# Western Energy Imbalance Market Resource Sufficiency Evaluation Metrics Report covering December 2022

February 15, 2023

Prepared by: Department of Market Monitoring

California Independent System Operator

# 1 Report overview

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

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

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

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

# 2 Overview of the flexible ramp sufficiency and capacity tests

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

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

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

If an area fails either the flexible ramp sufficiency test or bid range capacity test in the *upward* direction, WEIM transfers into that area cannot be *increased*.[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.* Any undersupply infeasibility in the last 15-minute market interval is also accounted for in the flexibility test requirement as of June 1, 2022.

**Equation 1. Flexible Ramp Sufficiency Test Formulation**

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

$$Down\ Requirement = -\Delta Load + Down\ uncertainty - \min\left[\begin{matrix} Net\ export\ capability, \\ Diversity\ benefit + Down\ credit \end{matrix}\right] - Undersupply\ infeasibility$$

Change in load forecast | Net load uncertainty | Discounts: diversity benefit and credit reduction capped by transfer capability | Undersupply infeasibility in last 15-minute market interval, excluding imbalance conformance

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

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

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

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

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

The uncertainty component currently used in the flexible ramp sufficiency test is calculated from the historical net load error observation. The 2.5 percentile of historical net load error observations is used for the downward requirement and the 97.5 percentile if used for the upward requirement.[3] The uncertainty component is expected to be enhanced on February 1, 2023 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*. Intertie uncertainty was removed on June 1, 2022.

**Equation 2. Bid Range Capacity Test Formulation**

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

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

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

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

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

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

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

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

# 3 Frequency of resource sufficiency evaluation failures

This section summarizes the frequency and shortfall amount for bid-range capacity test and flexible ramping sufficiency test failures.[6] If a balancing area fails either (or both) of these tests, then transfers between that and the rest of the WEIM areas are limited.

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

Net load uncertainty was removed from the bid-range capacity test on February 15, 2022. Intertie uncertainty was removed on June 1, 2022. Net load uncertainty is proposed to return to the capacity test in the summer of 2023.[7] This is following the introduction of the new quantile regression methodology for calculating uncertainty that will be deployed as part of the flexible ramping product enhancements expected on February 1, 2023. The CAISO is also proposing to permanently remove intertie uncertainty from the capacity test.

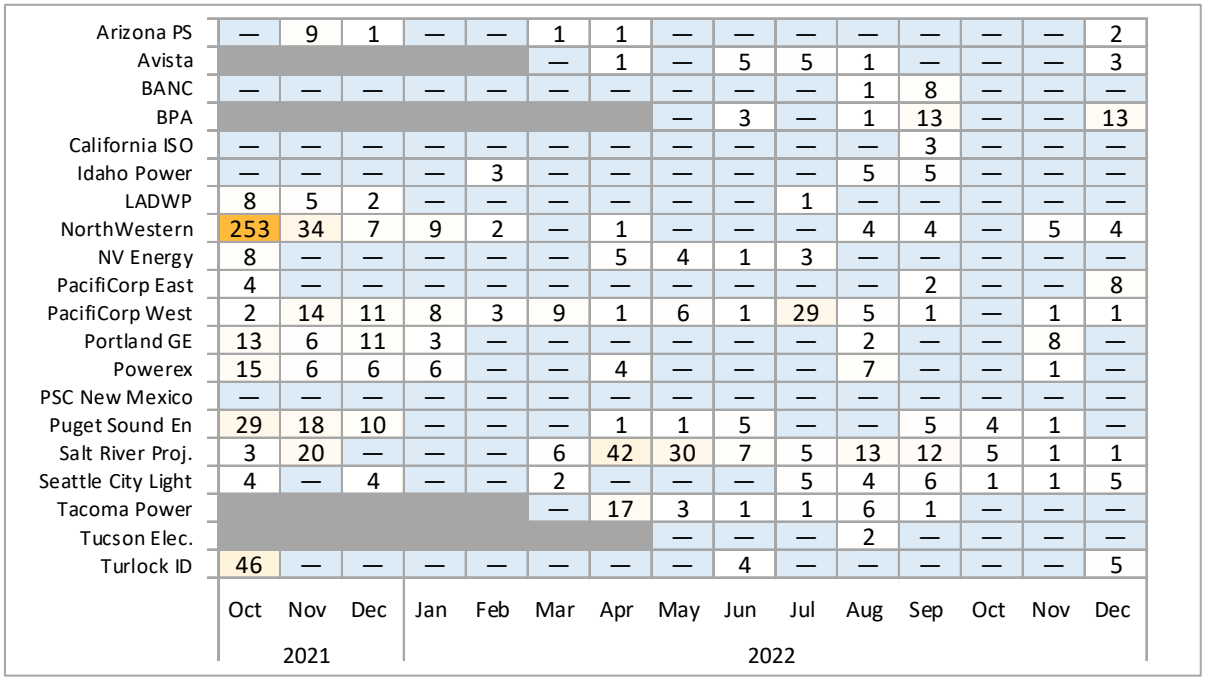
Figure 4.9 summarizes the overlap between failure of the upward capacity and the flexibility tests during the month. The black horizontal line (right axis) shows the number of 15-minute intervals with either a capacity or a flexibility test failure for each WEIM area. The areas are shown in descending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

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

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

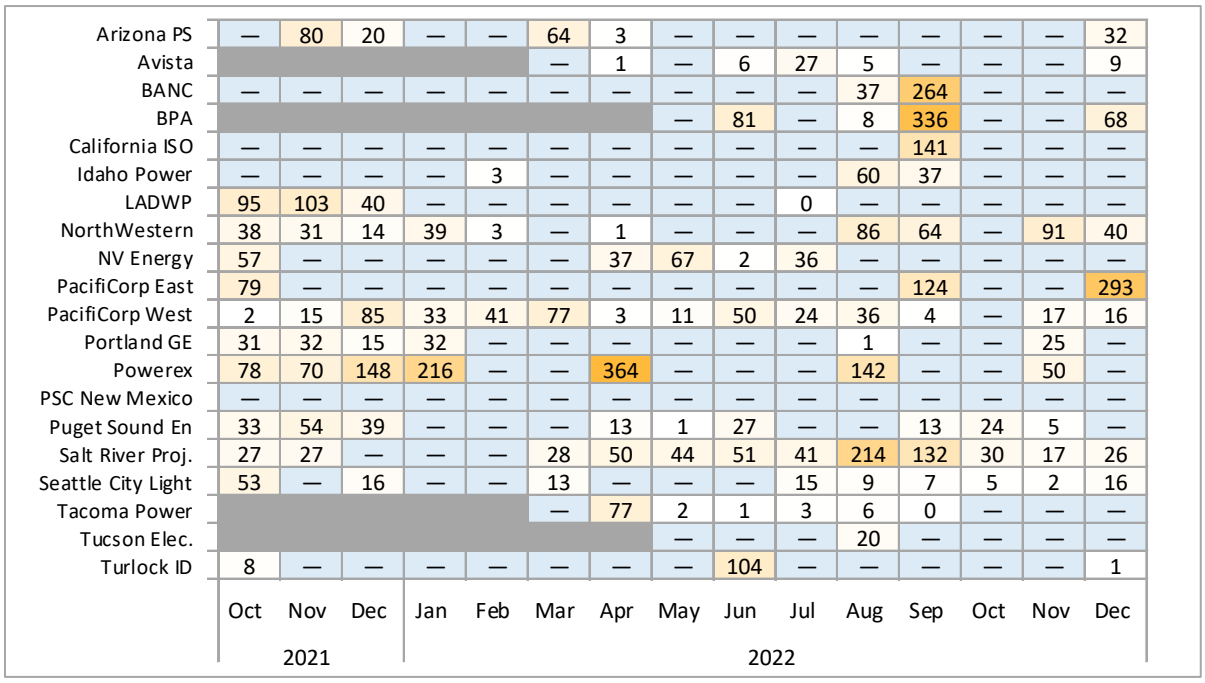
[7] California ISO, *EIM Resource Sufficiency Evaluation Enhancements Phase 2 Straw Proposal*, July 1, 2022. http://www.caiso.com/InitiativeDocuments/StrawProposal-WEIMResourceSufficiencyEvaluationEnhancementsPhase2.pdf

