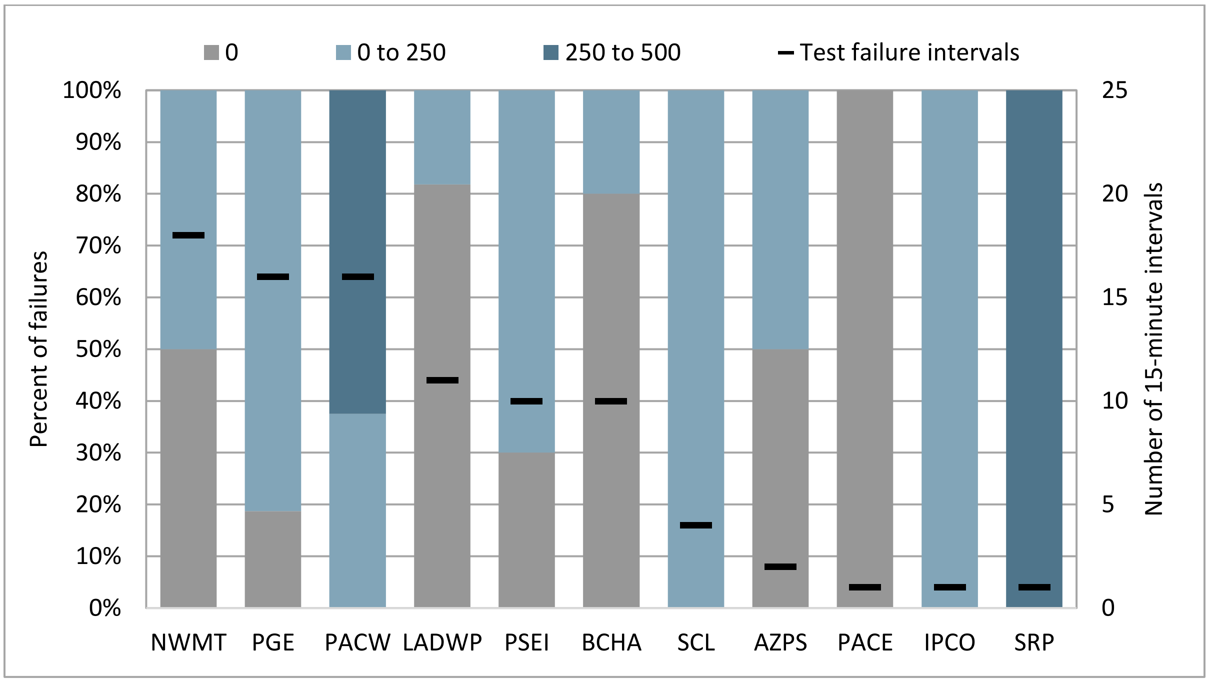


Figure 3.16 summarizes *incremental* EIM import limits above base transfers (fixed bilateral transactions between EIM entities) after failing either test in the upward direction. From this perspective, the incremental EIM import limit after a test failure is set by the greater of (1) zero or (2) the transfer from the last 15-minute market interval minus the current base transfer. Therefore, the incremental EIM import limits show the incremental flexibility available through the 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.[10]

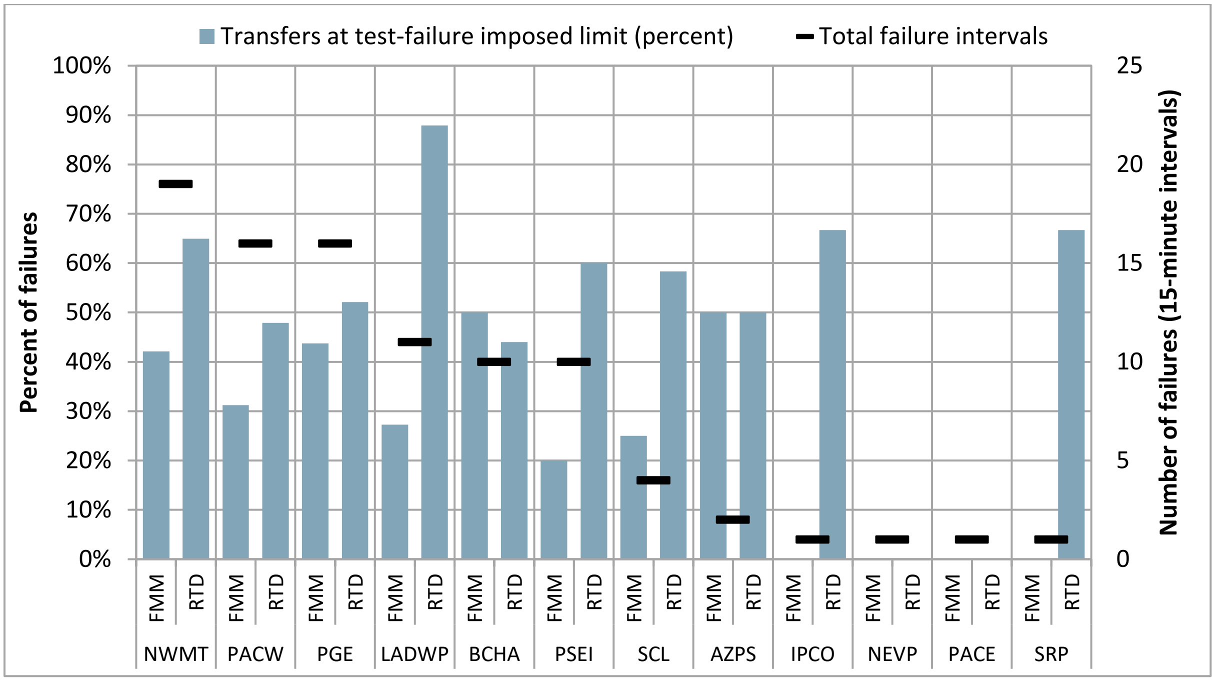
Figure 3.17 summarizes whether the import limit that was imposed after failing either test in the upward direction ultimately impacted market transfers. It shows the percent of failure intervals in which the resulting transfers are constrained to the limit imposed after failing the test. These results are shown separately for the 15-minute (FMM) and 5-minute (RTD) markets.

Figure 3.16. Upward capacity/flexibility test failure intervals by incremental import limit (December 2021)



[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 3.17. Percent of upward test failure intervals with market transfers at the imposed cap (December 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 the flexible ramp sufficiency tests; however, they can impact test results indirectly in at least 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.[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 the flexibility 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

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

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

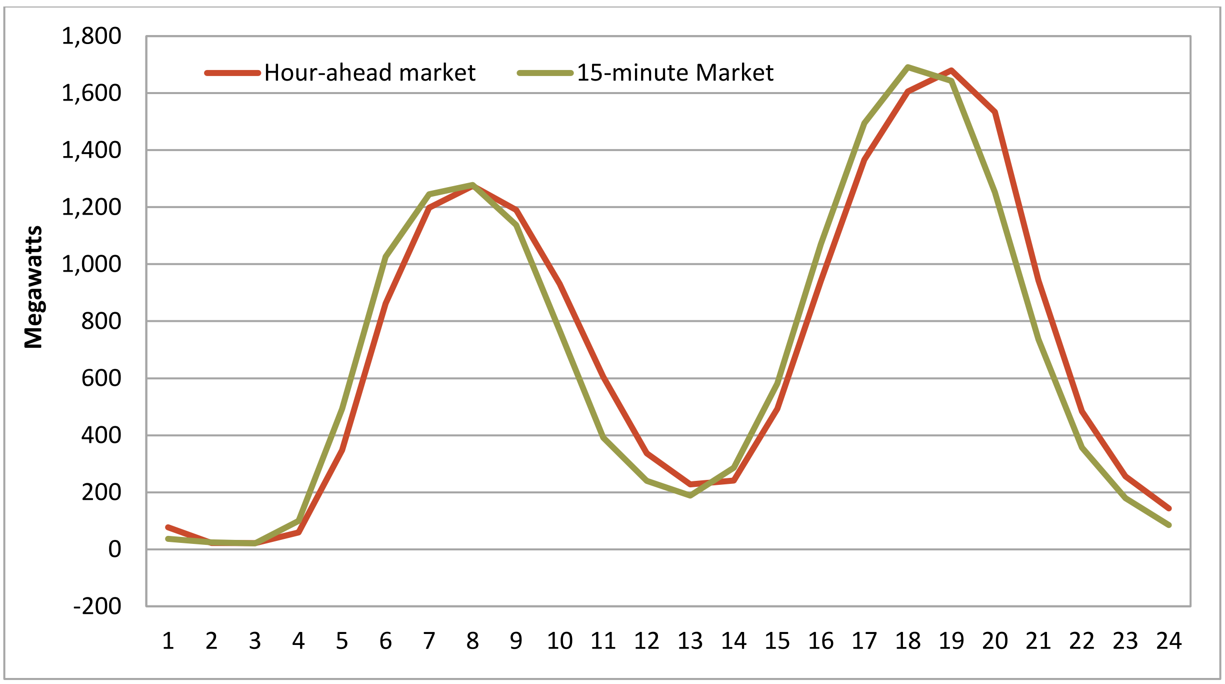
In the resource sufficiency evaluation enhancements initiative, the ISO does not propose to incorporate load conformance into the tests, but plans to revisit this in a second phase.[12]

Figure 3.18 summarizes average hour-ahead and 15-minute market imbalance conformance adjustments entered by operators in the ISO during the month. Figure 3.19 shows the hourly distribution of 15-minute market imbalance conformance.

Figure 3.20 shows the same information for each of the EIM entities with substantial imbalance conformance and Figure 3.21 shows adjustments as a percent of total load.[13]

Table 3.1 summarizes the average frequency and size of 15-minute and 5-minute market imbalance conformance for all balancing authority areas.

Figure 3.18. Average ISO hour-ahead and 15-minute market imbalance conformance (December 2021)



12 *EIM Resource Sufficiency Evaluation Enhancements Phase 1 Revised Draft Final* Proposal, December 16, 2021. http://www.caiso.com/InitiativeDocuments/RevisedDraftFinalProposal-EIMResourceSufficiencyEvaluationEnhancements.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 3.19. Distribution of ISO 15-minute market imbalance conformance (December 2021)

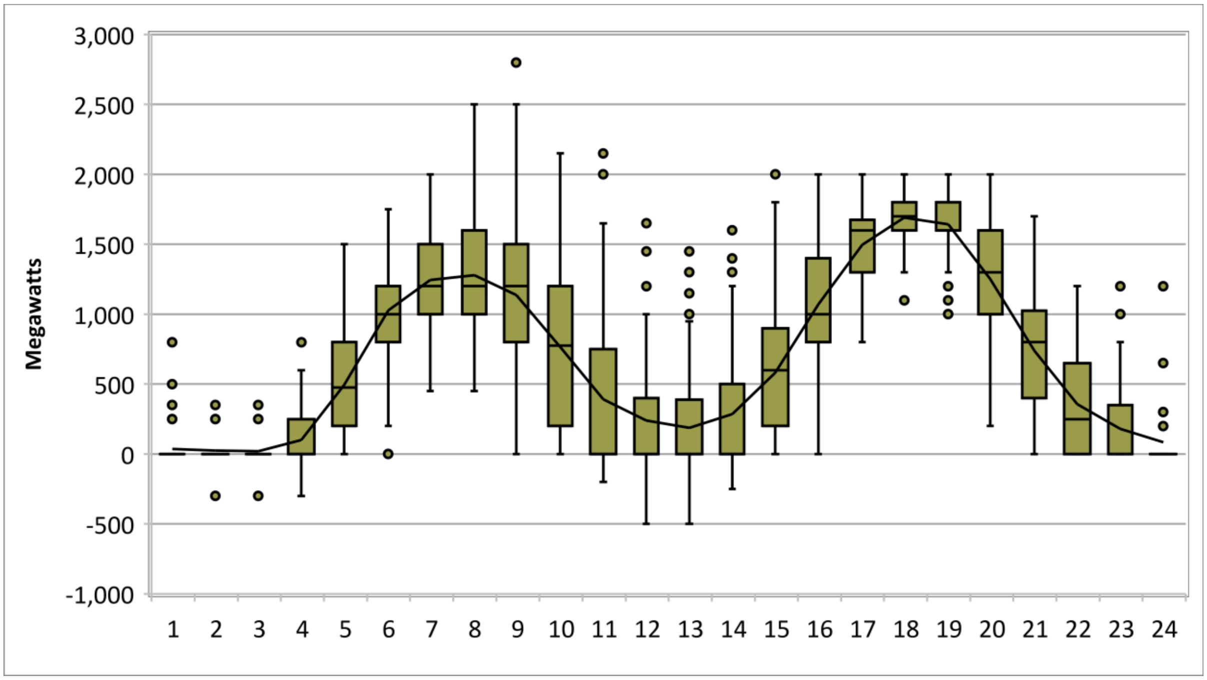


Figure 3.20. Average hourly non-ISO 15-minute market imbalance conformance (December 2021)

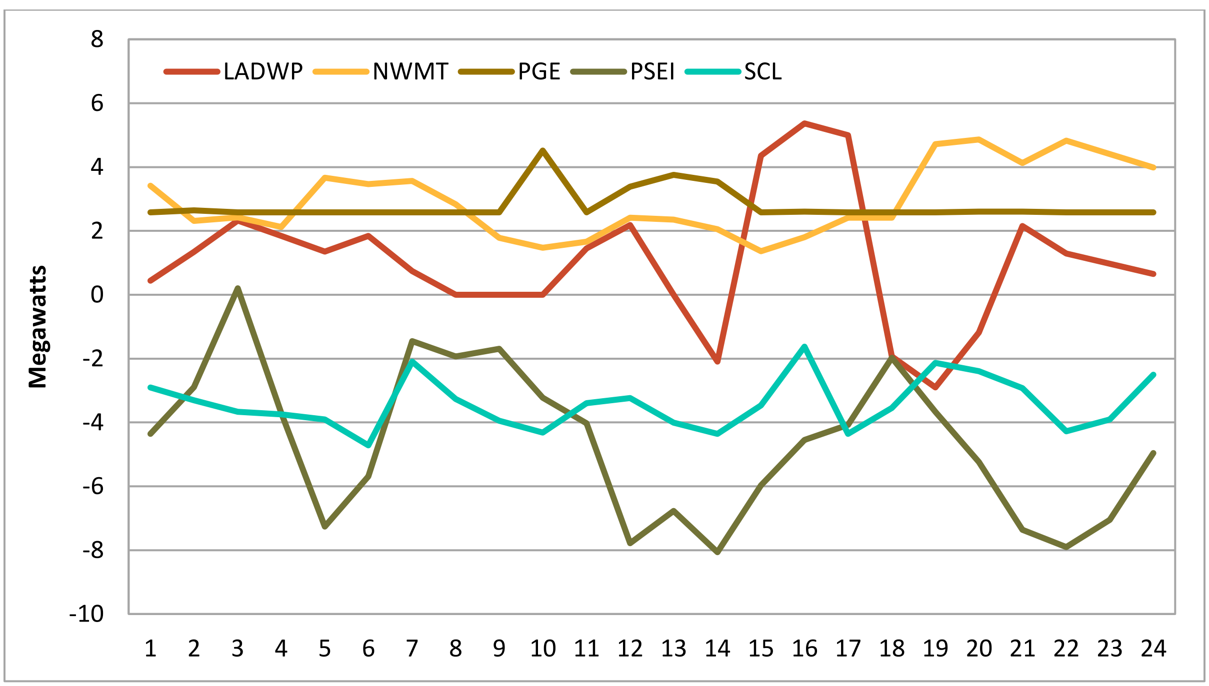


Figure 3.21. Average hourly 15-minute market imbalance conformance *as a percent of load* (December 2021)

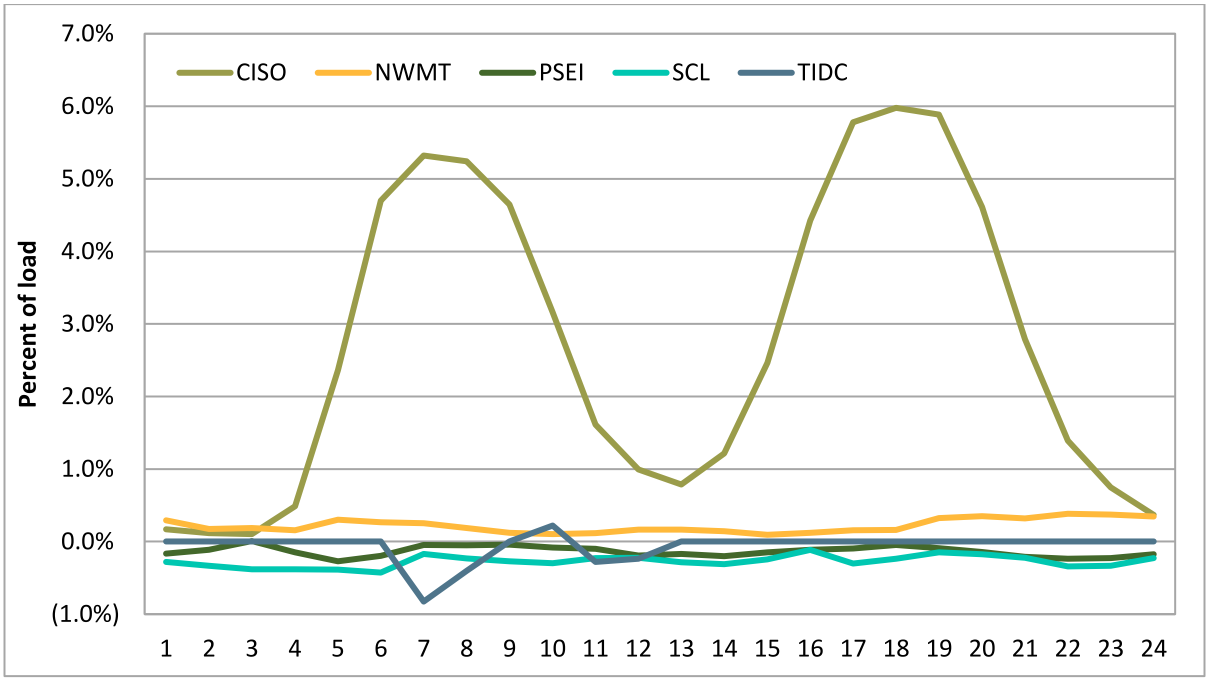


Table 3.1. Average frequency and size of imbalance conformance (December 2021)

	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%	N/A	N/A	0.1%	-363	14.1%	0
5-minute market	33%	56	1.9%	31%	-70	2.6%	-3
BANC							
15-minute market	0.7%	29	1.6%	0.1%	-25	1.3%	0
5-minute market	2%	52	2.7%	0.9%	-46	2.6%	1
California ISO							
15-minute market	64%	1067	4.3%	1%	-286	1.3%	681
5-minute market	57%	281	1.2%	15%	-278	1.2%	120
Idaho Power							
15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
5-minute market	9%	50	2.5%	3%	-51	2.8%	3
Los Angeles Dept. of Water and Power							
15-minute market	3%	61	2.4%	1%	-43	1.6%	1
5-minute market	13%	52	2.1%	6%	-46	1.8%	4
NorthWestern Energy							
15-minute market	26%	13	1.0%	2%	-21	1.6%	3
5-minute market	43%	15	1.1%	4%	-19	1.3%	6
NV Energy							
15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
5-minute market	11%	126	3.2%	5%	-199	5.5%	3
PacifiCorp East							
15-minute market	0%	N/A	N/A	0.7%	-125	2.4%	-1
5-minute market	19%	110	2.1%	25%	-123	2.3%	-9
PacifiCorp West							
15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
5-minute market	4%	61	2.3%	22%	-61	2.2%	-11
Portland General Electric							
15-minute market	4%	75	2.5%	0%	N/A	N/A	3
5-minute market	28%	46	1.6%	1%	-30	1.1%	13
Public Service Company of New Mexico							
15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
5-minute market	1%	167	12.0%	4%	-207	14.7%	-7
Puget Sound Energy							
15-minute market	0.4%	38	1.2%	10%	-50	1.4%	-5
5-minute market	2%	37	1.0%	61%	-43	1.3%	-26
Salt River Project							
15-minute market	1%	56	1.9%	0.03%	-25	0.8%	1
5-minute market	7%	56	1.9%	1%	-47	1.6%	3
Seattle City Light							
15-minute market	1%	20	1.5%	16%	-22	1.7%	-3
5-minute market	2%	19	1.5%	66%	-24	1.8%	-15
Turlock Irrigation District							
15-minute market	0.3%	30	9.0%	0.3%	-92	34%	0
5-minute market	0.4%	20	6.0%	0.3%	-102	39%	0

4 Metrics for key time periods

This section in these monthly reports is reserved for highlighting results and outcomes during specific periods of interest. However, during December, 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 Input differences between the resource sufficiency evaluation and latest 15-minute market run

This section was previously titled *unloaded capacity and EIM imports.* DMM reviewed cases in the ISO that optimized net EIM imports in the market that significantly exceeded the unloaded capacity calculated by the resource sufficiency evaluation — but the ISO area 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 EIM transfers. For the ISO, the base schedules used in the requirement are from the advisory schedules from the latest 15-minute market run.