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



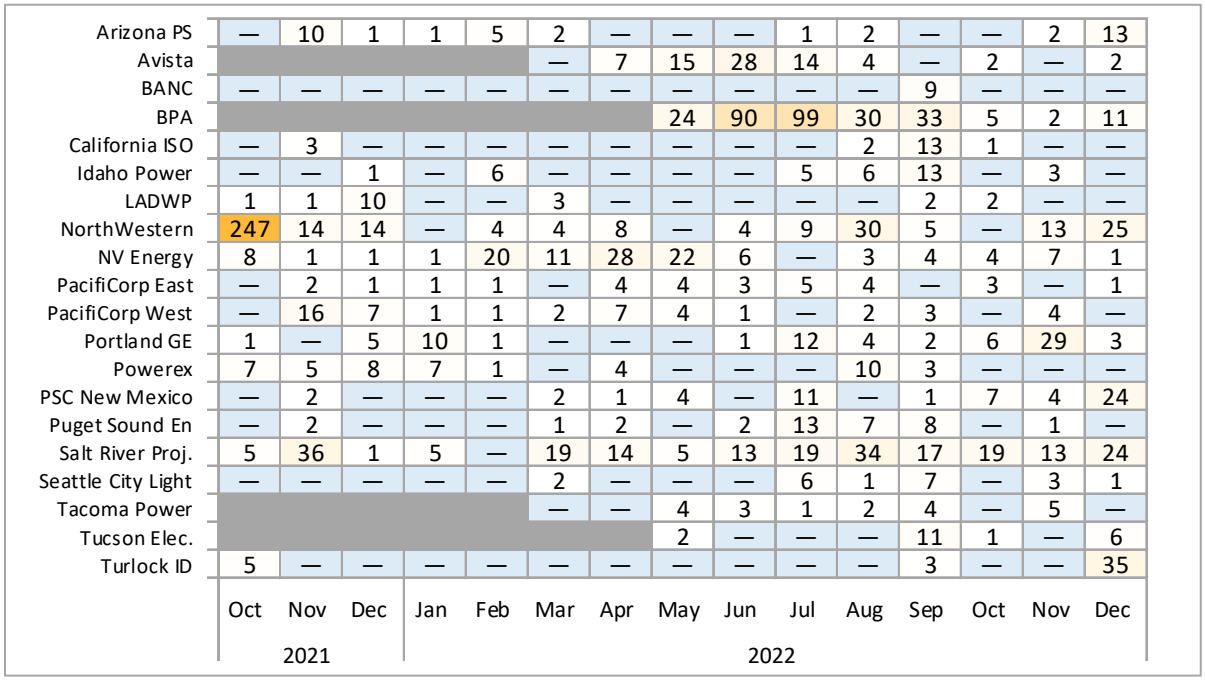
| | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2021 | | | 2022 | | | | | | | | | | | |
| Arizona PS | — | 9 | 1 | — | — | 1 | 1 | — | — | — | — | — | — | — | 2 |
| Avista | | | | | | —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

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



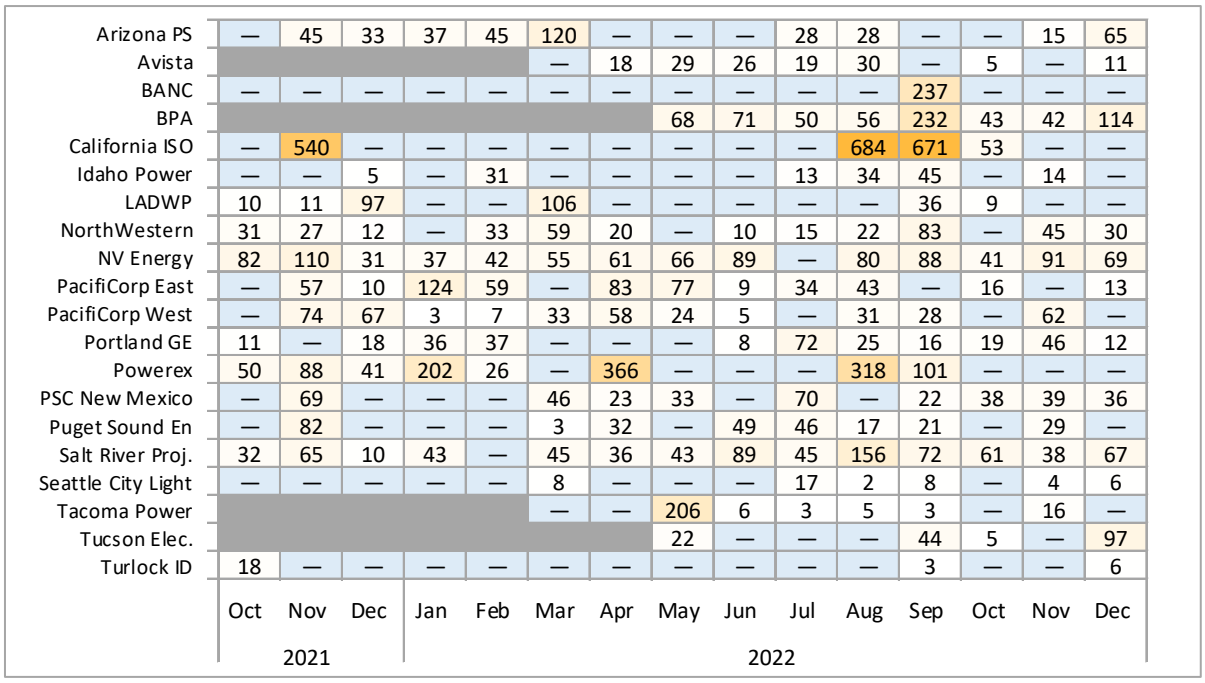
| | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2021 | | | 2022 | | | | | | | | | | | |
| Arizona PS | — | 80 | 20 | — | — | 64 | 3 | — | — | — | — | — | — | — | 32 |
| Avista | | | | | | — | 1 | — | 6 | 27 | 5 | — | — | — | 9 |
| BANC | — | — | — | — | — | — | — | — | — | — | 37 | 264 | — | — | — |
| BPA | | | | | | | | — | 81 | — | 8 | 336 | — | — | 68 |
| California ISO | — | — | — | — | — | — | — | — | — | — | — | 141 | — | — | — |
| Idaho Power | — | — | — | — | 3 | — | — | — | — | — | 60 | 37 | — | — | — |
| LADWP | 95 | 103 | 40 | — | — | — | — | — | — | 0 | — | — | — | — | — |
| NorthWestern | 38 | 31 | 14 | 39 | 3 | — | 1 | — | — | — | 86 | 64 | — | 91 | 40 |
| NV Energy | 57 | — | — | — | — | — | 37 | 67 | 2 | 36 | — | — | — | — | — |
| PacifiCorp East | 79 | — | — | — | — | — | — | — | — | — | — | 124 | — | — | 293 |
| PacifiCorp West | 2 | 15 | 85 | 33 | 41 | 77 | 3 | 11 | 50 | 24 | 36 | 4 | — | 17 | 16 |
| Portland GE | 31 | 32 | 15 | 32 | — | — | — | — | — | — | 1 | — | — | 25 | — |
| Powerex | 78 | 70 | 148 | 216 | — | — | 364 | — | — | — | 142 | — | — | 50 | — |
| PSC New Mexico | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Puget Sound En | 33 | 54 | 39 | — | — | — | 13 | 1 | 27 | — | — | 13 | 24 | 5 | — |
| Salt River Proj. | 27 | 27 | — | — | — | 28 | 50 | 44 | 51 | 41 | 214 | 132 | 30 | 17 | 26 |
| Seattle City Light | 53 | — | 16 | — | — | 13 | — | — | — | 15 | 9 | 7 | 5 | 2 | 16 |
| Tacoma Power | | | | | | — | 77 | 2 | 1 | 3 | 6 | 0 | — | — | — |
| Tucson Elec. | | | | | | | | — | — | — | 20 | — | — | — | — |
| Turlock ID | 8 | — | — | — | — | — | — | — | 104 | — | — | — | — | — | 1 |