Figure 5.1 compares the imbalance requirement in the bid-range capacity test with advisory EIM transfers from the latest 15-minute market run, on average for December. 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 EIM transfers. The green bars show advisory net EIM 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.[14] These values can be interpreted as the EIM imports balancing supply and demand in the advisory interval or the *market perspective* for the amount needed to replace to balance internal supply without EIM transfers.[15] Figure 5.1 compares these advisory net EIM imports (green bars) 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; Figure 5.2 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 December.

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

Figure 5.1. Average capacity test imbalance requirement and net EIM imports (December 2021)

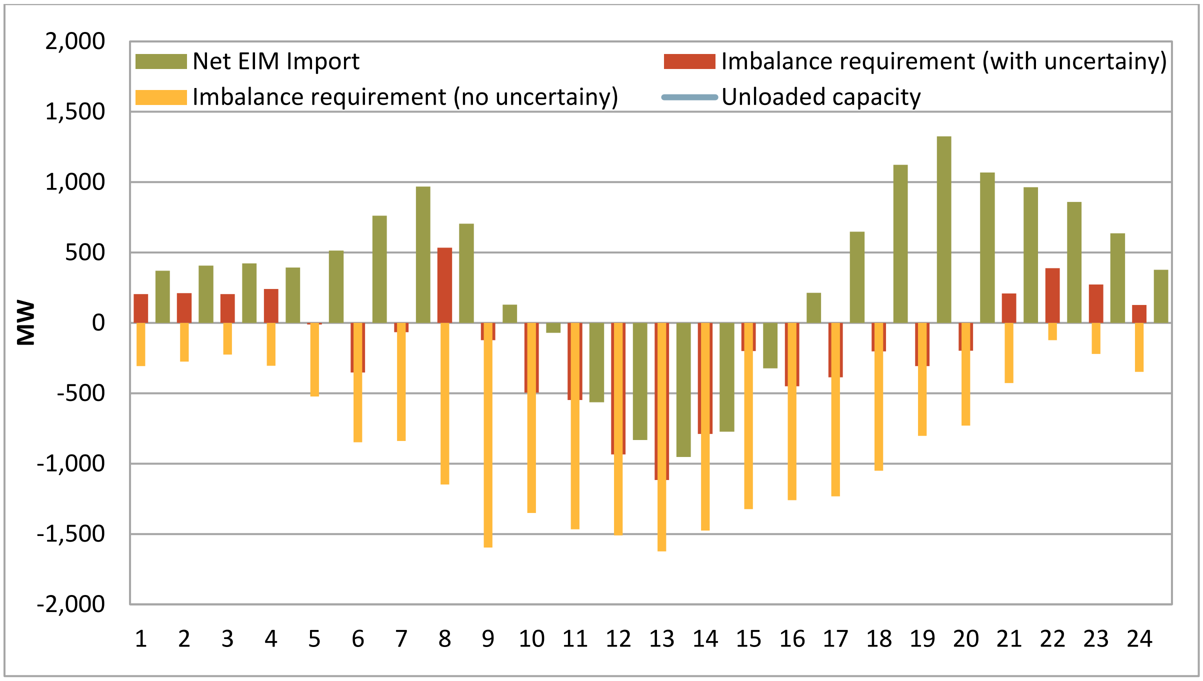
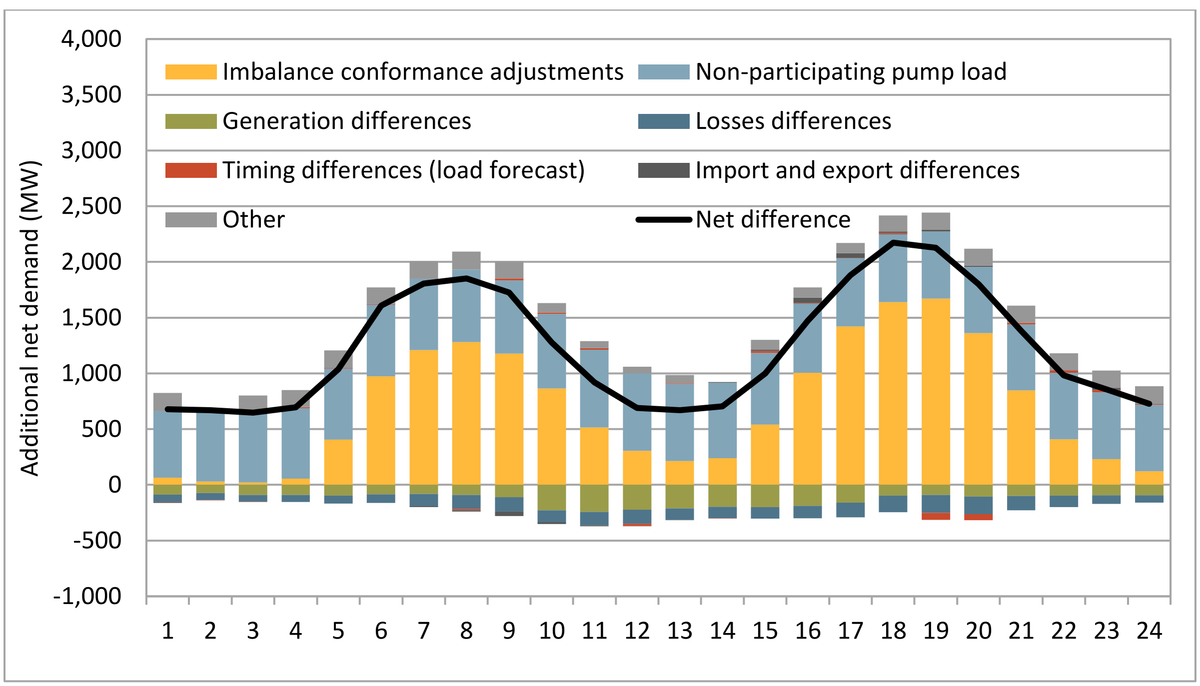


Figure 5.2. Additional net demand in the latest 15-minute market run not accounted for in the bid-range capacity test (December 2021)



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

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 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.[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 6.1 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.[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

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.

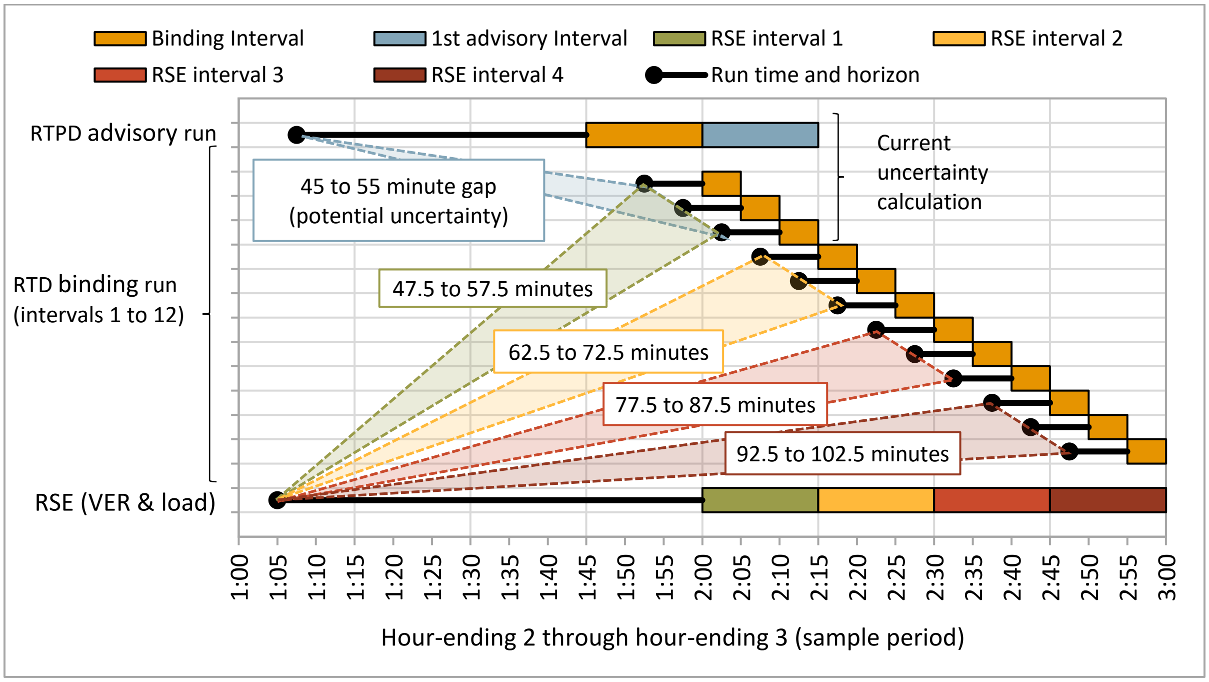
17 *Comments on EIM Resource Sufficiency Evaluation Enhancements Issue Paper*, September 8, 2021. http://www.caiso.com/Documents/DMM-Comments-on-EIM-Resource-Sufficiency-Evaluation-Enhancements-Issue-Paper-Sep-8-2021.pdf

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.

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 6.1. 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 6.2 summarizes the current source of net load error from either load, wind, or solar error in December for the ISO. 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 6.3 summarizes the difference between net load forecasts used in the bid range capacity test and those used in the 5-minute market for the ISO during December. 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 6.4 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 6.5 through

Figure 6.49 provide the same information for all EIM entities.

Figure 6.2. California ISO average uncertainty by component (Weekdays, December 2021)

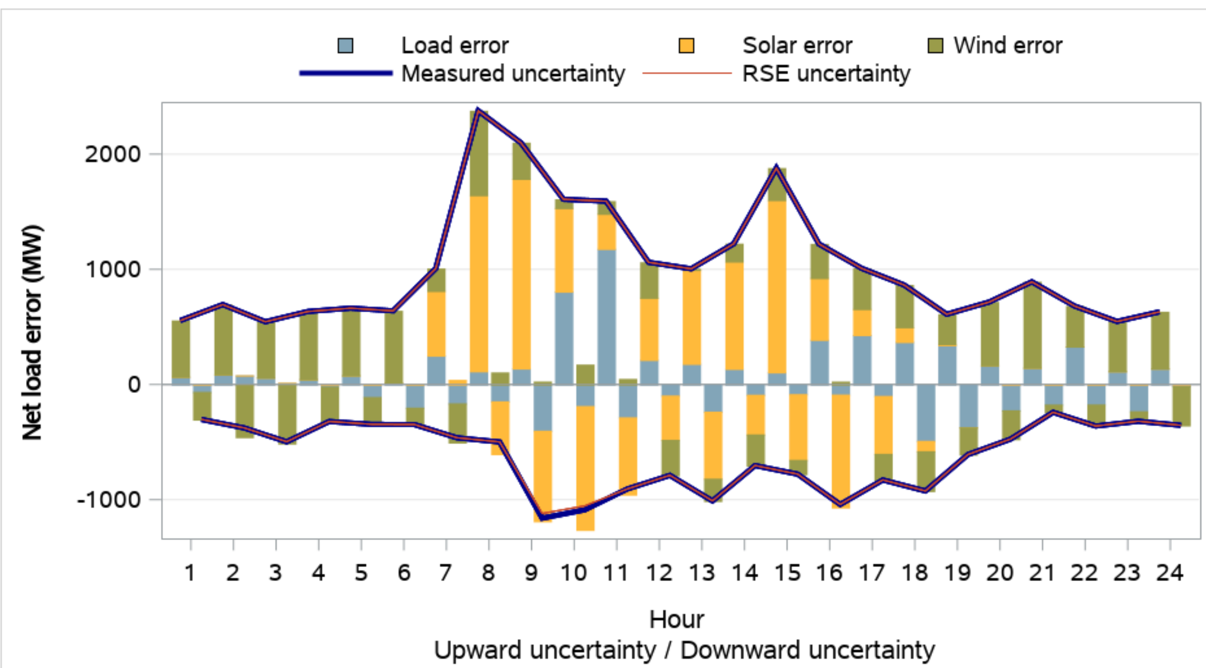


Figure 6.3. California ISO distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, December 2021)

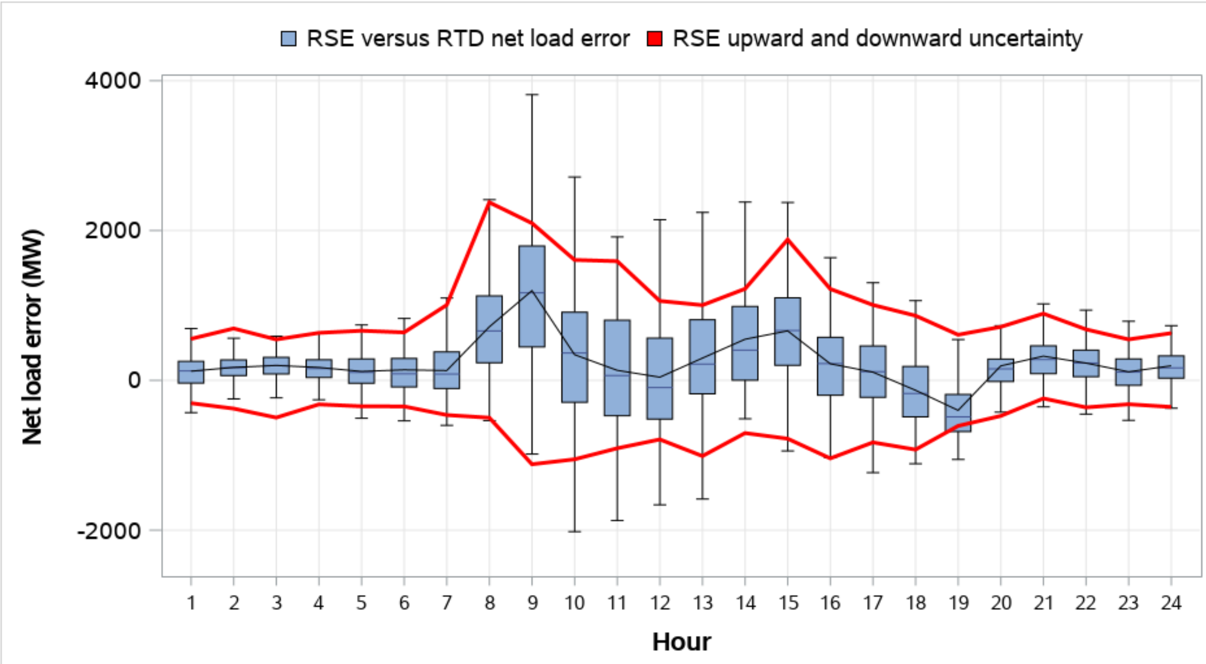


Figure 6.4. California ISO distribution of RSE and RTD load and VER error (Weekdays, December 2021)

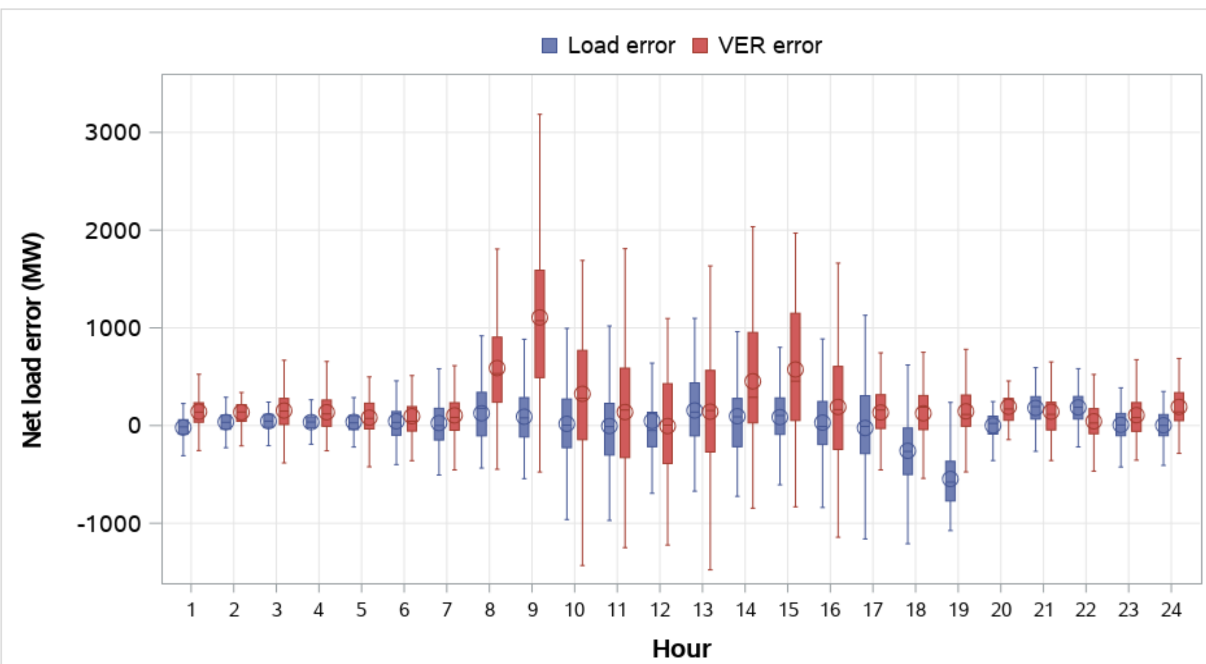


Figure 6.5. Arizona Public Service average uncertainty by component (Weekdays, December 2021)