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



| | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2021 | | | 2022 | | | | | | | | | | | |
| Arizona PS | — | 10 | 1 | 1 | 5 | 2 | — | — | — | 1 | 2 | — | — | 2 | 13 |
| Avista | | | | | | — | 7 | 15 | 28 | 14 | 4 | — | 2 | — | 2 |
| BANC | — | — | — | — | — | — | — | — | — | — | — | 9 | — | — | — |
| BPA | | | | | | | | 24 | 90 | 99 | 30 | 33 | 5 | 2 | 11 |
| California ISO | — | 3 | — | — | — | — | — | — | — | — | 2 | 13 | 1 | — | — |
| Idaho Power | — | — | 1 | — | 6 | — | — | — | — | 5 | 6 | 13 | — | 3 | — |
| LADWP | 1 | 1 | 10 | — | — | 3 | — | — | — | — | — | 2 | 2 | — | — |
| NorthWestern | 247 | 14 | 14 | — | 4 | 4 | 8 | — | 4 | 9 | 30 | 5 | — | 13 | 25 |
| NV Energy | 8 | 1 | 1 | 1 | 20 | 11 | 28 | 22 | 6 | — | 3 | 4 | 4 | 7 | 1 |
| PacifiCorp East | — | 2 | 1 | 1 | 1 | — | 4 | 4 | 3 | 5 | 4 | — | 3 | — | 1 |
| PacifiCorp West | — | 16 | 7 | 1 | 1 | 2 | 7 | 4 | 1 | — | 2 | 3 | — | 4 | — |
| Portland GE | 1 | — | 5 | 10 | 1 | — | — | — | 1 | 12 | 4 | 2 | 6 | 29 | 3 |
| Powerex | 7 | 5 | 8 | 7 | 1 | — | 4 | — | — | — | 10 | 3 | — | — | — |
| PSC New Mexico | — | 2 | — | — | — | 2 | 1 | 4 | — | 11 | — | 1 | 7 | 4 | 24 |
| Puget Sound En | — | 2 | — | — | — | 1 | 2 | — | 2 | 13 | 7 | 8 | — | 1 | — |
| Salt River Proj. | 5 | 36 | 1 | 5 | — | 19 | 14 | 5 | 13 | 19 | 34 | 17 | 19 | 13 | 24 |
| Seattle City Light | — | — | — | — | — | 2 | — | — | — | 6 | 1 | 7 | — | 3 | 1 |
| Tacoma Power | | | | | | — | — | 4 | 3 | 1 | 2 | 4 | — | 5 | — |
| Tucson Elec. | | | | | | | | 2 | — | — | — | 11 | 1 | — | 6 |
| Turlock ID | 5 | — | — | — | — | — | — | — | — | — | — | 3 | — | — | 35 |

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



| | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2021 | | | 2022 | | | | | | | | | | | |
| Arizona PS | — | 45 | 33 | 37 | 45 | 120 | — | — | — | 28 | 28 | — | — | 15 | 65 |
| Avista | | | | | | — | 18 | 29 | 26 | 19 | 30 | — | 5 | — | 11 |
| BANC | — | — | — | — | — | — | — | — | — | — | — | 237 | — | — | — |
| BPA | | | | | | | | 68 | 71 | 50 | 56 | 232 | 43 | 42 | 114 |
| California ISO | — | 540 | — | — | — | — | — | — | — | — | 684 | 671 | 53 | — | — |
| Idaho Power | — | — | 5 | — | 31 | — | — | — | — | 13 | 34 | 45 | — | 14 | — |
| LADWP | 10 | 11 | 97 | — | — | 106 | — | — | — | — | — | 36 | 9 | — | — |
| NorthWestern | 31 | 27 | 12 | — | 33 | 59 | 20 | — | 10 | 15 | 22 | 83 | — | 45 | 30 |
| NV Energy | 82 | 110 | 31 | 37 | 42 | 55 | 61 | 66 | 89 | — | 80 | 88 | 41 | 91 | 69 |
| PacifiCorp East | — | 57 | 10 | 124 | 59 | — | 83 | 77 | 9 | 34 | 43 | — | 16 | — | 13 |
| PacifiCorp West | — | 74 | 67 | 3 | 7 | 33 | 58 | 24 | 5 | — | 31 | 28 | — | 62 | — |
| Portland GE | 11 | — | 18 | 36 | 37 | — | — | — | 8 | 72 | 25 | 16 | 19 | 46 | 12 |
| Powerex | 50 | 88 | 41 | 202 | 26 | — | 366 | — | — | — | 318 | 101 | — | — | — |
| PSC New Mexico | — | 69 | — | — | — | 46 | 23 | 33 | — | 70 | — | 22 | 38 | 39 | 36 |
| Puget Sound En | — | 82 | — | — | — | 3 | 32 | — | 49 | 46 | 17 | 21 | — | 29 | — |
| Salt River Proj. | 32 | 65 | 10 | 43 | — | 45 | 36 | 43 | 89 | 45 | 156 | 72 | 61 | 38 | 67 |
| Seattle City Light | — | — | — | — | — | 8 | — | — | — | 17 | 2 | 8 | — | 4 | 6 |
| Tacoma Power | | | | | | — | — | 206 | 6 | 3 | 5 | 3 | — | 16 | — |
| Tucson Elec. | | | | | | | | 22 | — | — | — | 44 | 5 | — | 97 |
| Turlock ID | 18 | — | — | — | — | — | — | — | — | — | — | 3 | — | — | 6 |