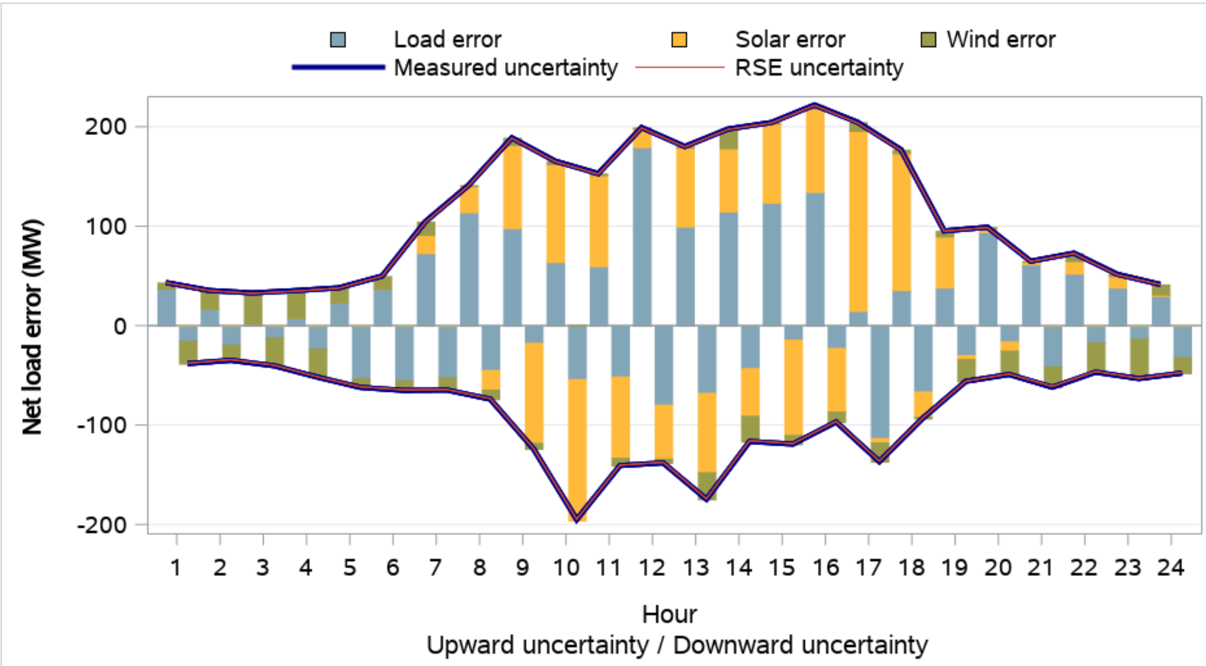


Figure 6.6. Arizona Public Service distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, December 2021)

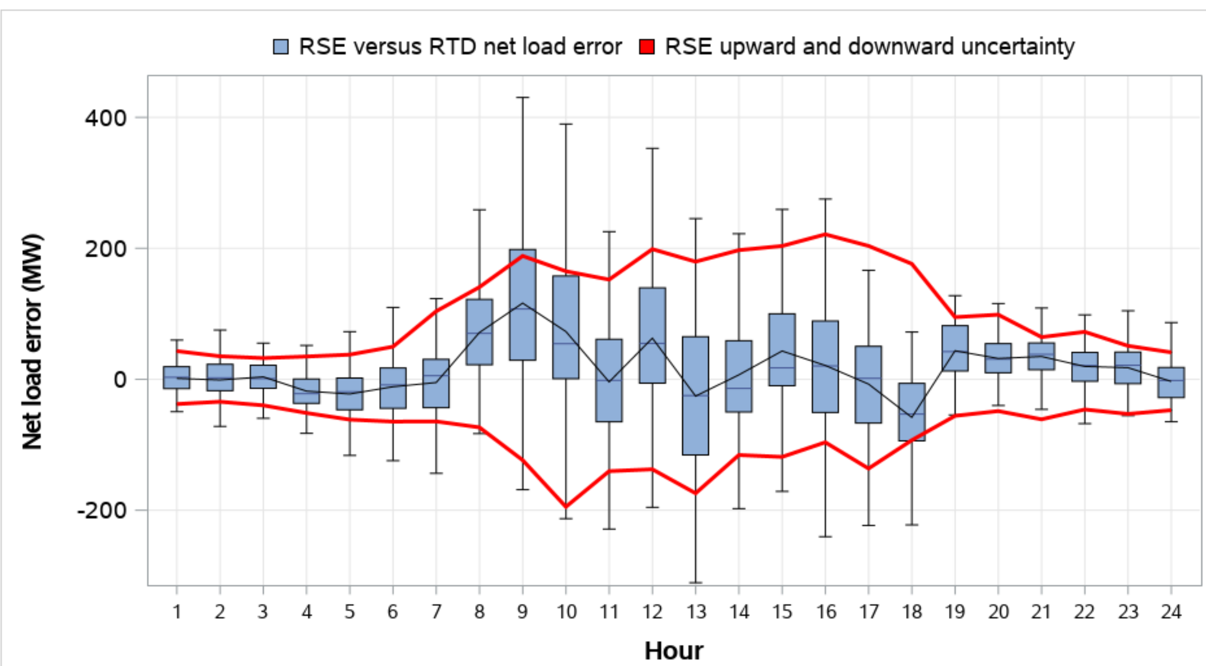


Figure 6.7. Arizona Public Service distribution of RSE and RTD load and VER error (Weekdays, December 2021)

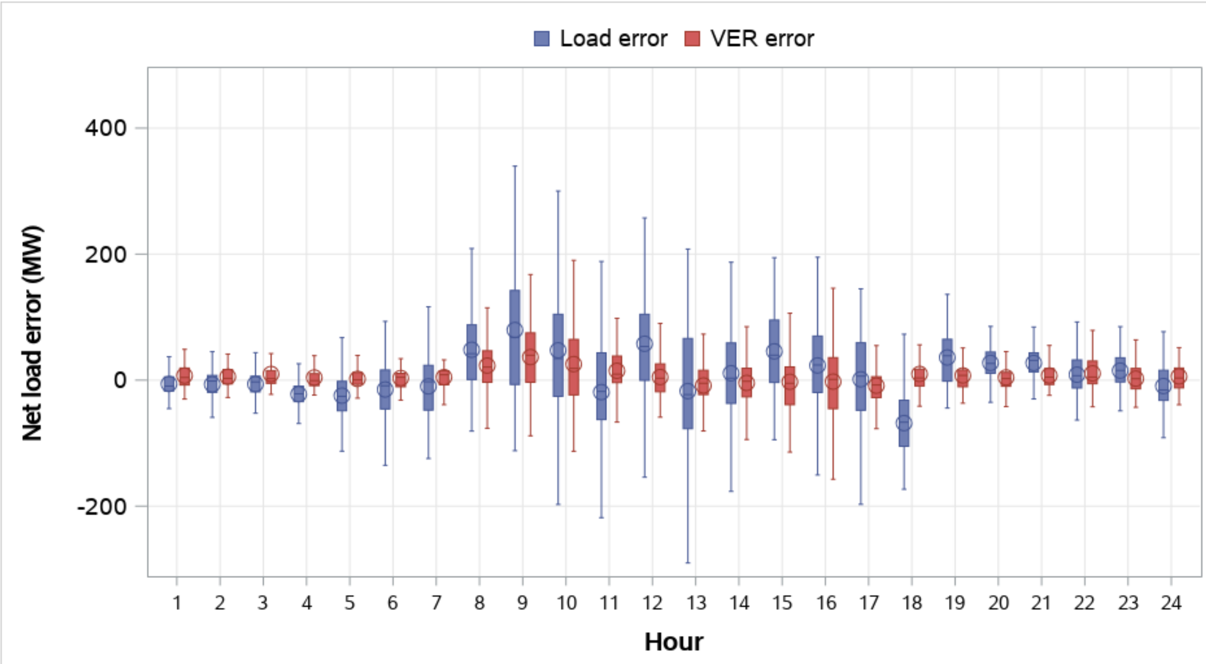


Figure 6.8. BANC average uncertainty by component (Weekdays, December 2021)

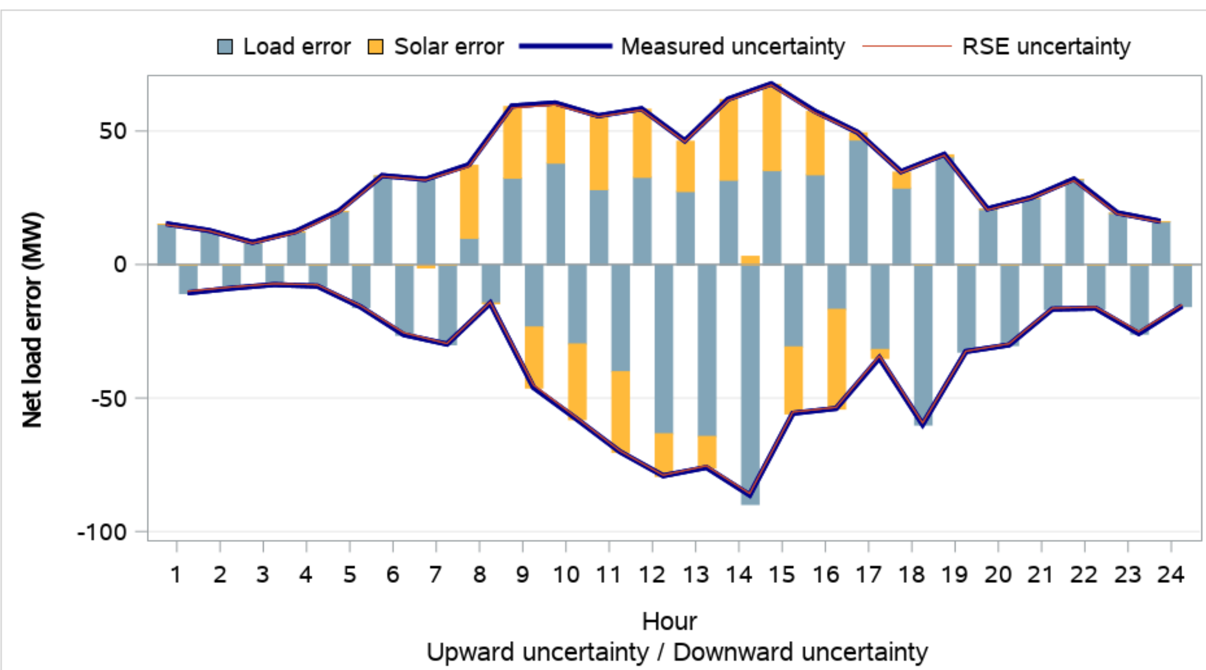


Figure 6.9. BANC distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, December 2021)

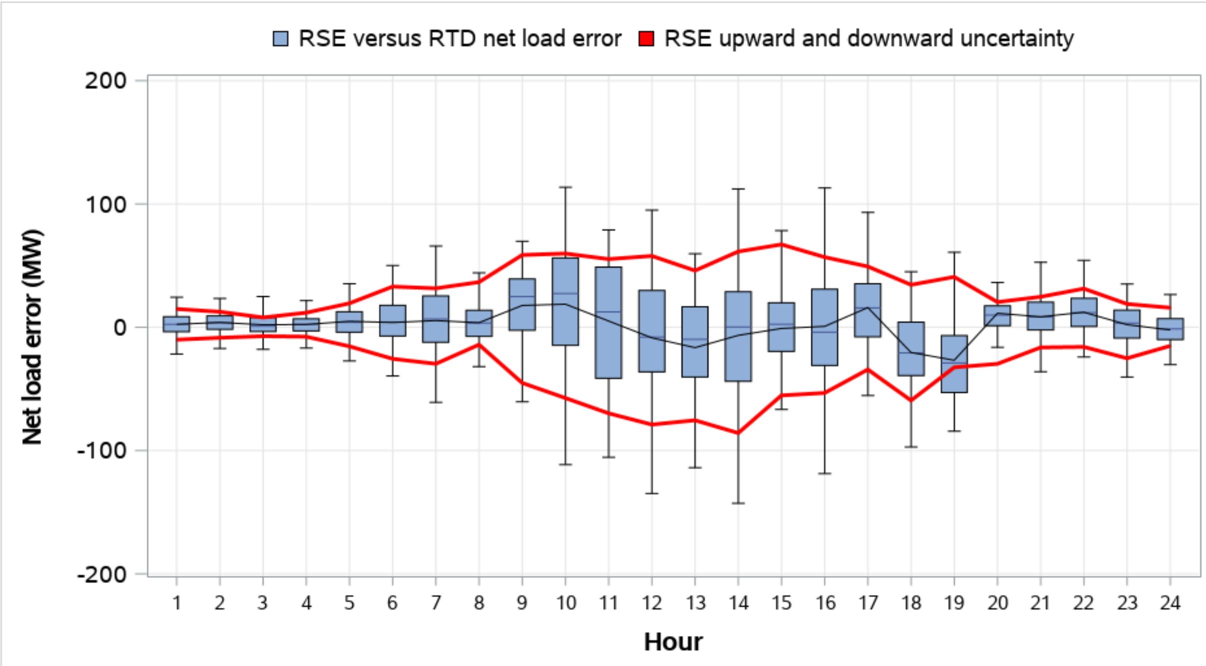


Figure 6.10. BANC distribution of RSE and RTD load and VER error (Weekdays, December 2021)

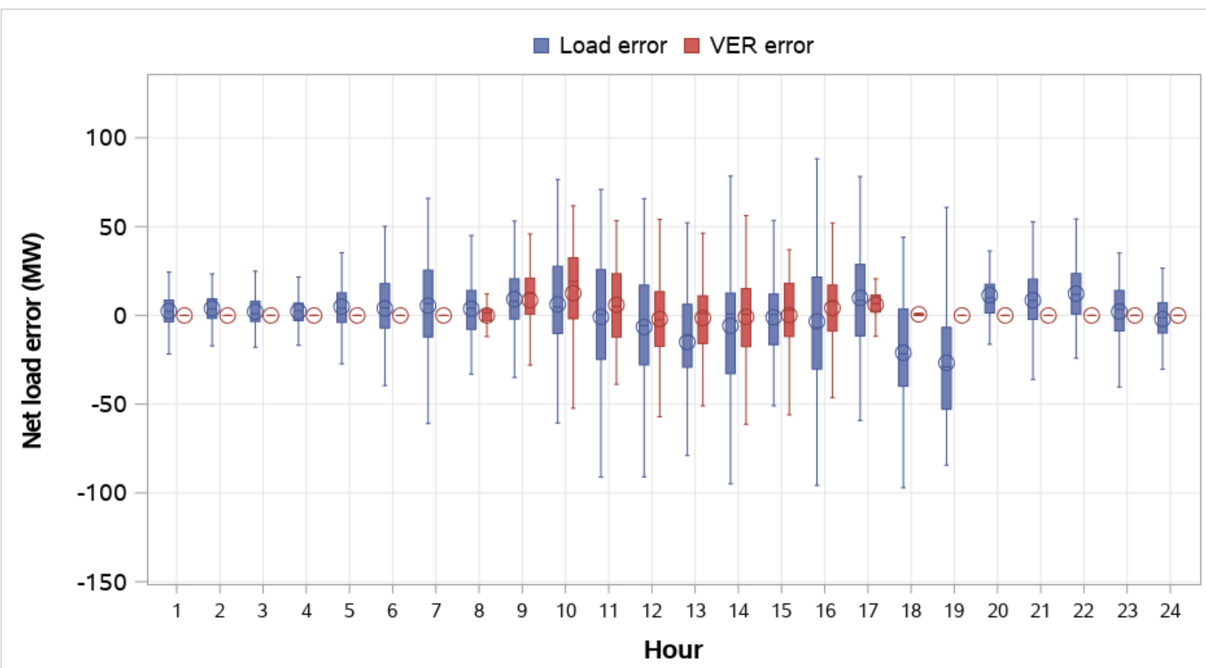


Figure 6.11. Idaho Power average uncertainty by component (Weekdays, December 2021)

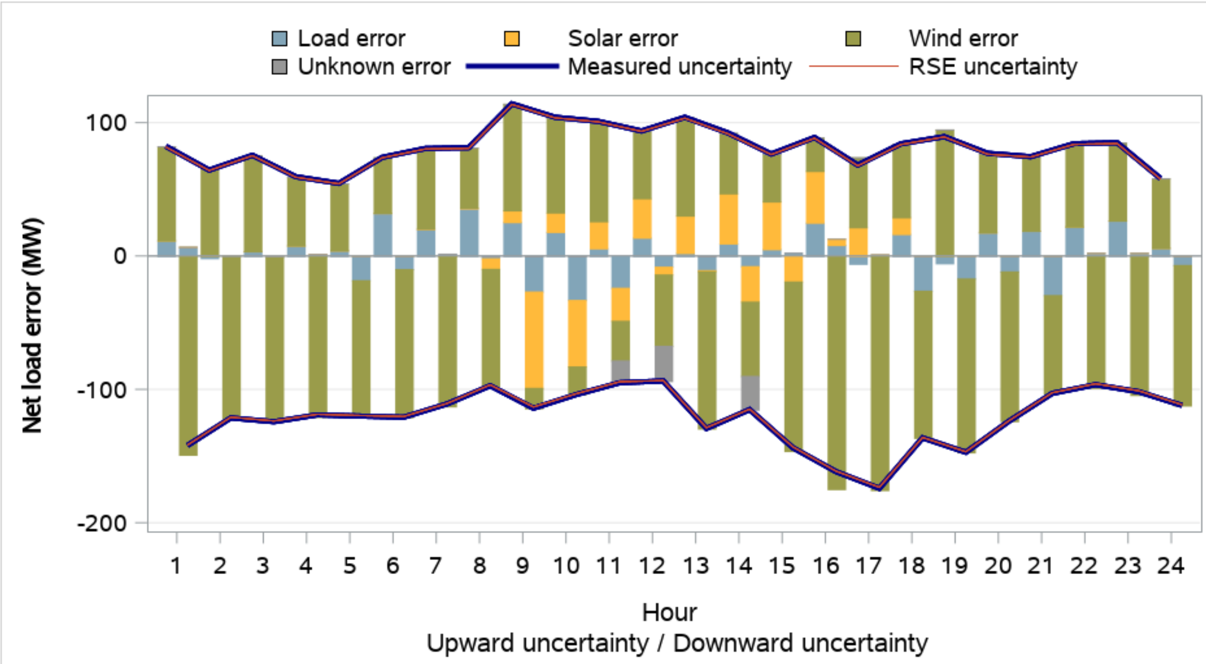


Figure 6.12. Idaho Power distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, December 2021)

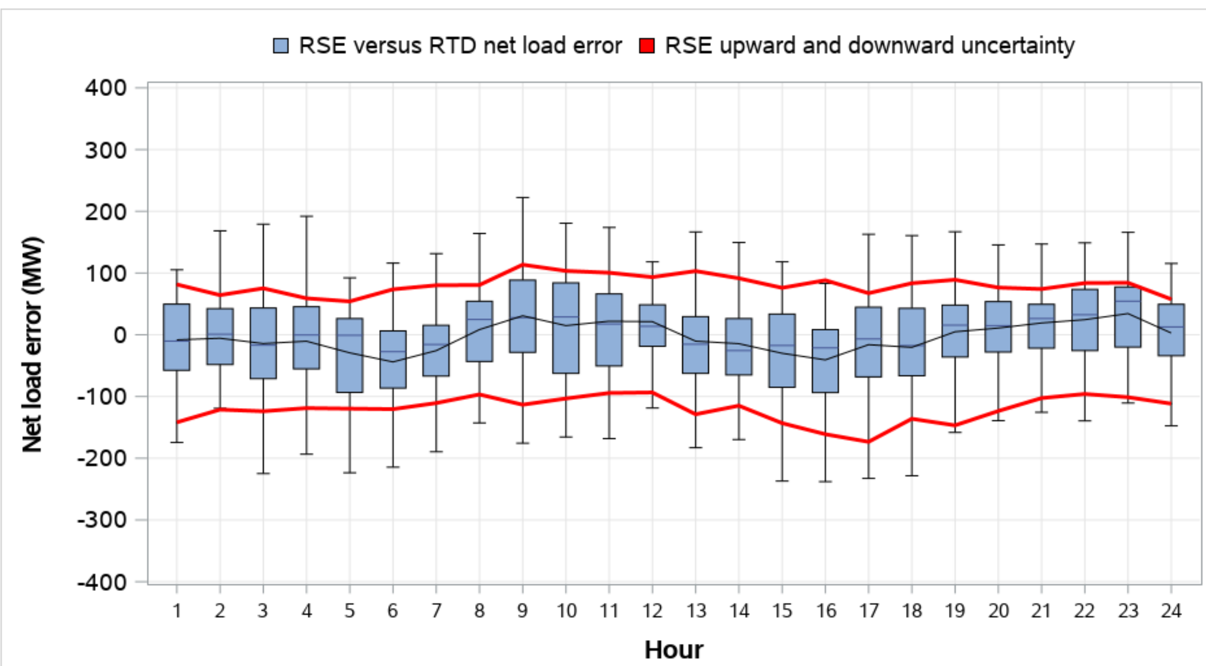


Figure 6.13. Idaho Power distribution of RSE and RTD load and VER error (Weekdays, December 2021)