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

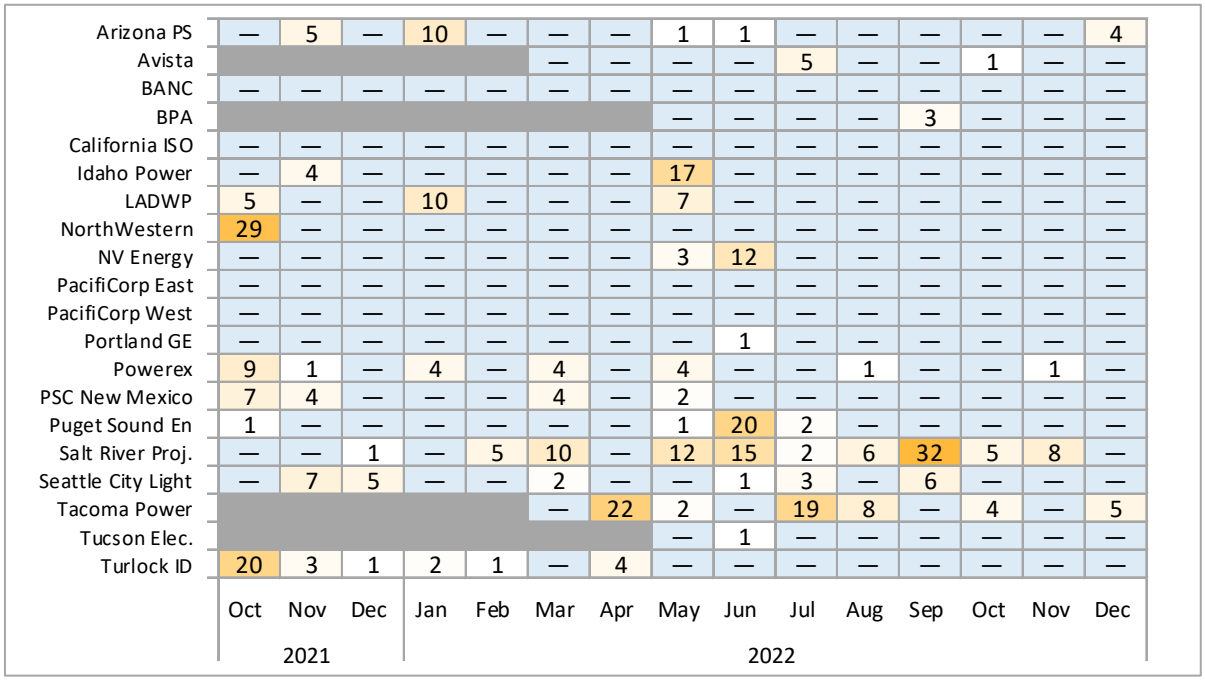



**Figure 4.6 Average shortfall of downward capacity test failures (MW)**

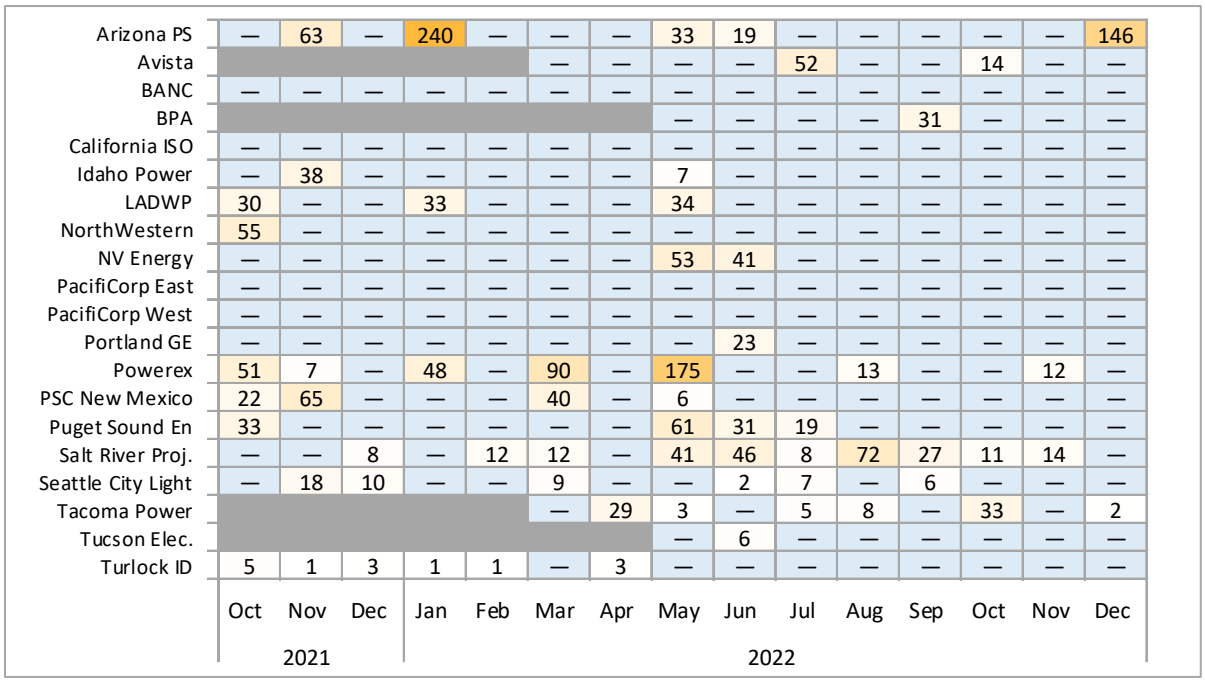


**Figure 4.7 Frequency of downward flexibility test failures (number of intervals)**

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

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

| | Oct 2021 | Nov 2021 | Dec 2021 | Jan 2022 | Feb 2022 | Mar 2022 | Apr 2022 | May 2022 | Jun 2022 | Jul 2022 | Aug 2022 | Sep 2022 | Oct 2022 | Nov 2022 | Dec 2022 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arizona PS | 36 | 81 | 51 | 69 | 32 | 42 | 54 | 58 | 33 | — | — | 81 | 20 | 28 | 31 |
| Avista | | | | | | — | — | — | 20 | — | — | 11 | 20 | — | 26 |
| BANC | — | — | 71 | — | — | 18 | 7 | 5 | 15 | — | — | — | — | — | — |
| BPA | | | | | | | | 212 | 55 | — | 4 | 149 | — | 77 | 191 |
| California ISO | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Idaho Power | — | 31 | 40 | — | 43 | — | 18 | 55 | — | — | 13 | — | — | — | — |
| LADWP | 5 | — | — | 43 | — | — | — | — | — | — | — | — | — | — | — |
| NorthWestern | 25 | 21 | 7 | — | — | — | — | 12 | 27 | 14 | — | — | — | 2 | 16 |
| NV Energy | 39 | 34 | 24 | 44 | 92 | 55 | 86 | 49 | 98 | 151 | 59 | 58 | 43 | 28 | 62 |
| PacifiCorp East | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| PacifiCorp West | — | 32 | — | — | — | 4 | 15 | 55 | 28 | 11 | — | — | 12 | — | 22 |
| Portland GE | — | — | — | — | — | — | — | — | 18 | — | — | — | — | — | — |
| Powerex | 101 | 16 | 163 | — | 15 | 184 | 3 | 257 | 244 | — | 87 | 62 | 86 | — | — |
| PSC New Mexico | 56 | 41 | 223 | 77 | 15 | 64 | 40 | 144 | 34 | 3 | 9 | 40 | 16 | 15 | — |
| Puget Sound En | — | 16 | — | — | — | — | — | 54 | 33 | 47 | — | — | 11 | — | — |
| Salt River Proj. | 22 | 4 | 11 | 45 | 35 | 49 | 74 | 62 | 34 | 54 | 155 | 42 | 42 | 113 | 38 |
| Seattle City Light | — | 2 | 3 | — | — | 10 | 6 | 7 | 11 | 10 | 21 | 10 | — | 24 | 39 |
| Tacoma Power | | | | | | — | 5 | 14 | — | 5 | 4 | — | — | — | 8 |
| Tucson Elec. | | | | | | | | — | — | — | — | — | — | 14 | — |
| Turlock ID | 16 | 3 | 94 | 9 | — | 5 | 20 | 5 | 6 | 3 | 2 | — | — | 5 | — |