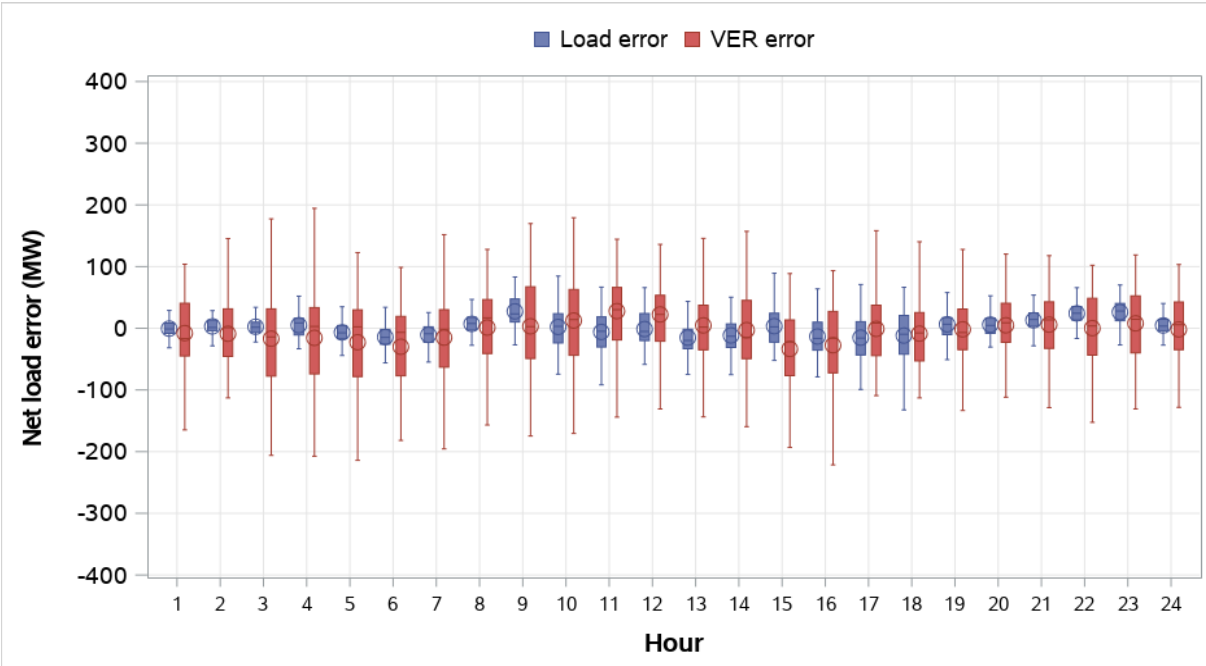


Figure 6.14. LADWP average uncertainty by component (Weekdays, December 2021)

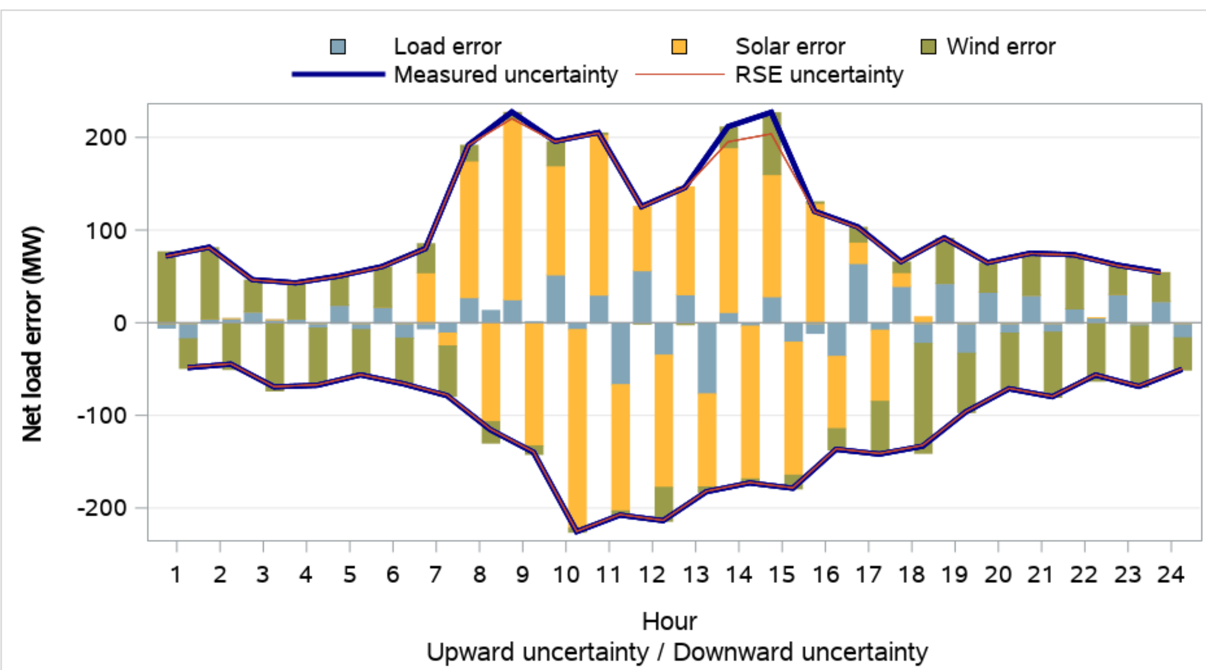


Figure 6.15. LADWP distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, December 2021)

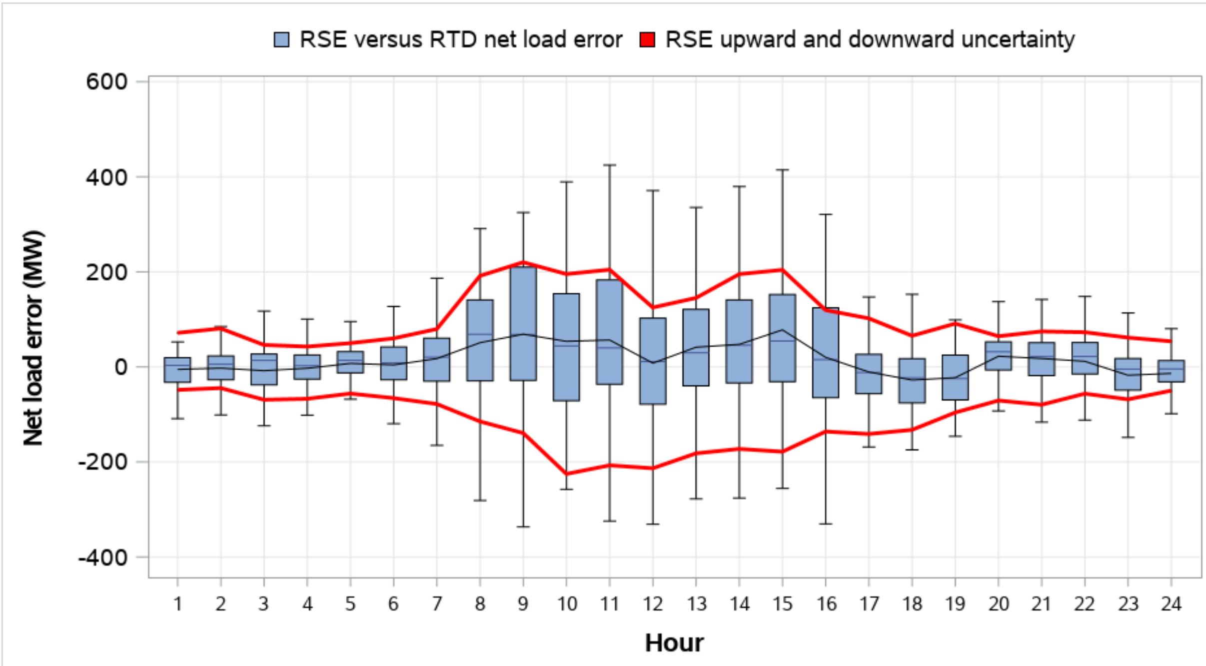


Figure 6.16. LADWP distribution of RSE and RTD load and VER error (Weekdays, December 2021)

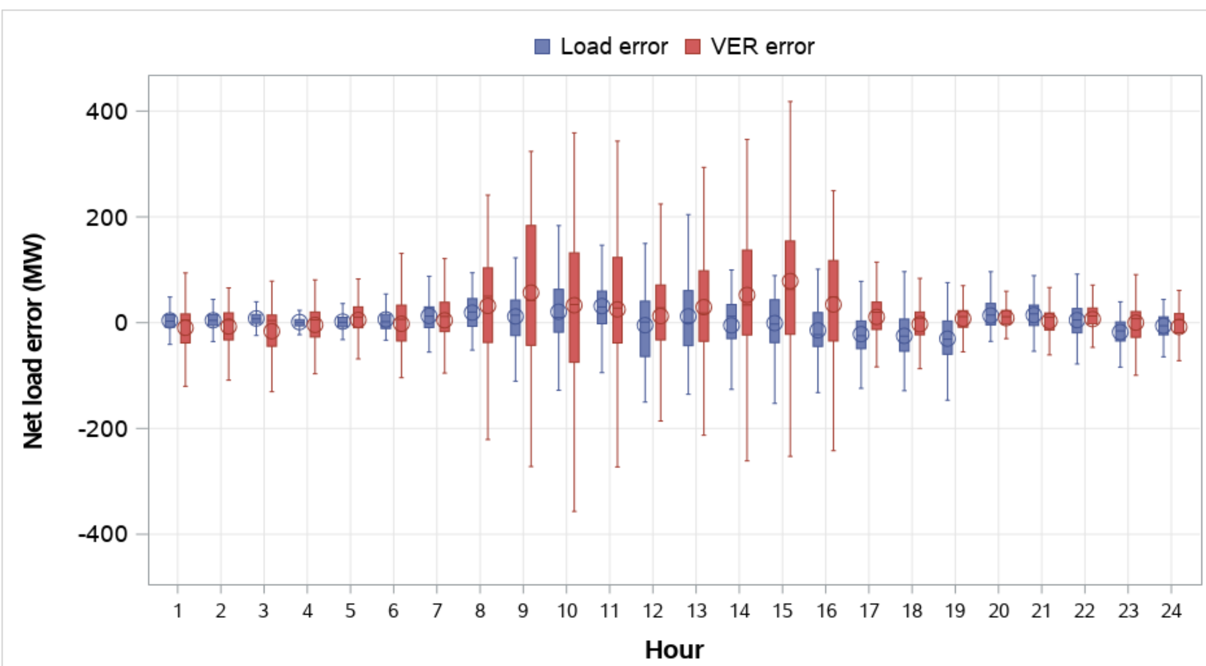


Figure 6.17. NorthWestern Energy average uncertainty by component (Weekdays, December 2021)

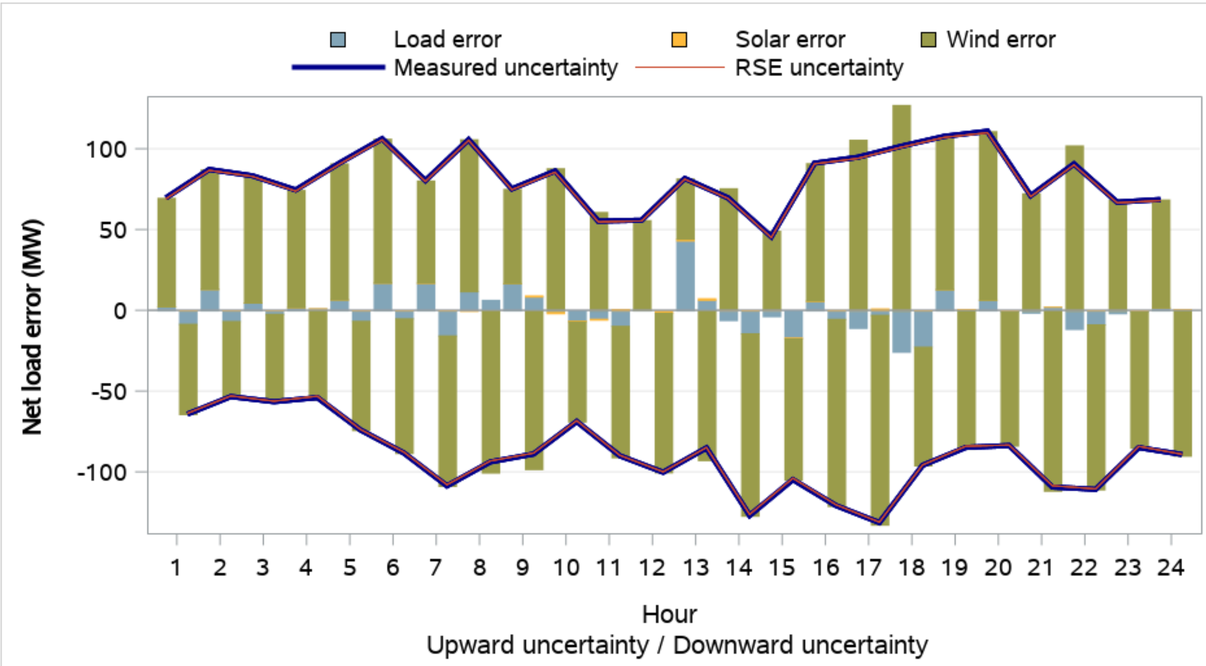


Figure 6.18. NorthWestern Energy distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, December 2021)

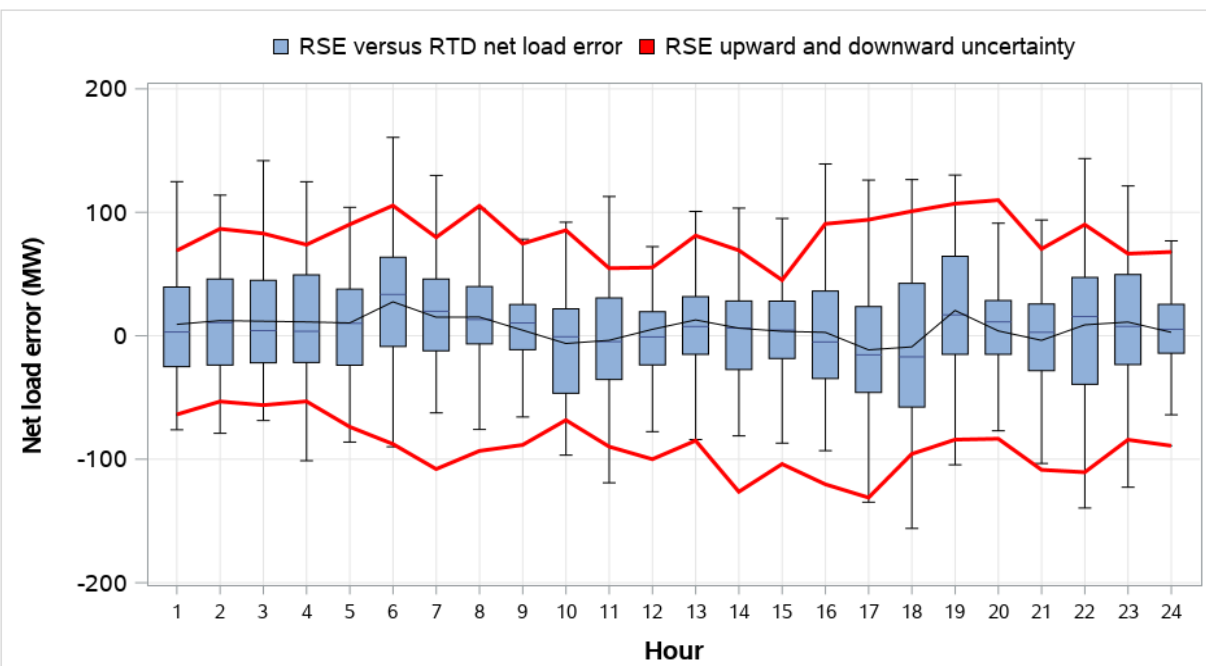


Figure 6.19. NorthWestern Energy distribution of RSE and RTD load and VER error (Weekdays, December 2021)

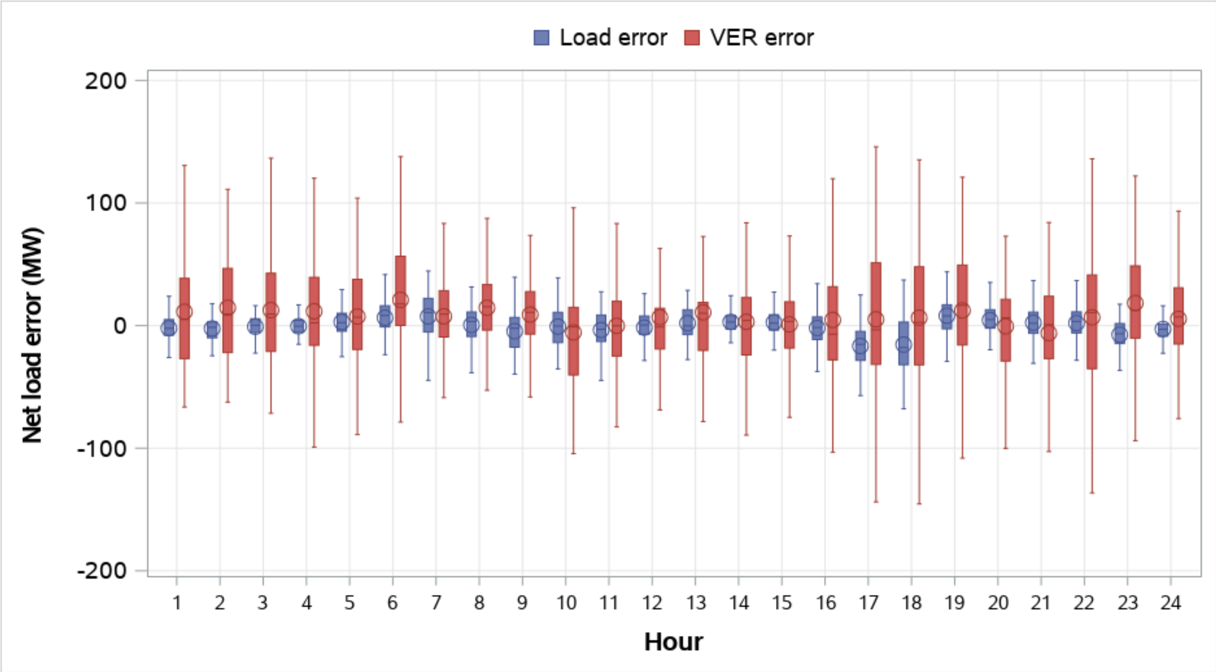


Figure 6.20. NV Energy average uncertainty by component (Weekdays, December 2021)

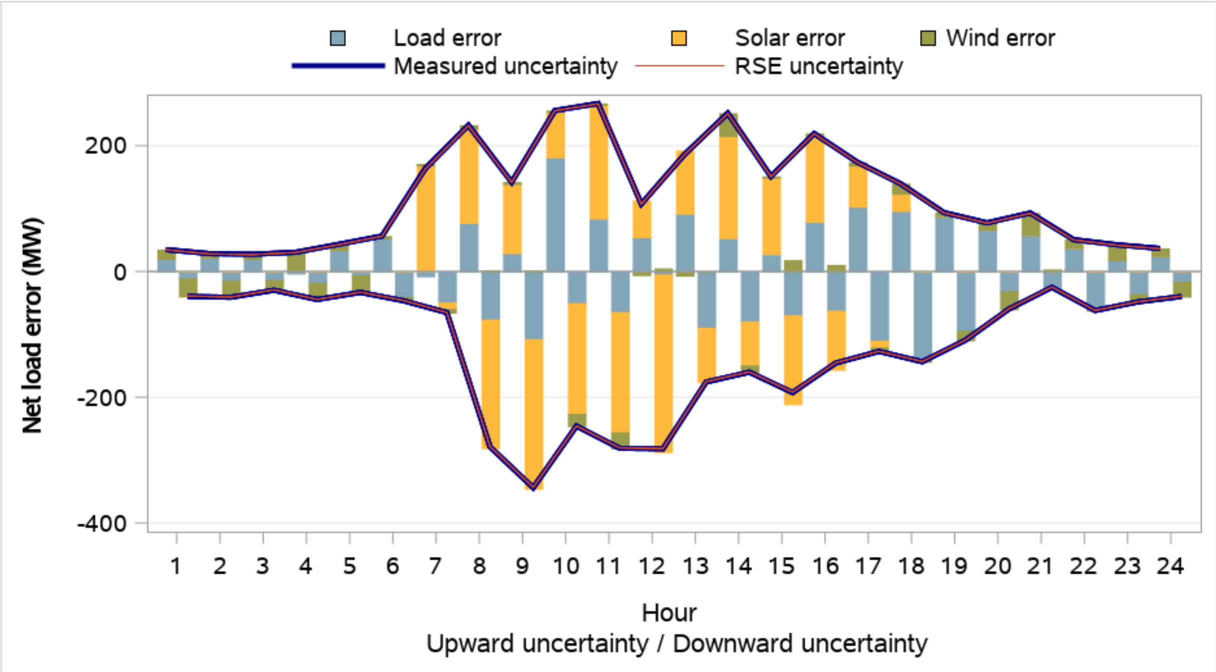


Figure 6.21. NV Energy distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, December 2021)

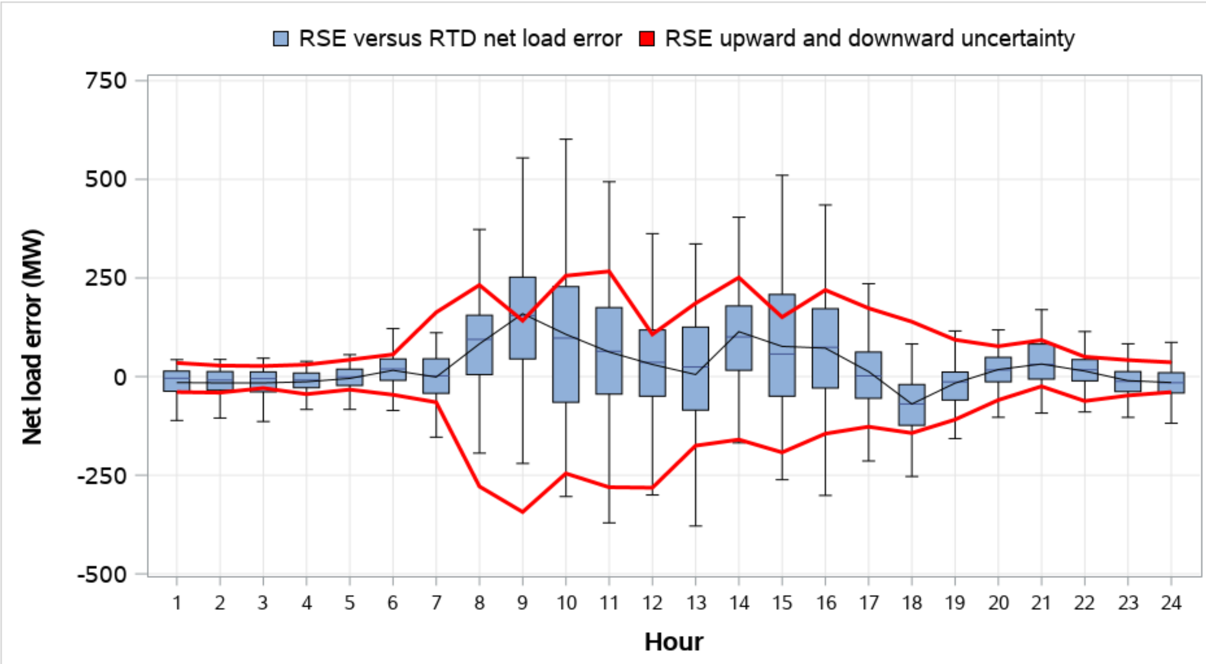


Figure 6.22. NV Energy distribution of RSE and RTD load and VER error (Weekdays, December 2021)

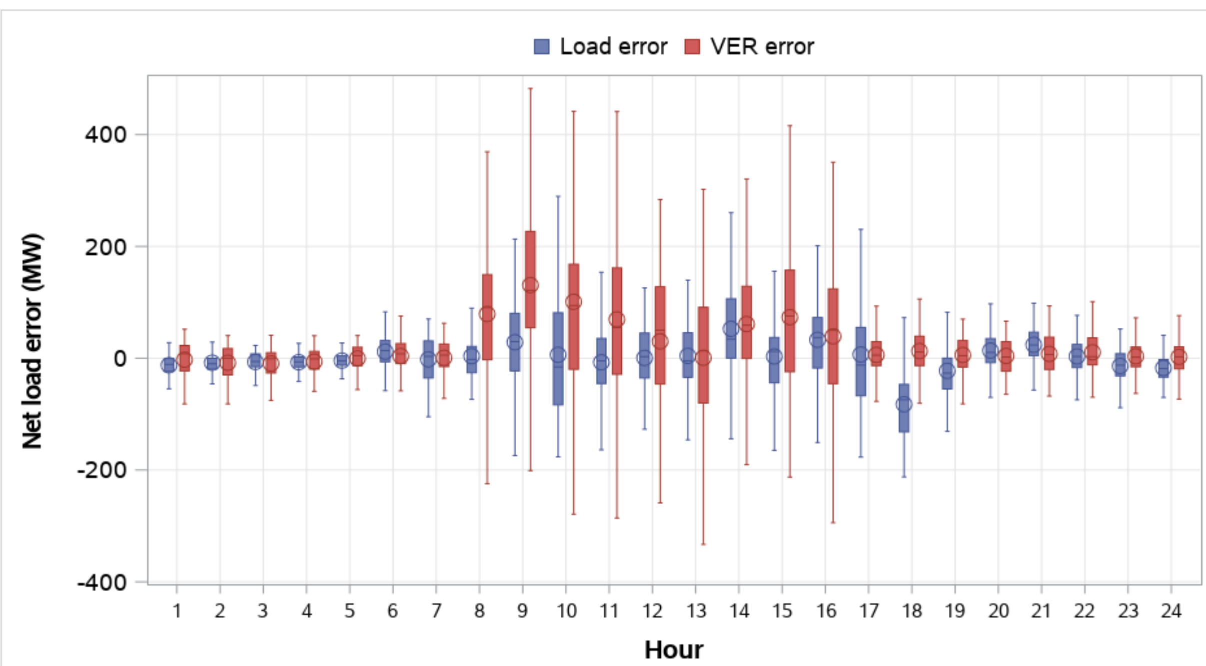


Figure 6.23. PacifiCorp East average uncertainty by component (Weekdays, December 2021)

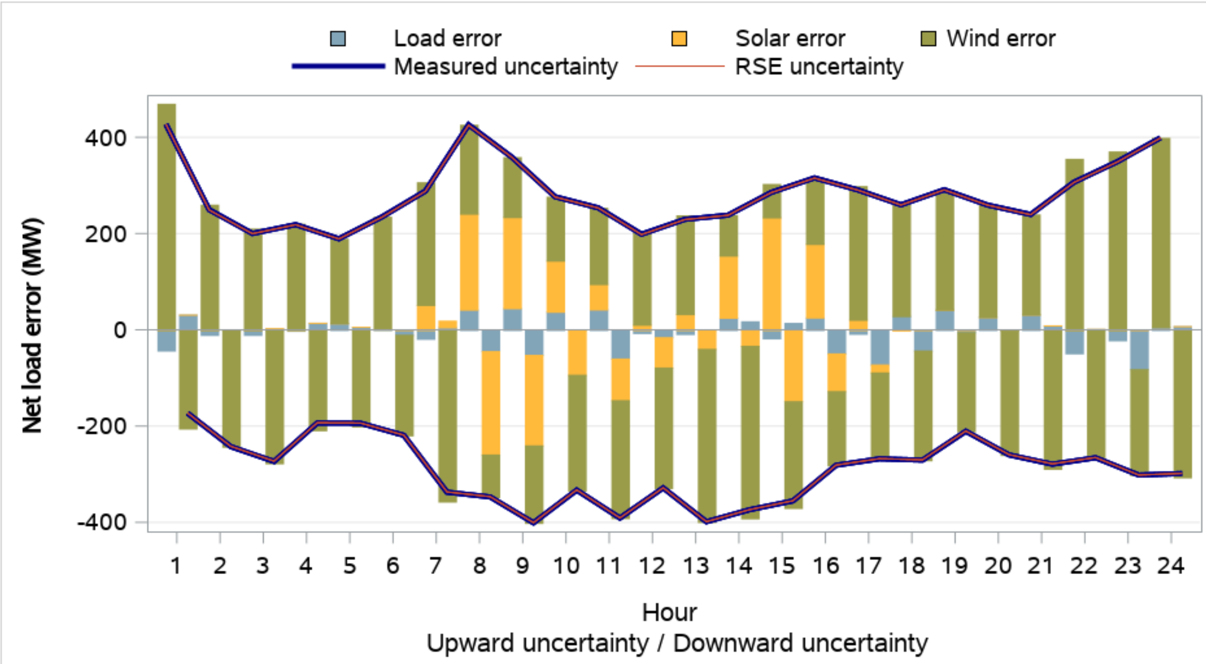


Figure 6.24. PacifiCorp East distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, December 2021)

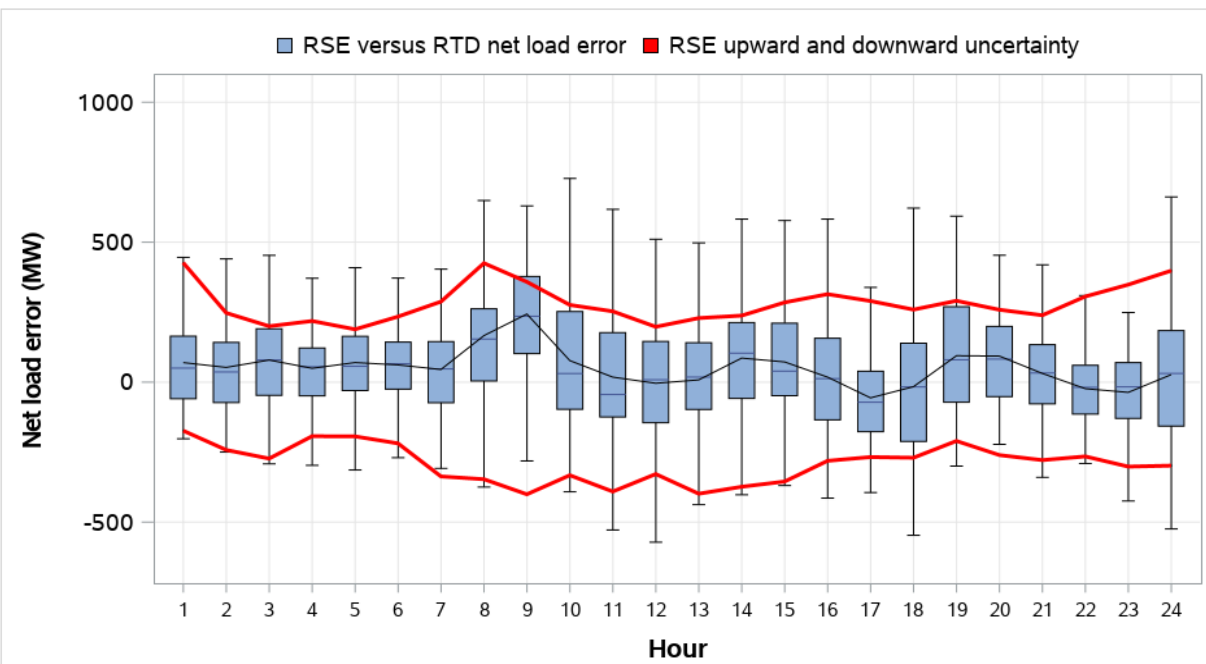


Figure 6.25. PacifiCorp East distribution of RSE and RTD load and VER error (Weekdays, December 2021)

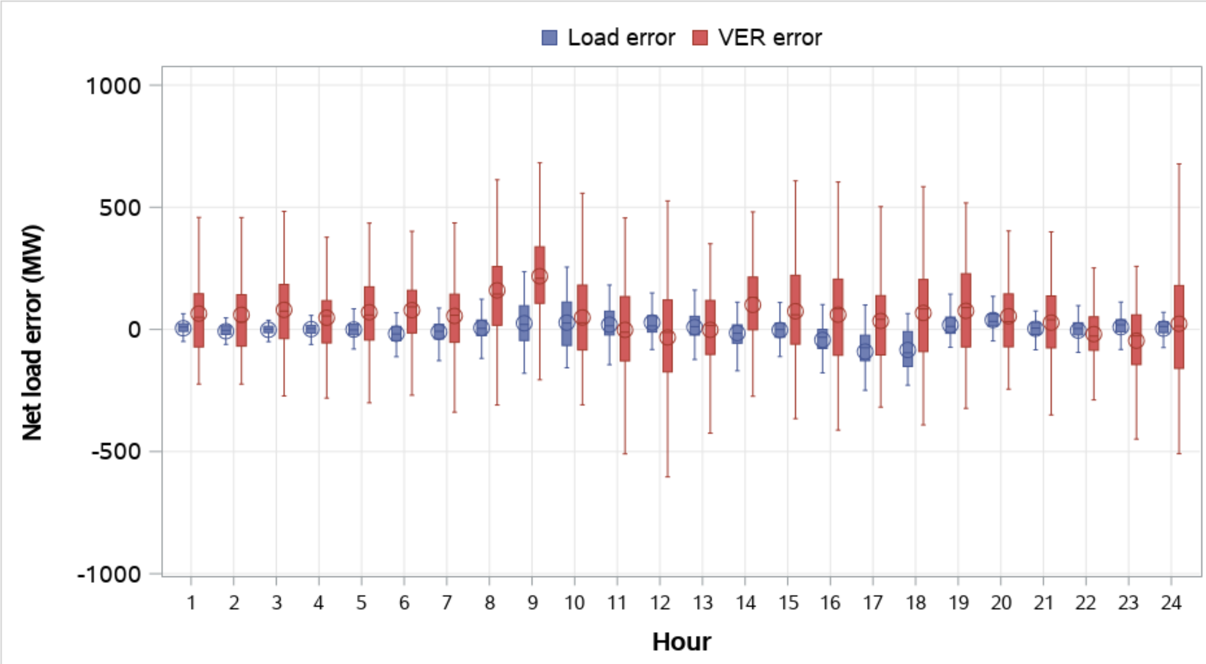


Figure 6.26. PacifiCorp West average uncertainty by component (Weekdays, December 2021)

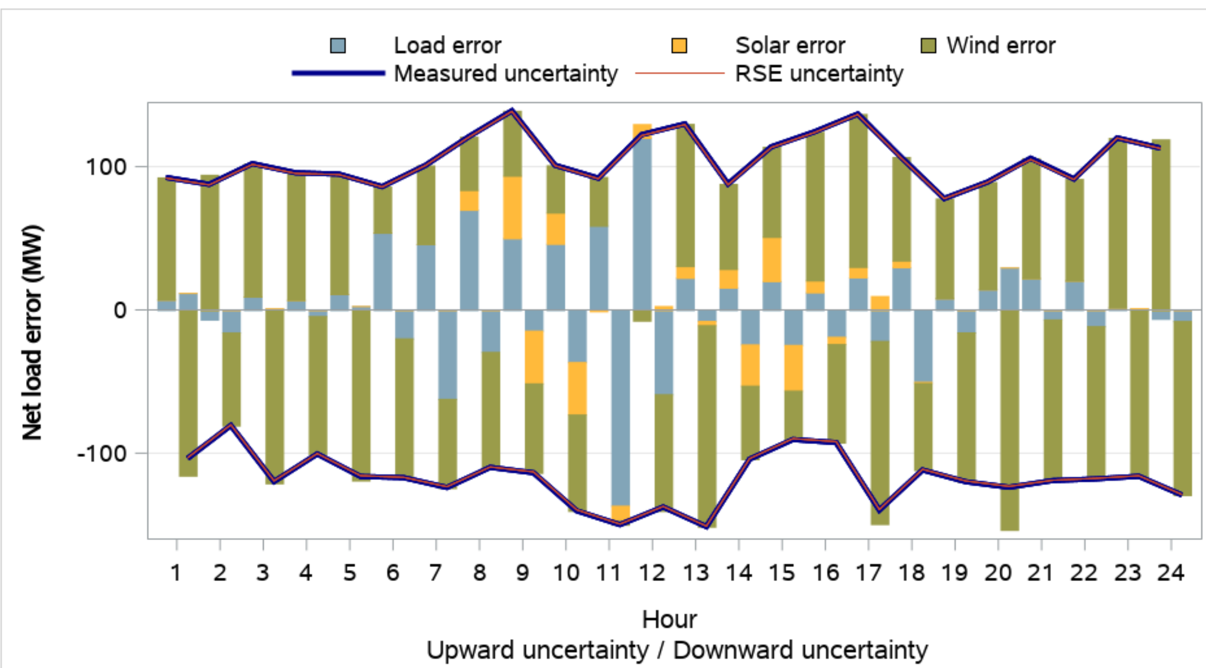


Figure 6.27. PacifiCorp West distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, December 2021)

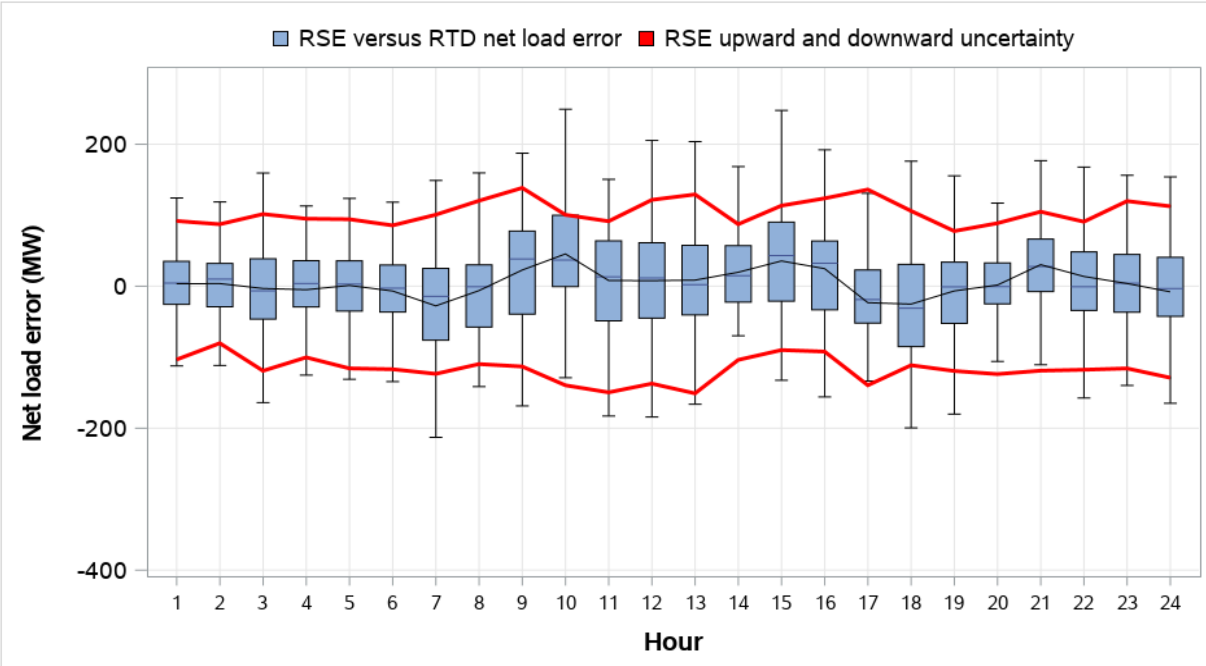


Figure 6.28. PacifiCorp West distribution of RSE and RTD load and VER error (Weekdays, December 2021)