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

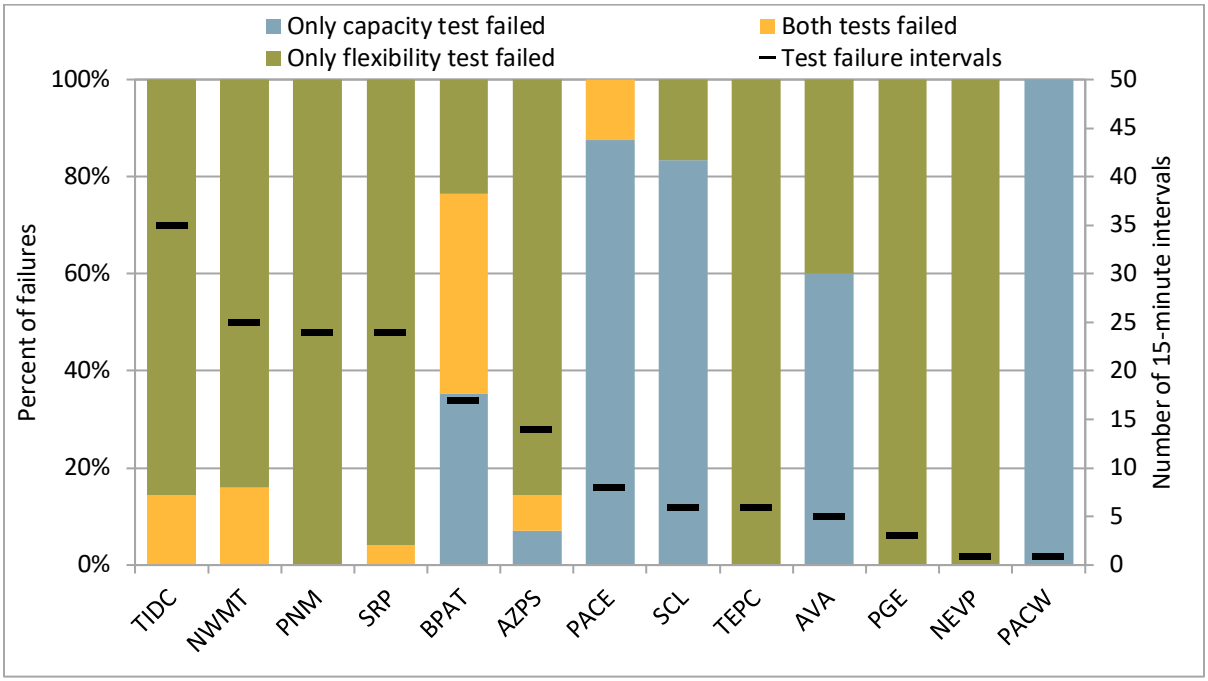
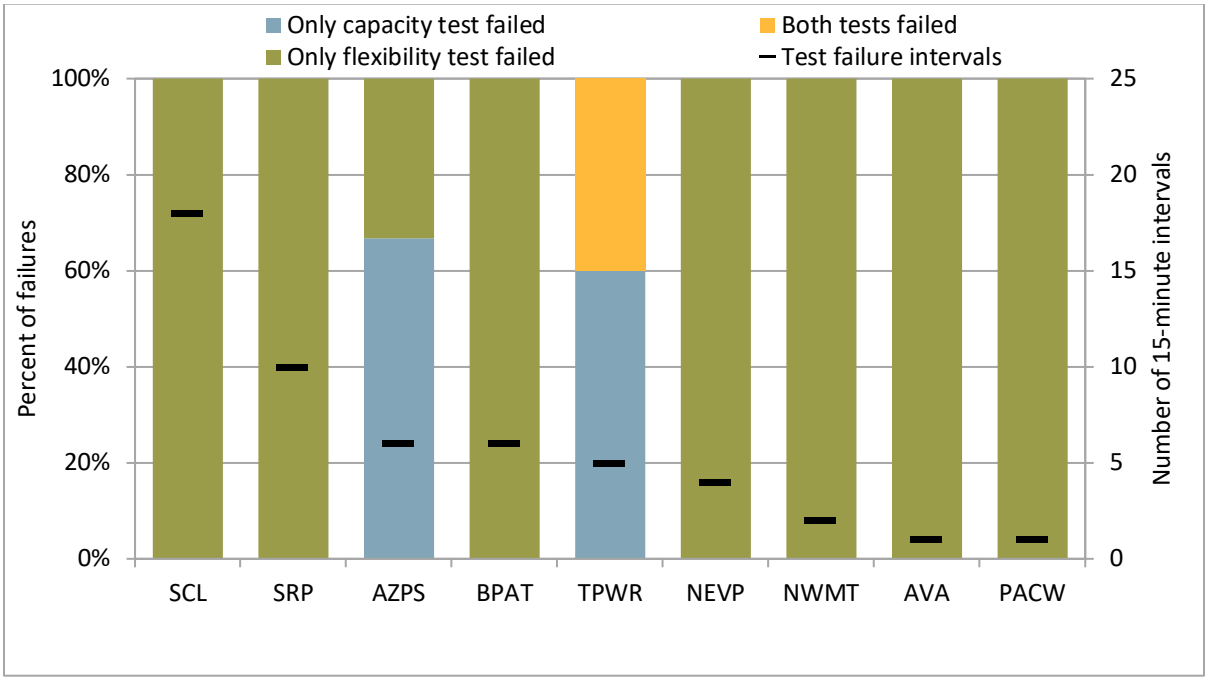



**Figure 4.10 Downward capacity/flexibility test failure intervals by concurrence (December 2022)**



# 4 WEIM limits and transfers following test failure

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

### WEIM import limits following test failure

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

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

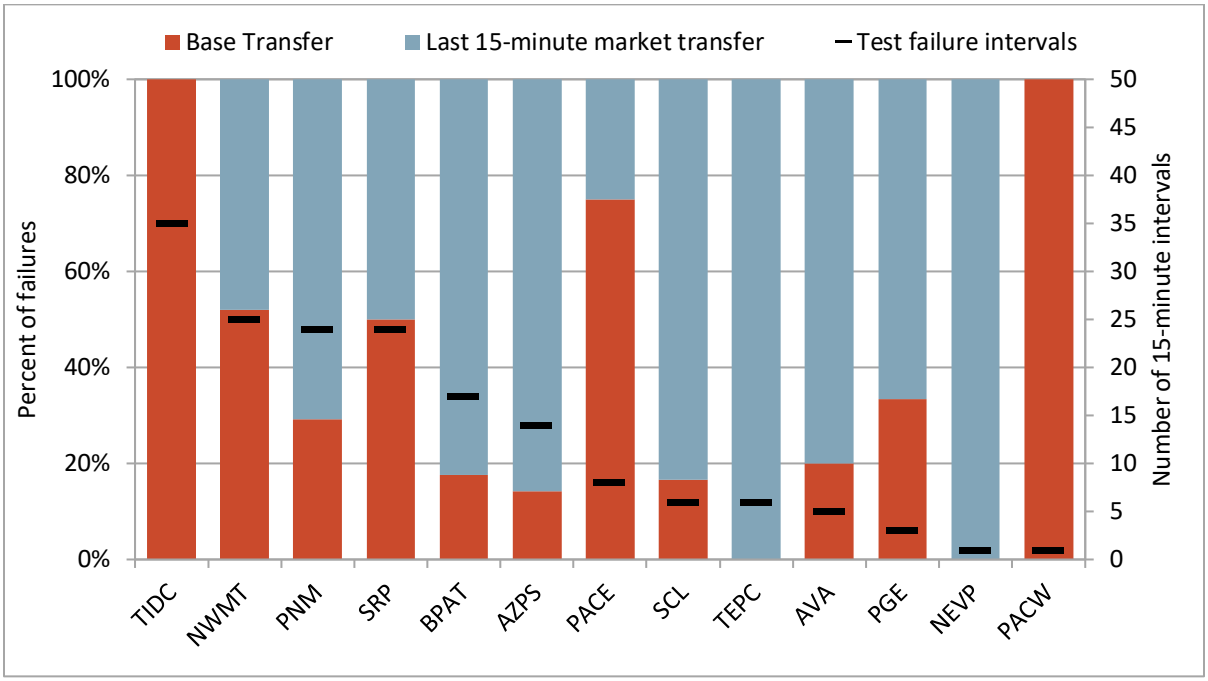
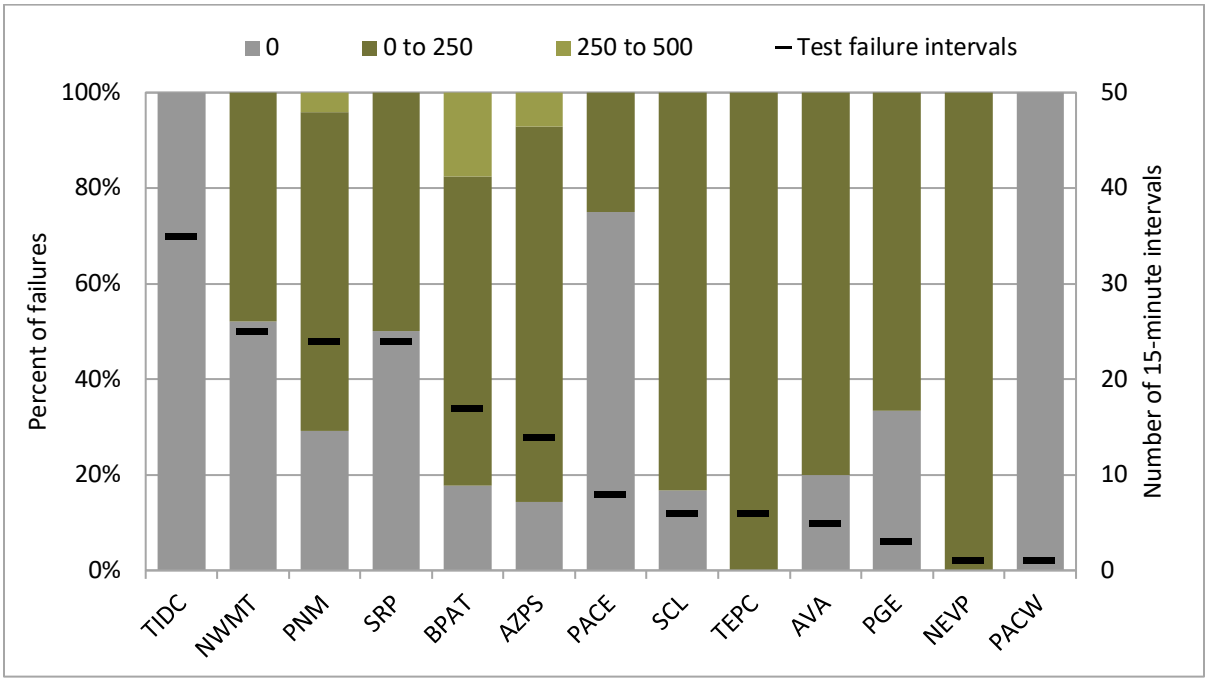



Figure 5.2 summarizes dynamic WEIM import limits above base transfers (fixed bilateral transactions between WEIM entities) after failing either test in the upward direction.[8] From this perspective, the incremental WEIM import limit after a test failure is set by the greater of (1) zero or (2) the transfer from the last 15-minute market interval minus the current base transfer. Therefore, the dynamic import limits show the incremental flexibility available through the WEIM after a resource sufficiency evaluation failure. The black horizontal line (right axis) shows the number of 15-minute intervals with an import limit imposed after a test failure. Areas without any upward test failures during the month were excluded.

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

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




## WEIM transfers following a test failure

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

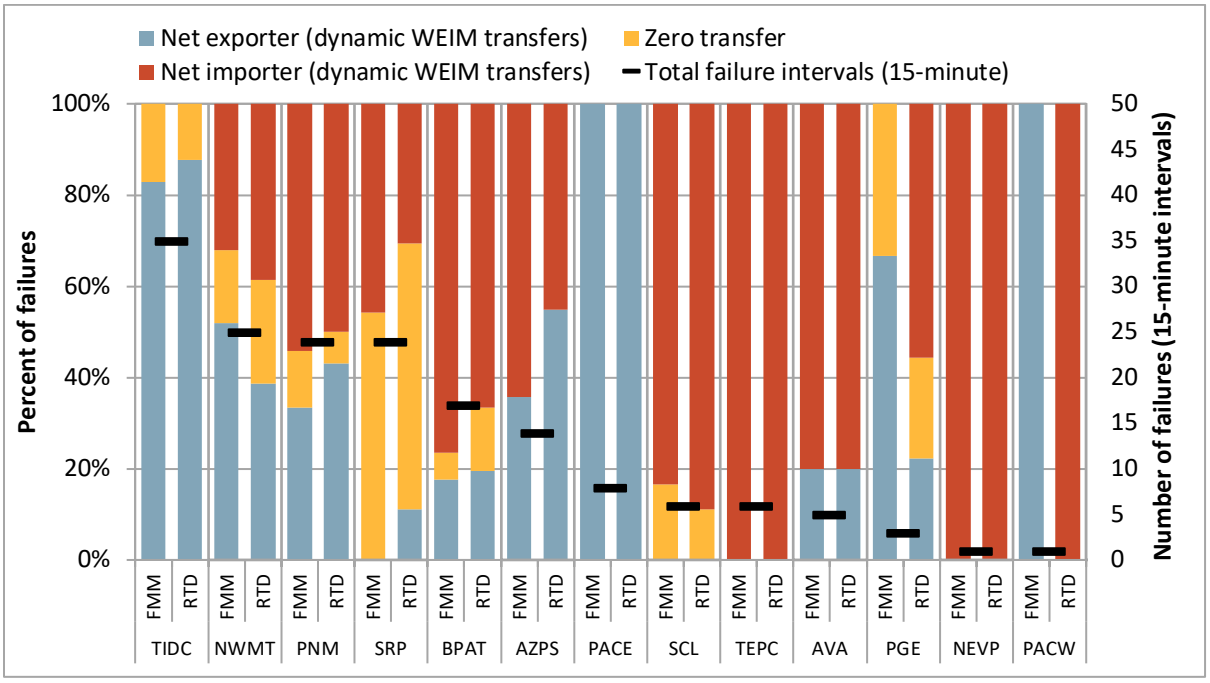
Figure 5.3 summarizes dynamic WEIM transfers (excluding any base transfer) on net for each area during an upward resource sufficiency evaluation failure in the month. Again, the black horizontal line (right axis) shows the number of 15-minute intervals with either a capacity or a flexibility test failure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

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

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

Figure 5.5 summarizes whether the import limit that was imposed after failing either test in the upward direction ultimately impacted market transfers.[9] It shows the percent of failure intervals in which the resulting transfers are constrained to the limit imposed after failing the test. These results are shown separately for the 15-minute (FMM) and 5-minute (RTD) markets.