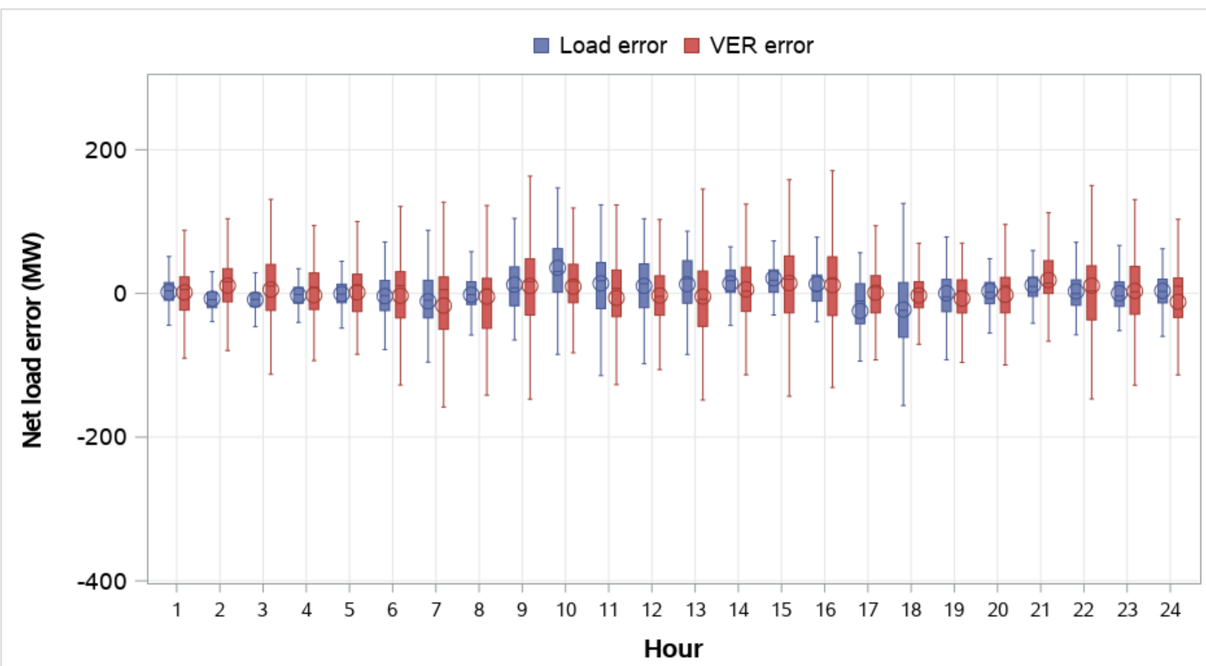


Figure 6.29. Portland General Electric average uncertainty by component (Weekdays, December 2021)

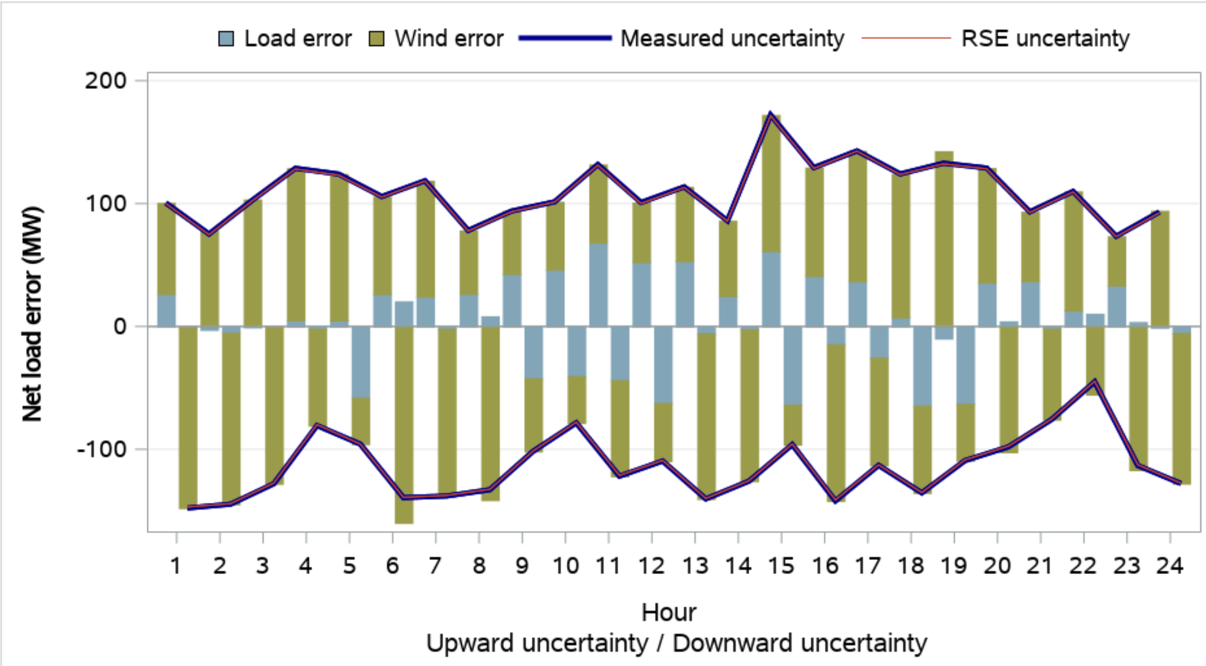


Figure 6.30. Portland General Electric distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, December 2021)

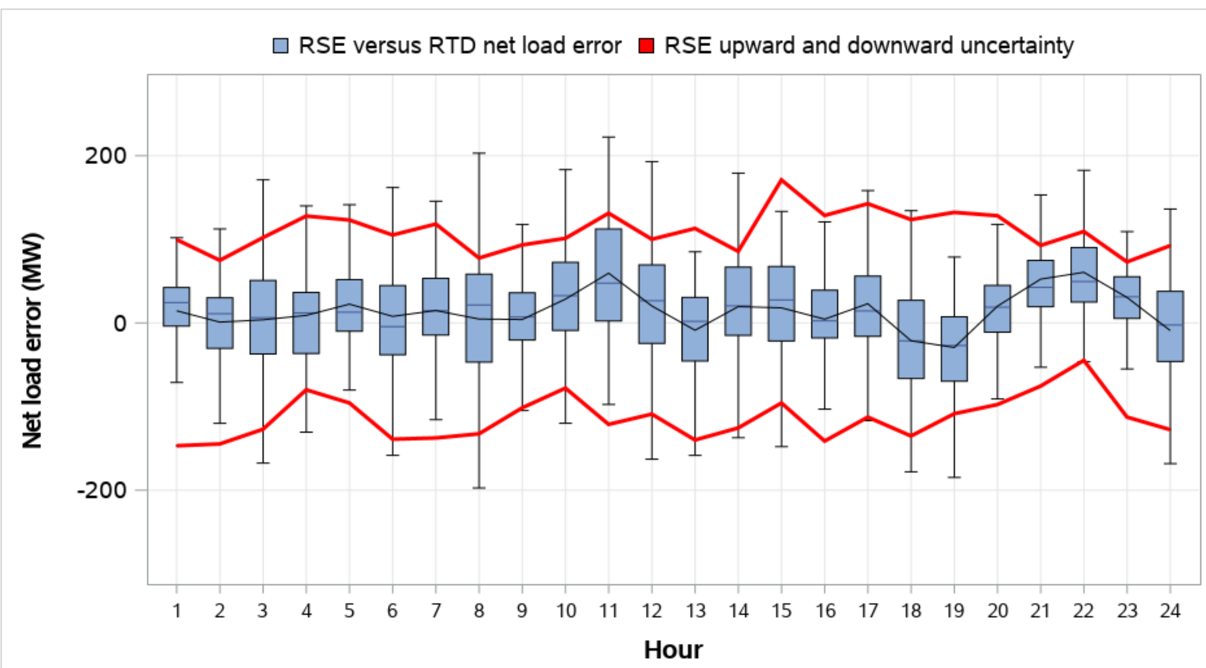


Figure 6.31. Portland General Electric distribution of RSE and RTD load and VER error (Weekdays, December 2021)

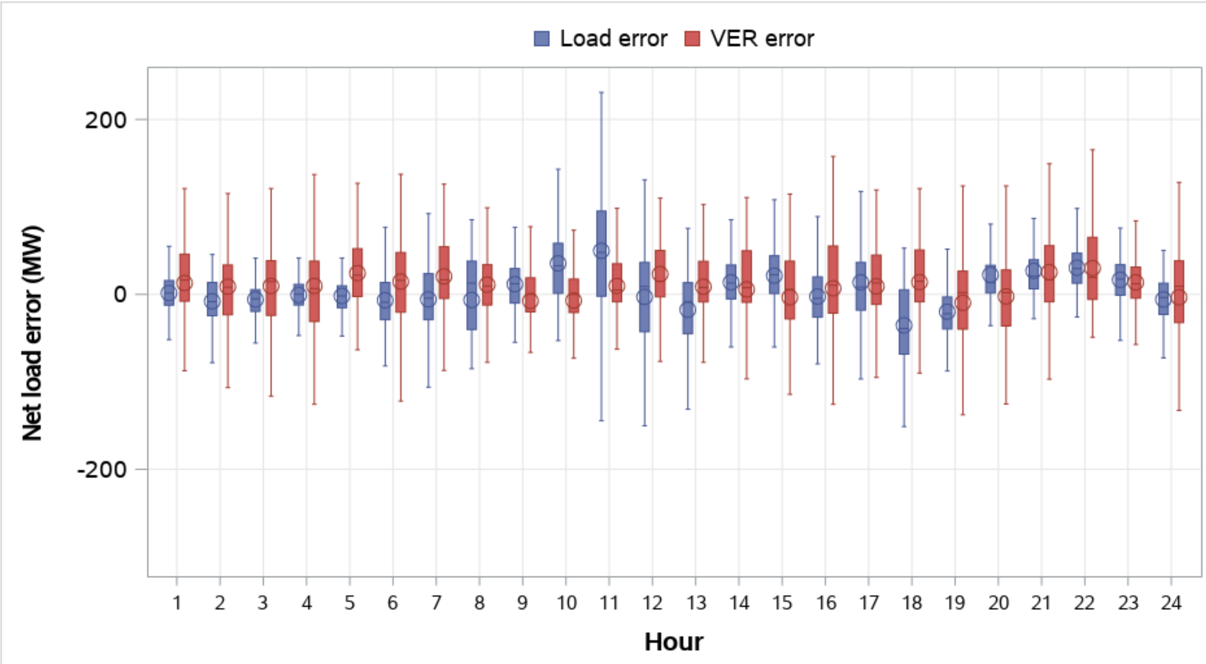


Figure 6.32. Powerex average uncertainty by component (Weekdays, December 2021)

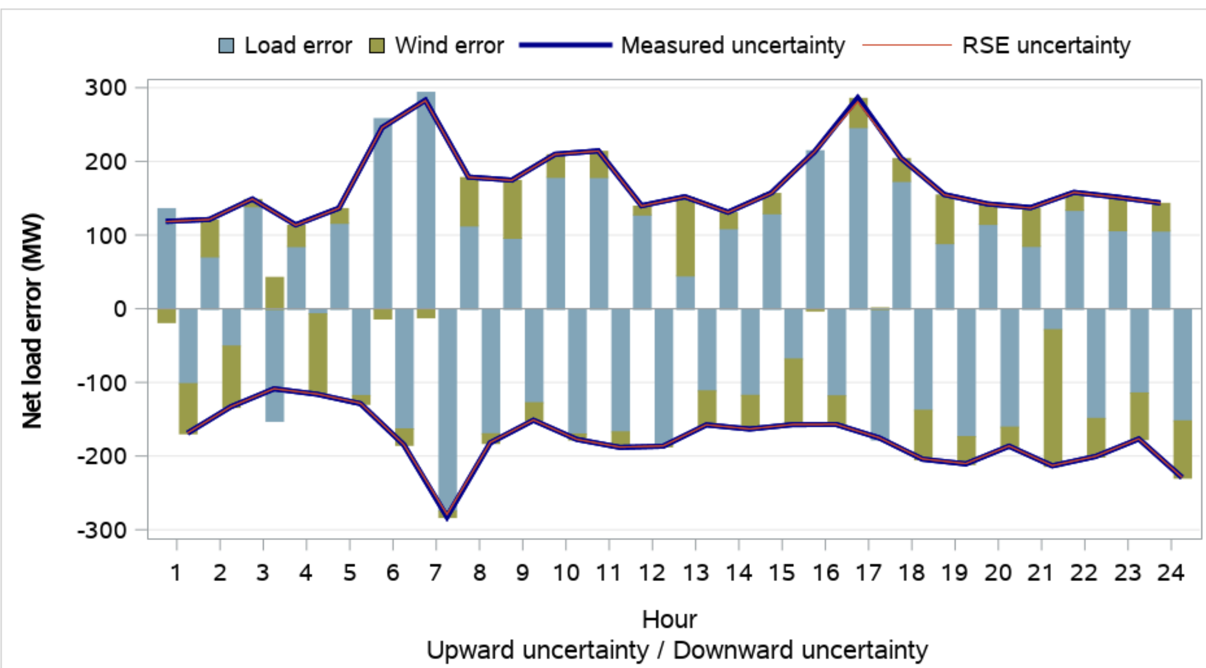


Figure 6.33. Powerex distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, December 2021)

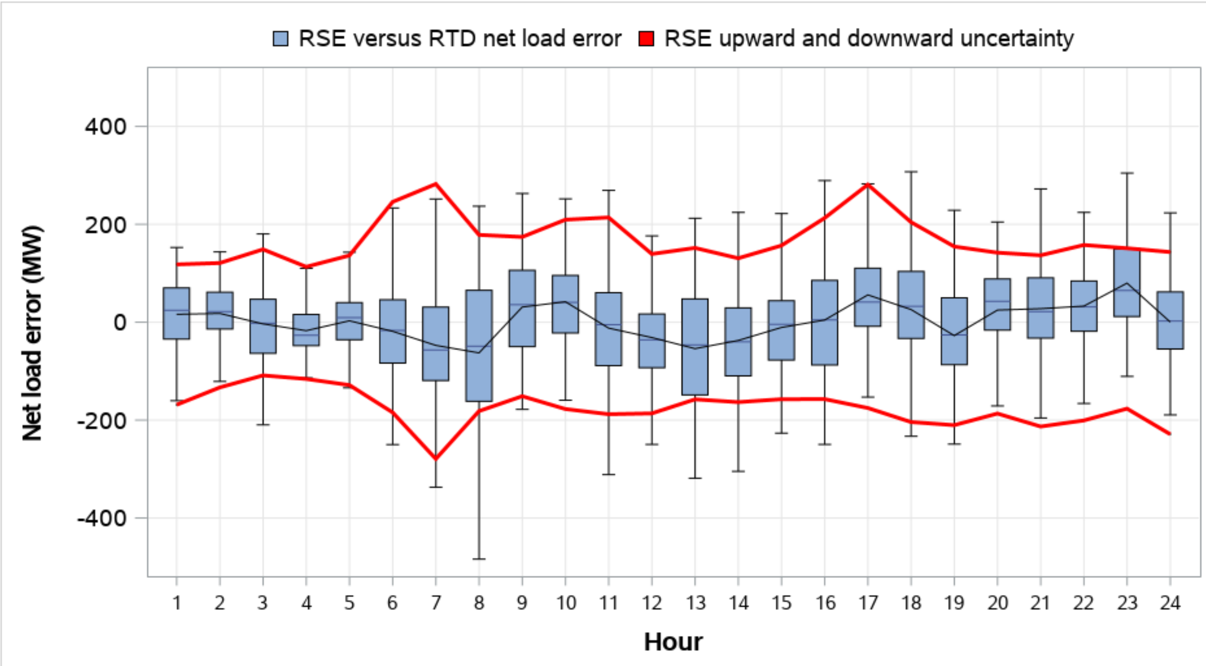


Figure 6.34. Powerex distribution of RSE and RTD load and VER error (Weekdays, December 2021)

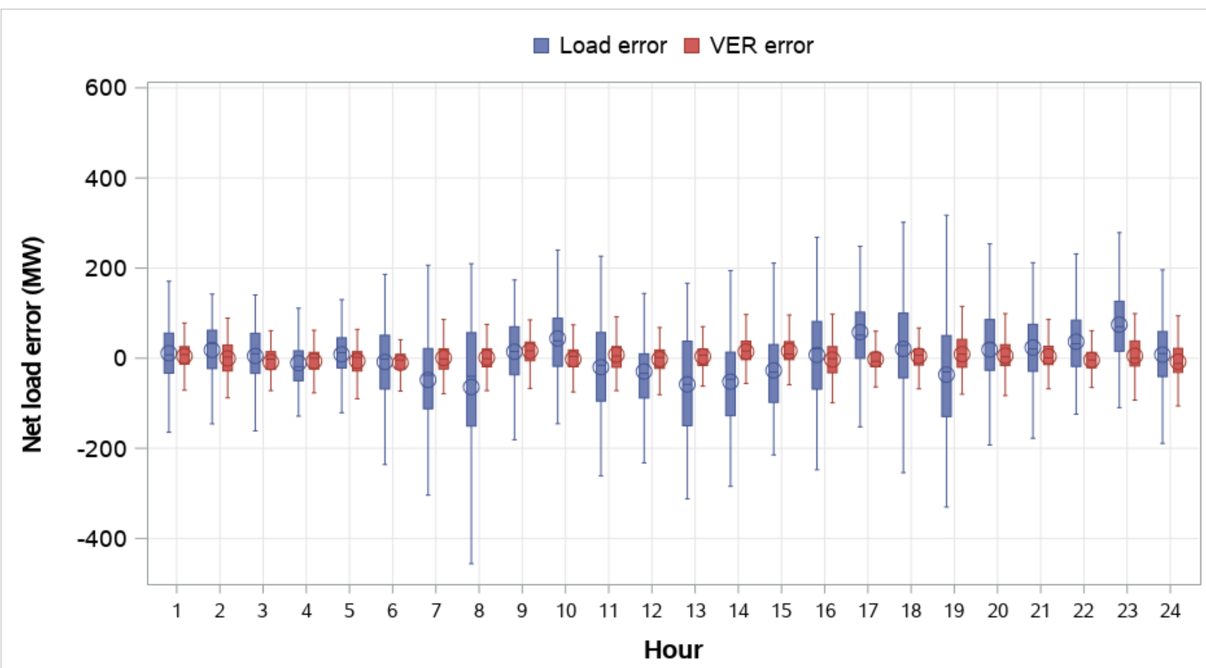


Figure 6.35. PNM average uncertainty by component (Weekdays, December 2021)

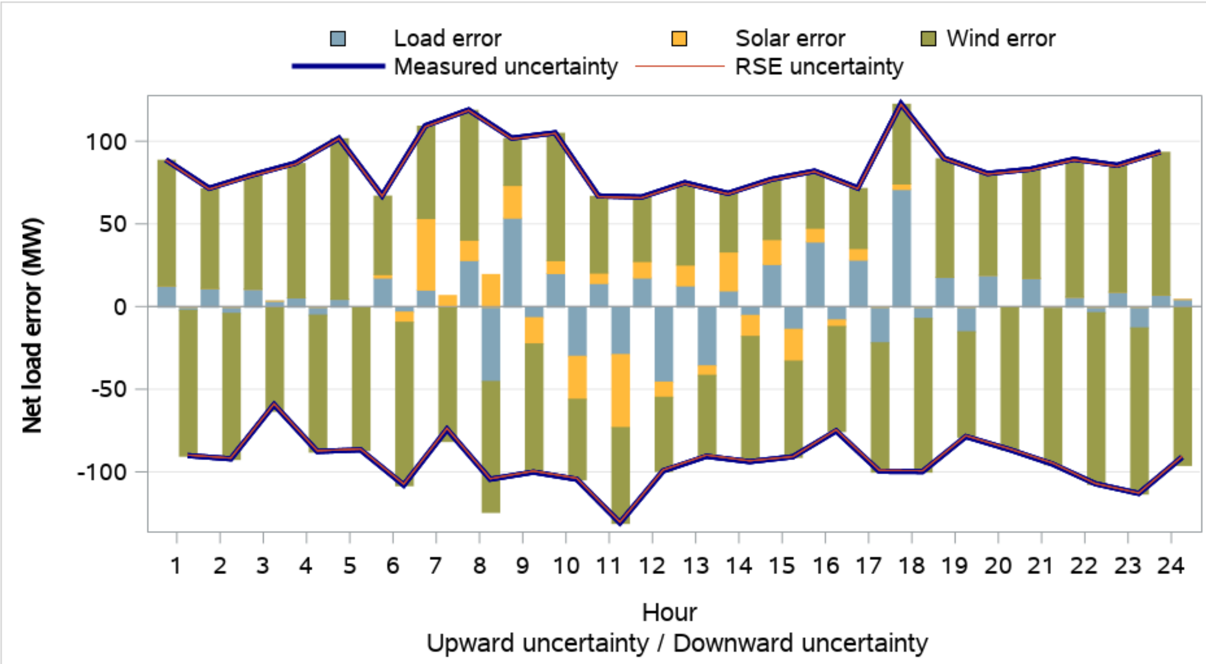


Figure 6.36. PNM distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, December 2021)

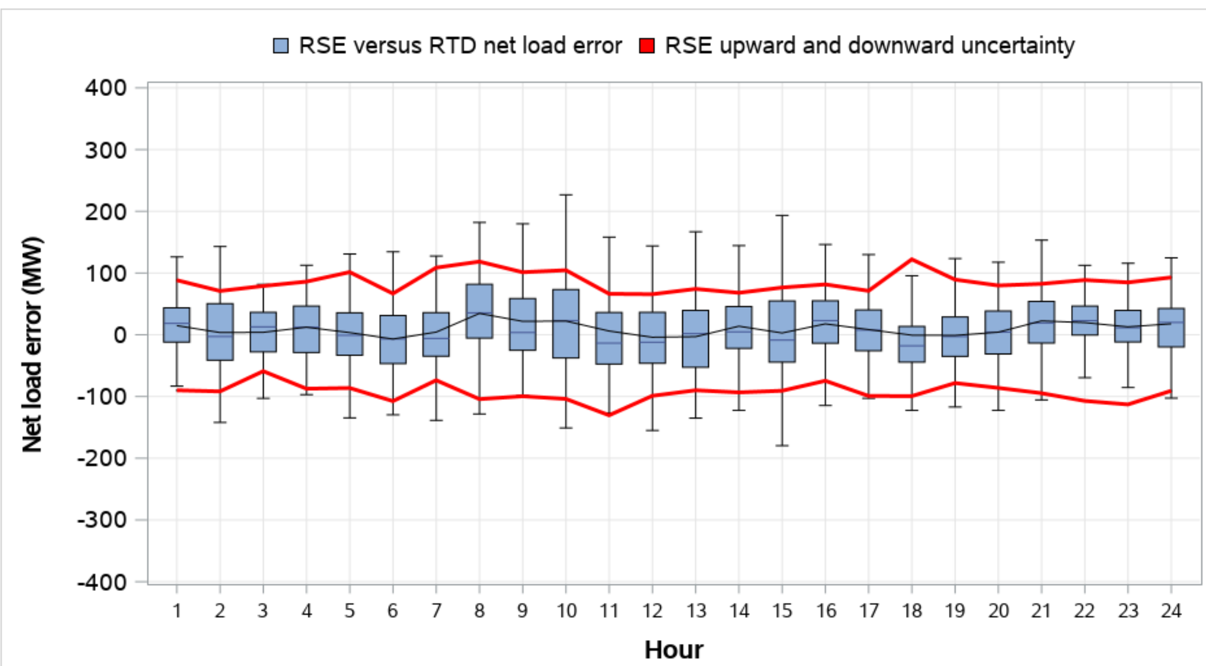


Figure 6.37. PNM distribution of RSE and RTD load and VER error (Weekdays, December 2021)

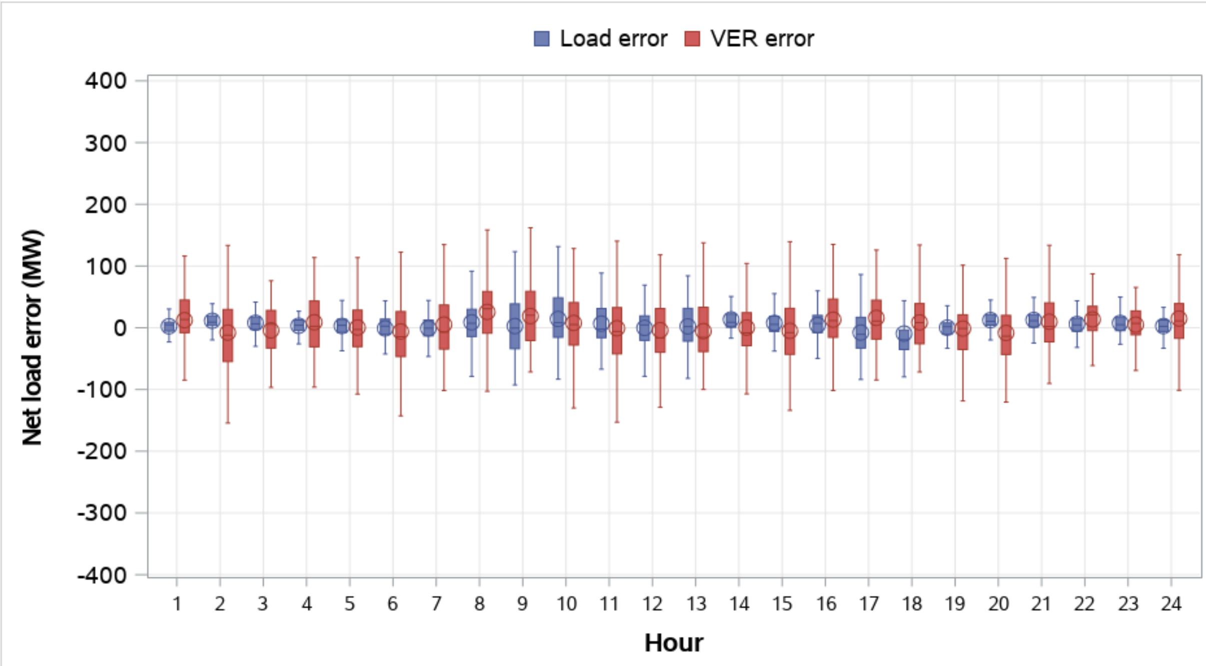


Figure 6.38. Puget Sound Energy average uncertainty by component (Weekdays, December 2021)

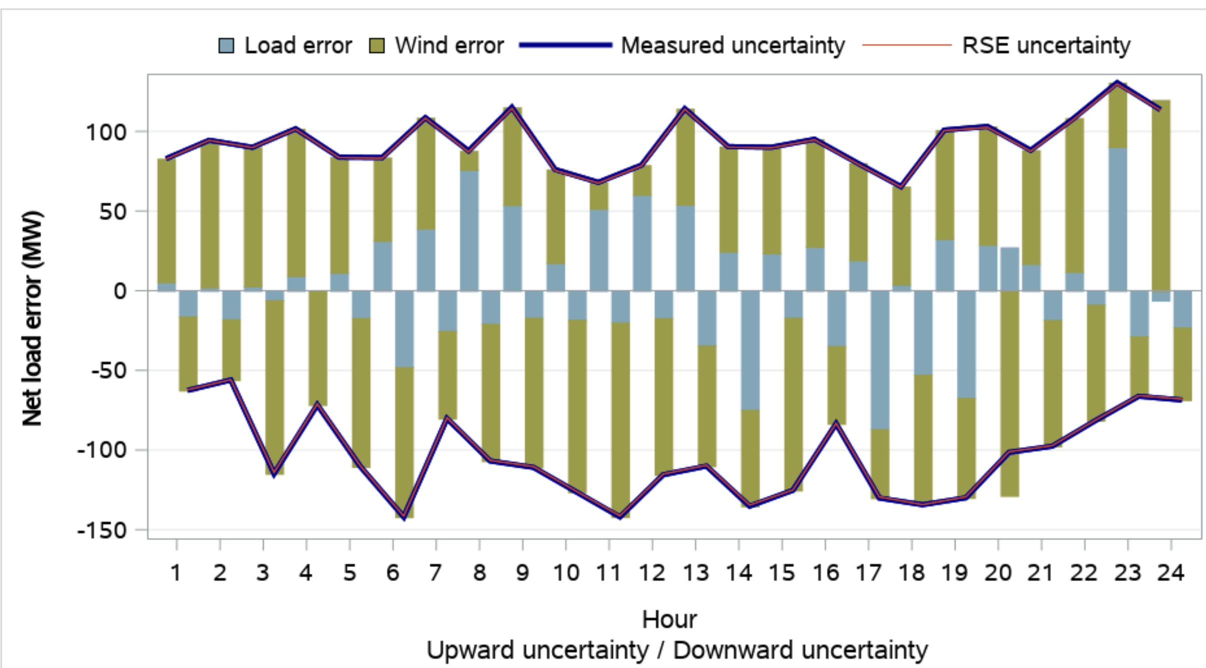


Figure 6.39. Puget Sound Energy distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, December 2021)

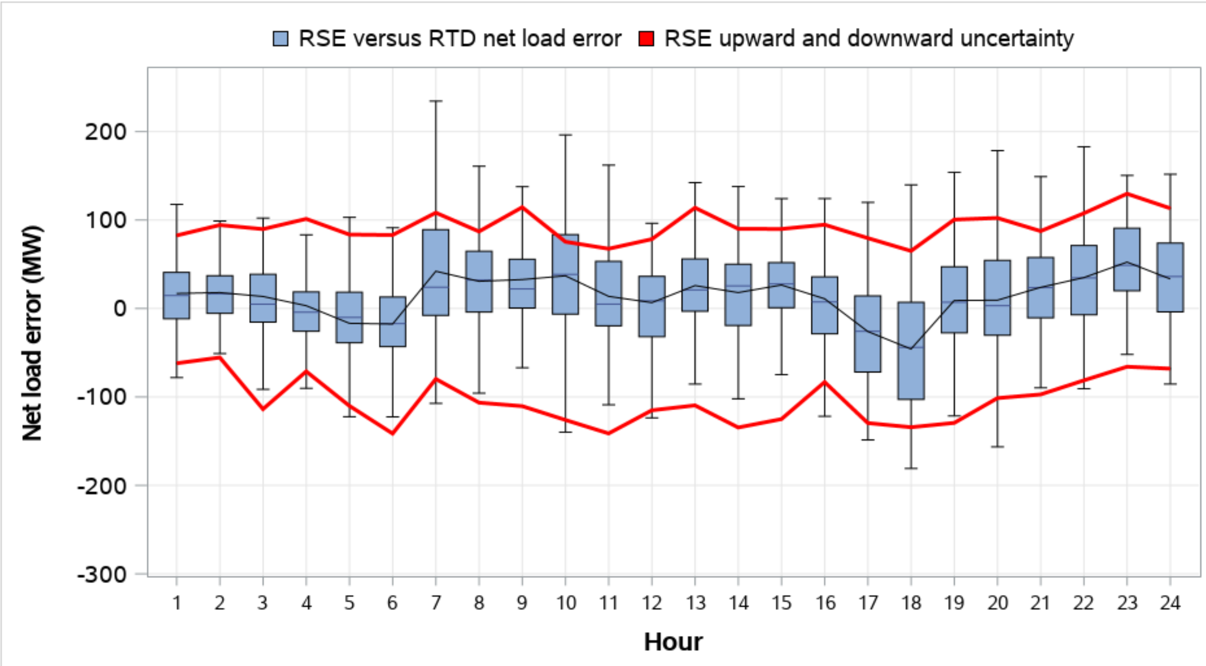


Figure 6.40. Puget Sound Energy distribution of RSE and RTD load and VER error (Weekdays, December 2021)

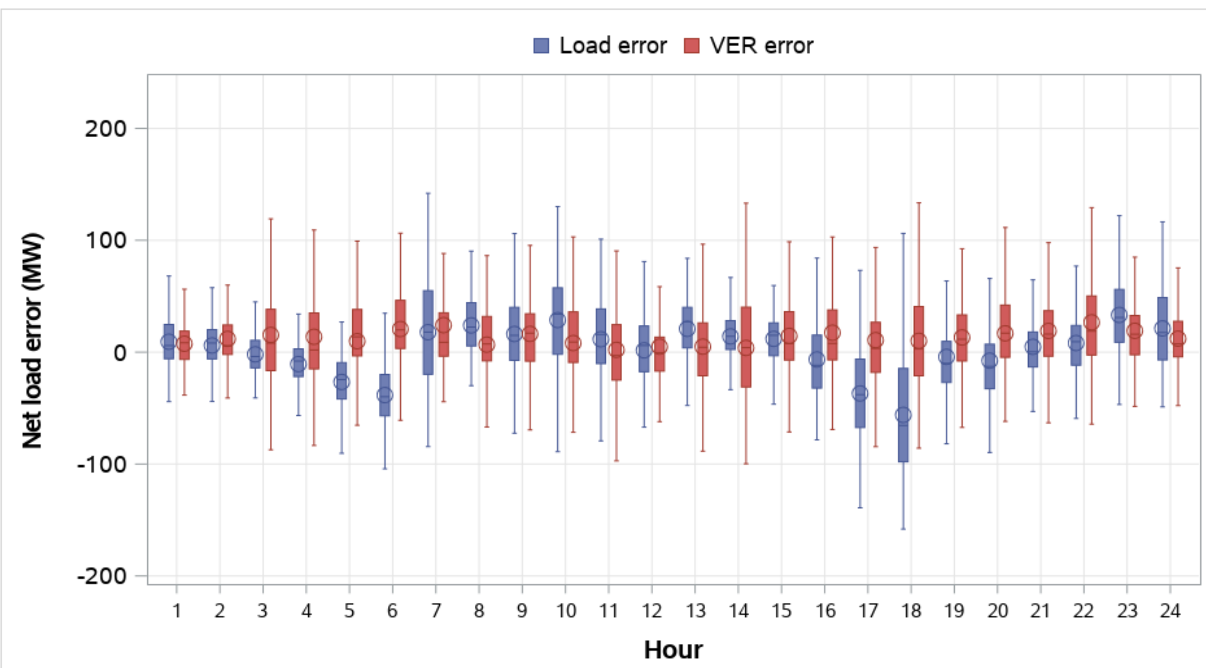


Figure 6.41. Salt River Project average uncertainty by component (Weekdays, December 2021)

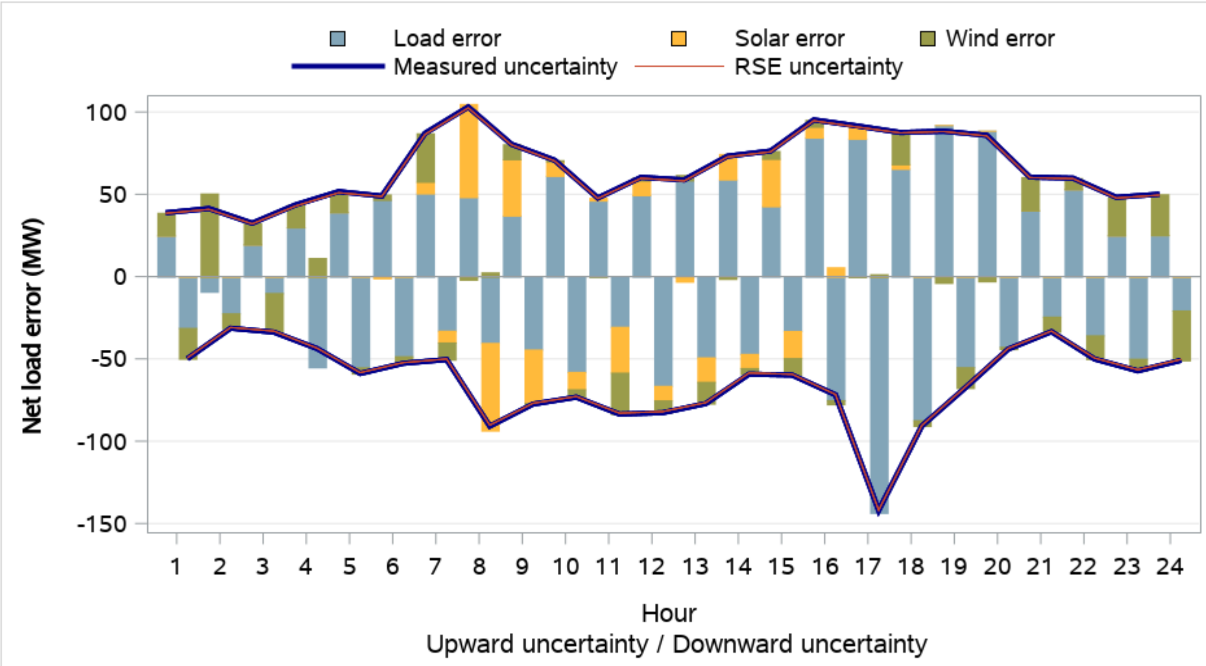


Figure 6.42. Salt River Project distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, December 2021)

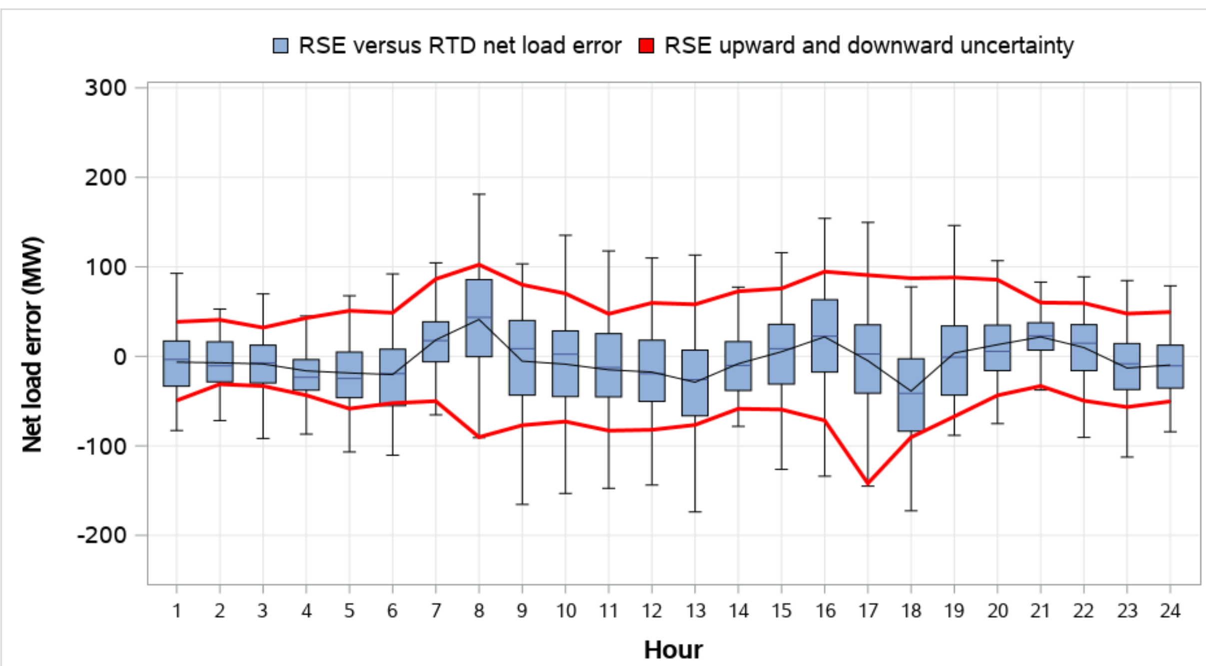


Figure 6.43. Salt River Project distribution of RSE and RTD load and VER error (Weekdays, December 2021)