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




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

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

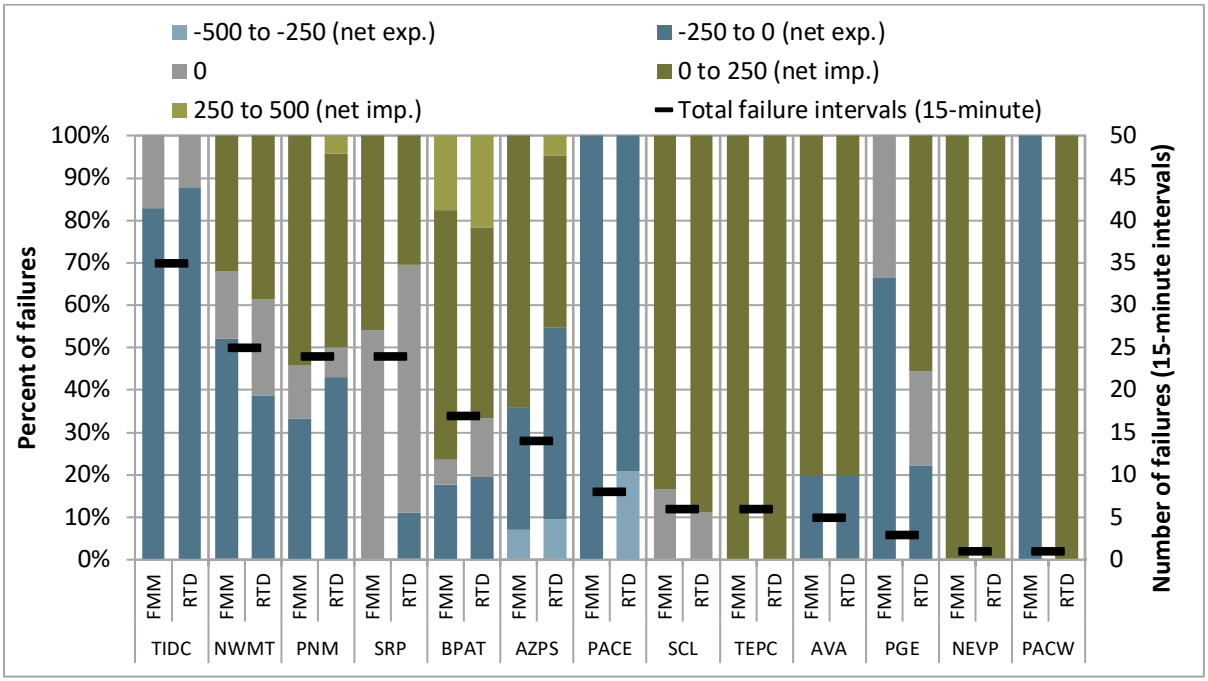
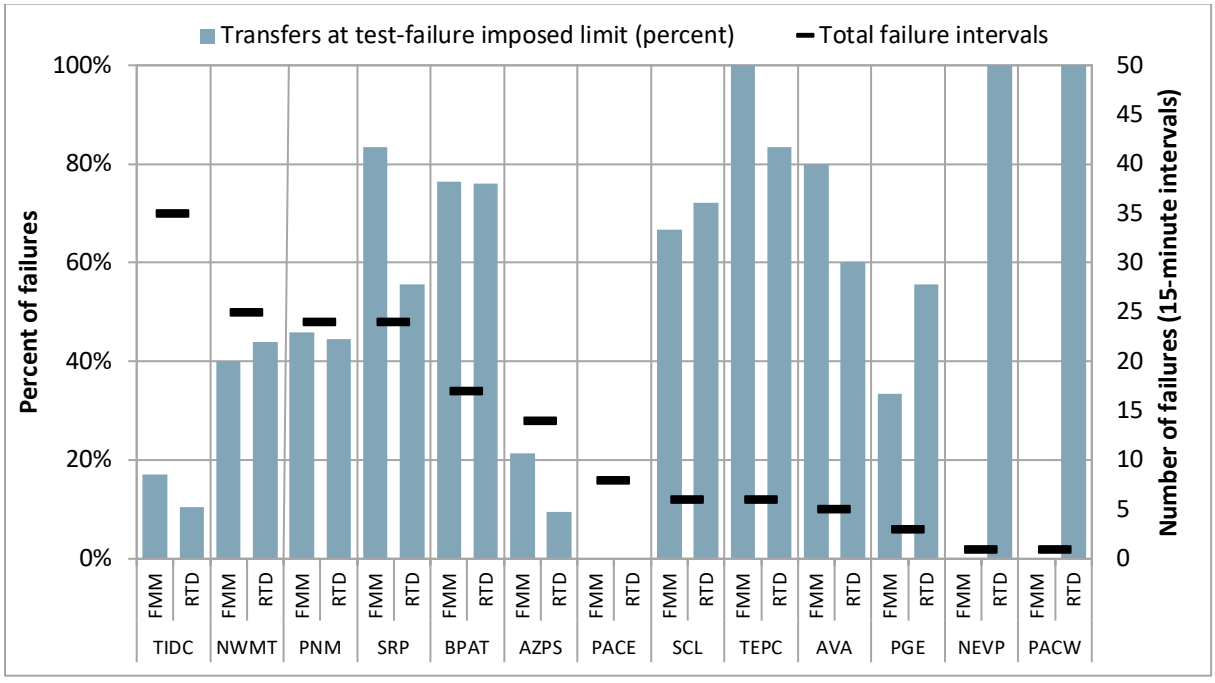



**Figure 5.5 Percent of upward test failure intervals with market transfers at the imposed cap (December 2022)**



# 5 Load conformance in the Western Energy Imbalance Market

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

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

The bid-range capacity test requirement includes all import and export base schedules.[10] Additional imports and exports (relative to these base schedules) that are *15-minute-dispatchabale* are then included as incremental or decremental capacity. Thus, the maximum of 15-minute-dispatchable imports would be included in the capacity test regardless of the dispatch. However, imbalance conformance adjustments made by the CAISO operators in the hour-ahead market can impact non-15-minute dispatchable import and export schedules included in the requirement.

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

The CAISO is not proposing any changes in the *WEIM resource sufficiency evaluation* to account for operator imbalance conformance.[11]

Figure 6.1 summarizes average hour-ahead and 15-minute market imbalance conformance adjustments entered by the CAISO operators during the month. Between peak hours 17 and 20, 15-minute market imbalance conformance averaged around 1,884 MW. Figure 6.2 shows the hourly distribution of 15-minute market imbalance conformance.