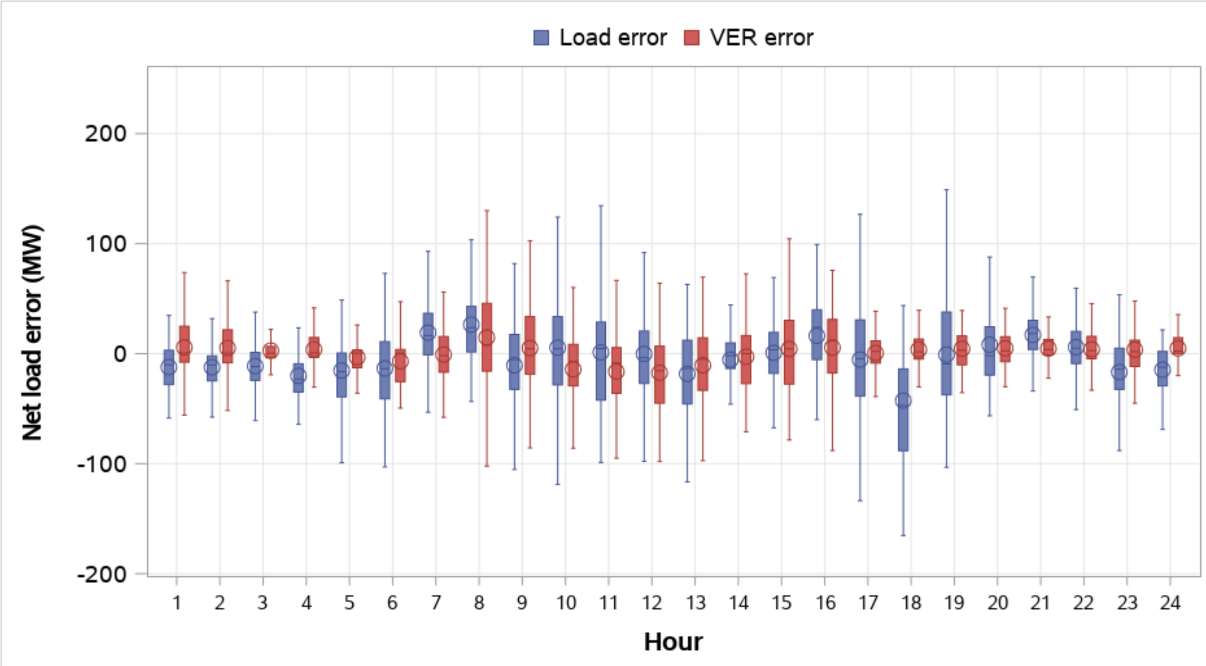


Figure 6.44. Seattle City Light average uncertainty by component (Weekdays, December 2021)

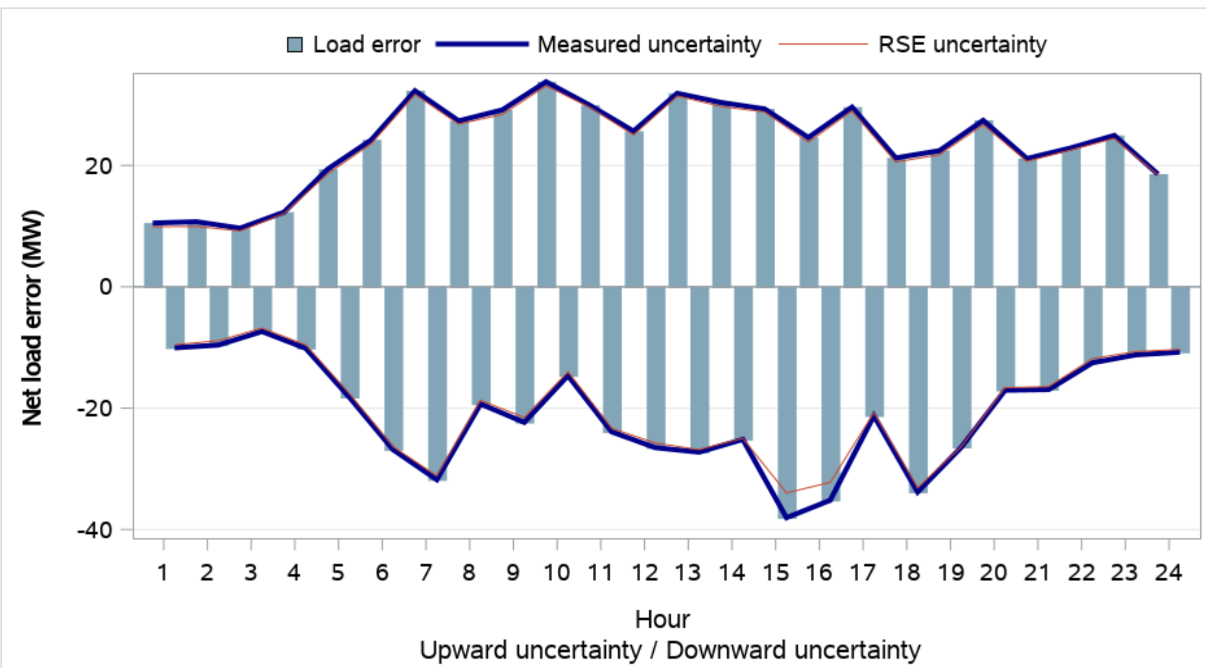


Figure 6.45. Seattle City Light distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, December 2021)

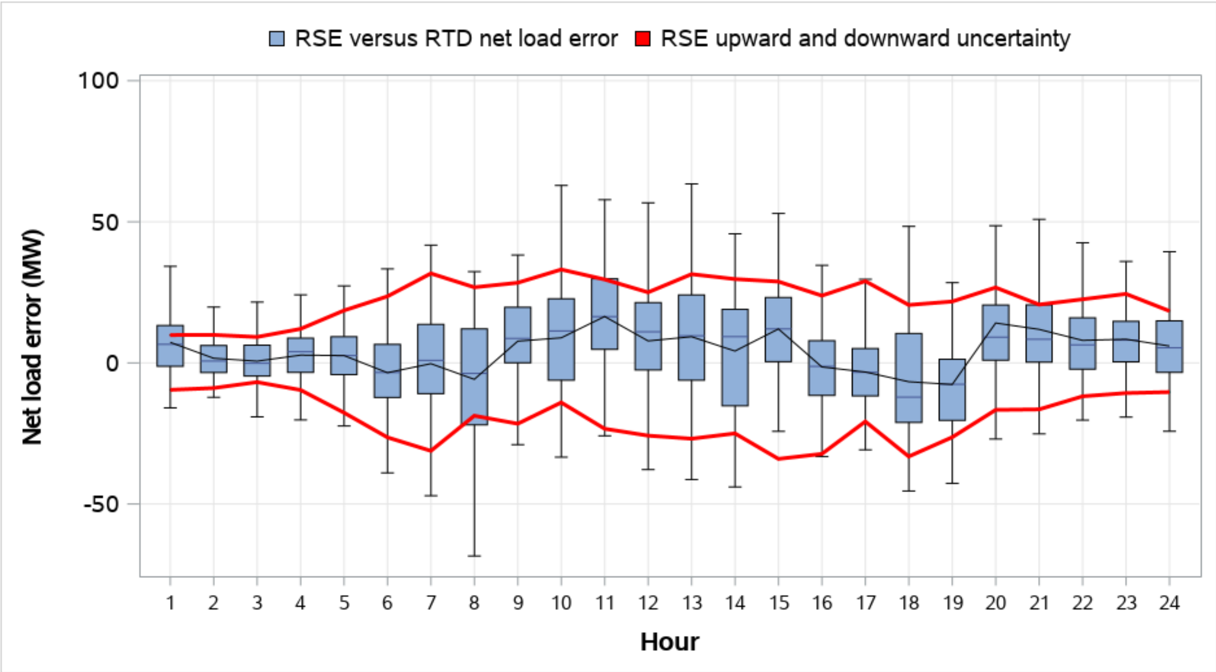


Figure 6.46. Seattle City Light distribution of RSE and RTD load and VER error (Weekdays, December 2021)

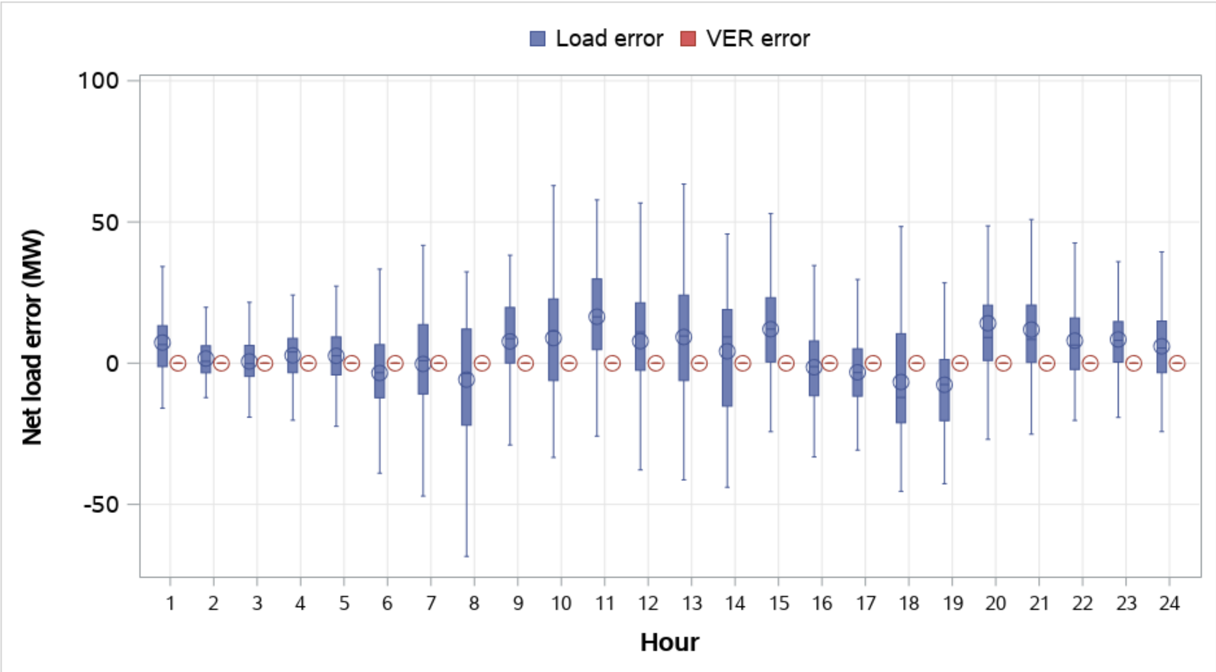


Figure 6.47. Turlock Irrigation District average uncertainty by component (Weekdays, December 2021)

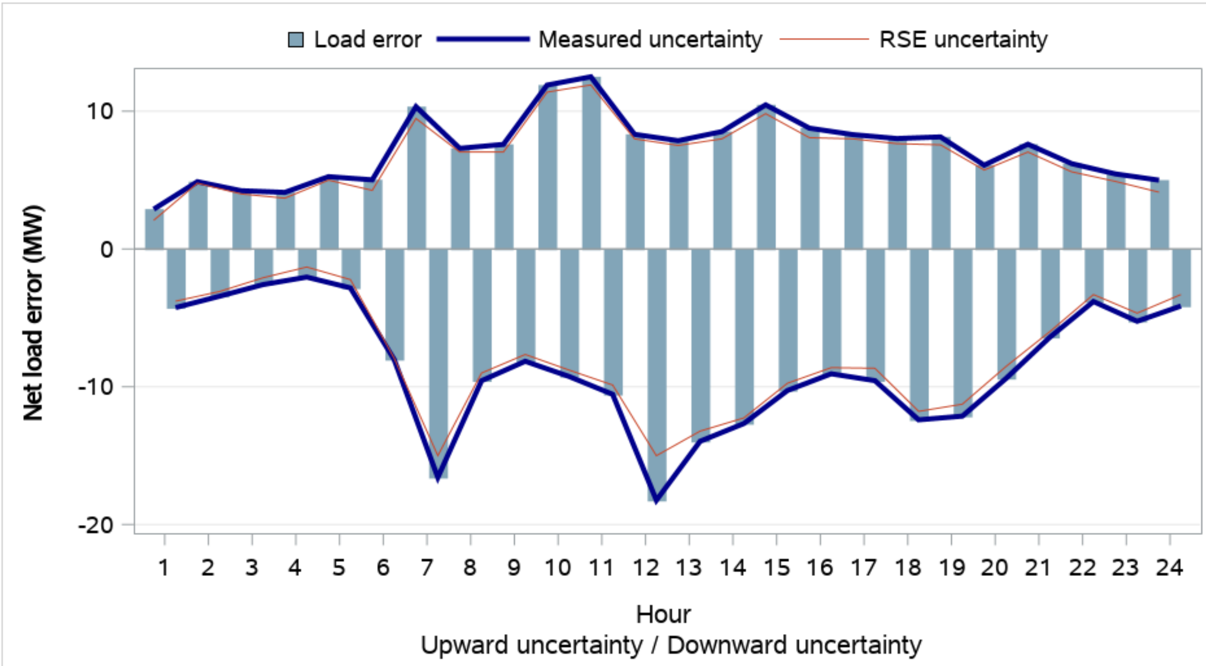


Figure 6.48. Turlock Irrigation District distribution of RSE and RTD net load error and comparison to RSE uncertainty (Weekdays, December 2021)

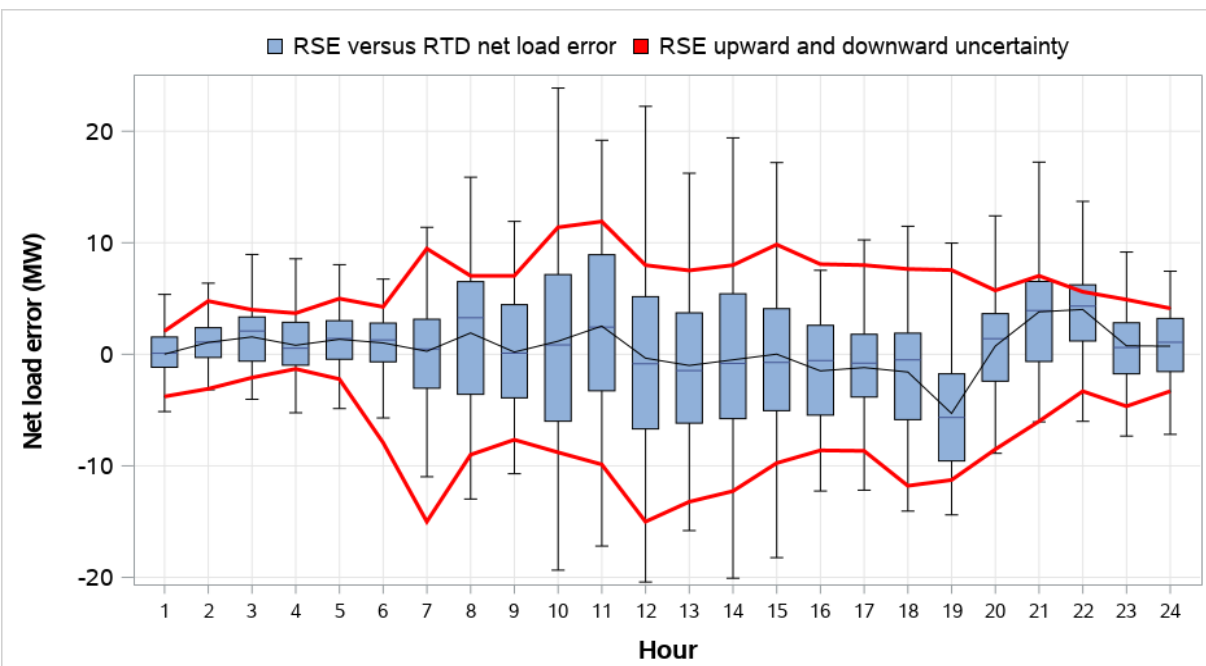
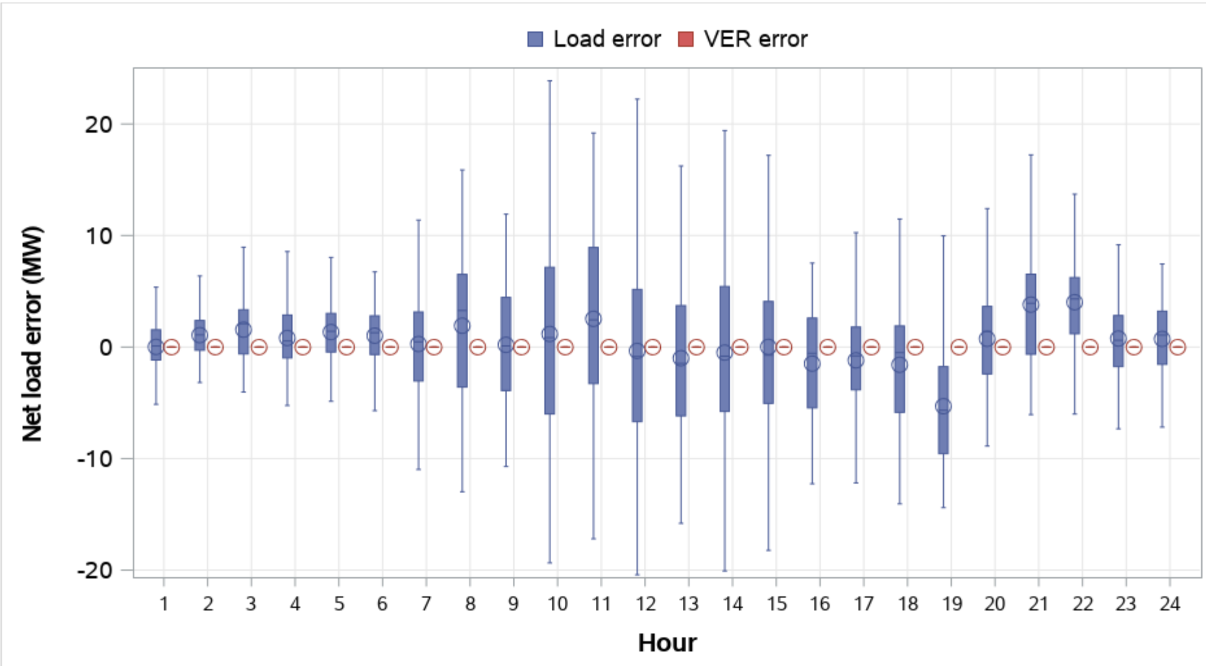


Figure 6.49. Turlock Irrigation District distribution of RSE and RTD load and VER error (Weekdays, December 2021)



7 Resource sufficiency evaluation implementation issues

This section summarizes resource sufficiency evaluation implementation issues identified by DMM or the ISO in 2021. Most issues listed below have been resolved; however, the list does not include the two issues discussed in the ISO's January 2021 workshop on the resource sufficiency evaluation and its application during the August 2020 heatwave; those issues were fixed effective February 4.[19]

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.

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.

3. **Under specific conditions, changes in base EIM 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 EIM transfers were counted twice on both the requirement side as a discount as well as on the supply side as ramping capacity. Here, base EIM transfers were incorrectly included in the net transfer capability calculation. The issue has not yet been fixed.

4. **In some cases, each side of an auto-mirror resource was counted differently for both the ISO and non-ISO balancing areas in the bid-range capacity test.** An update as part of summer 2021 enhancements allowed auto-mirroring for intertie transactions between ISO and non-ISO 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-ISO balancing area; however, for the ISO'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.

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

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