Figure 6.3 shows imbalance conformance adjustments for WEIM entities with substantial imbalance conformance and Figure 6.4 shows adjustments as a percent of total load.[12]

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

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

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

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

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

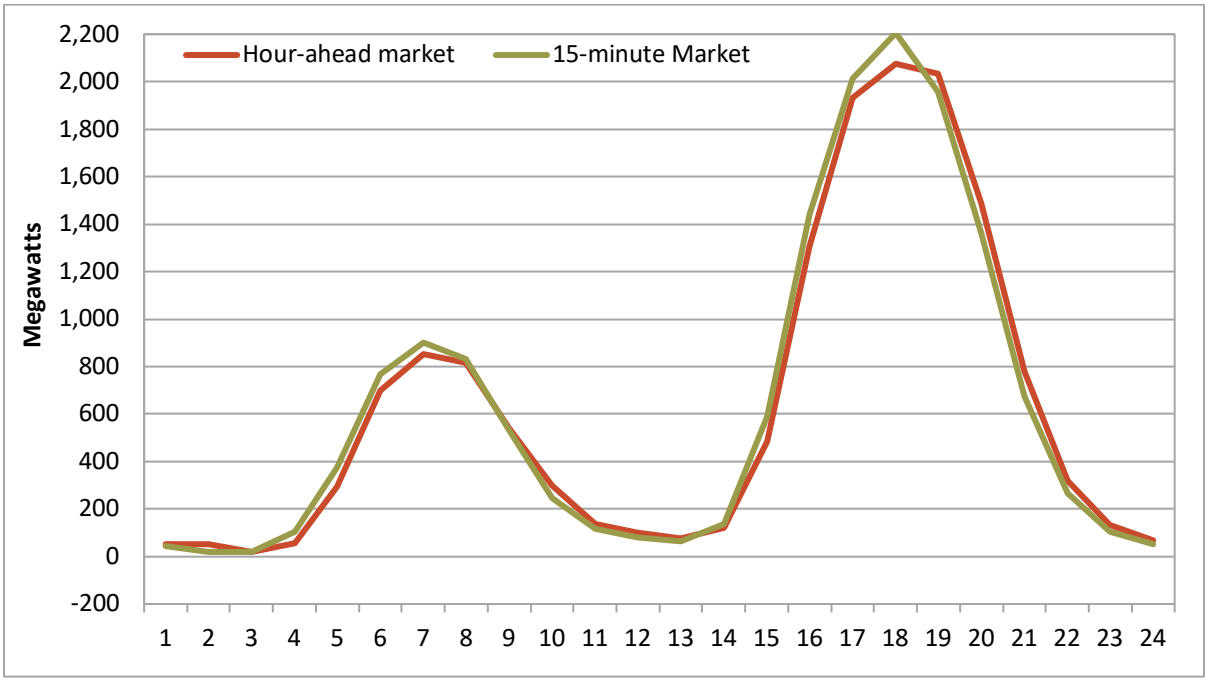



**Figure 6.2 Distribution of CAISO load conformance (December 2022)**

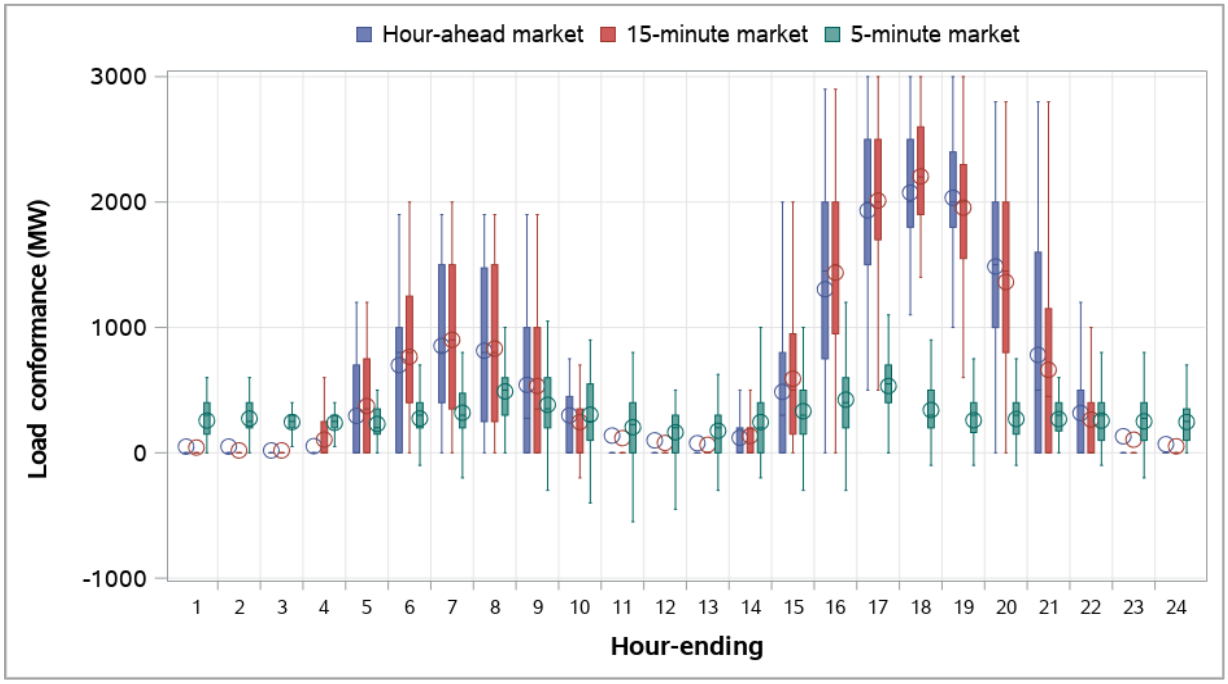


**Figure 6.3 Average hourly 15-minute market load conformance (December 2022)**

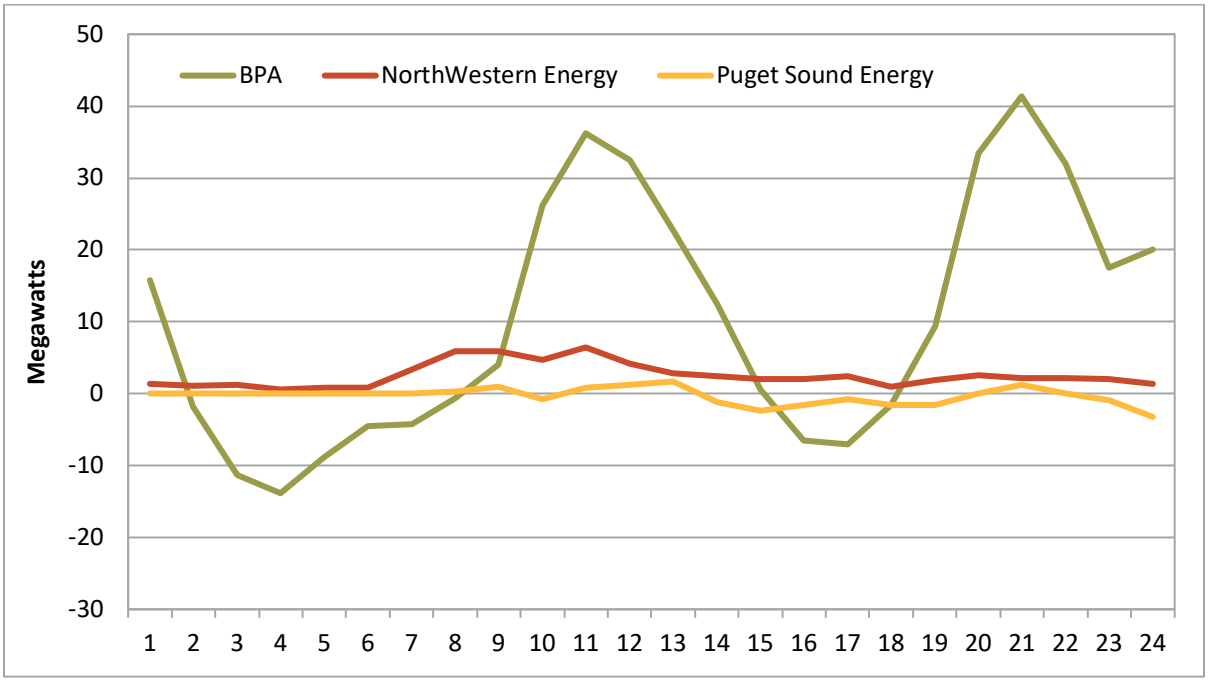
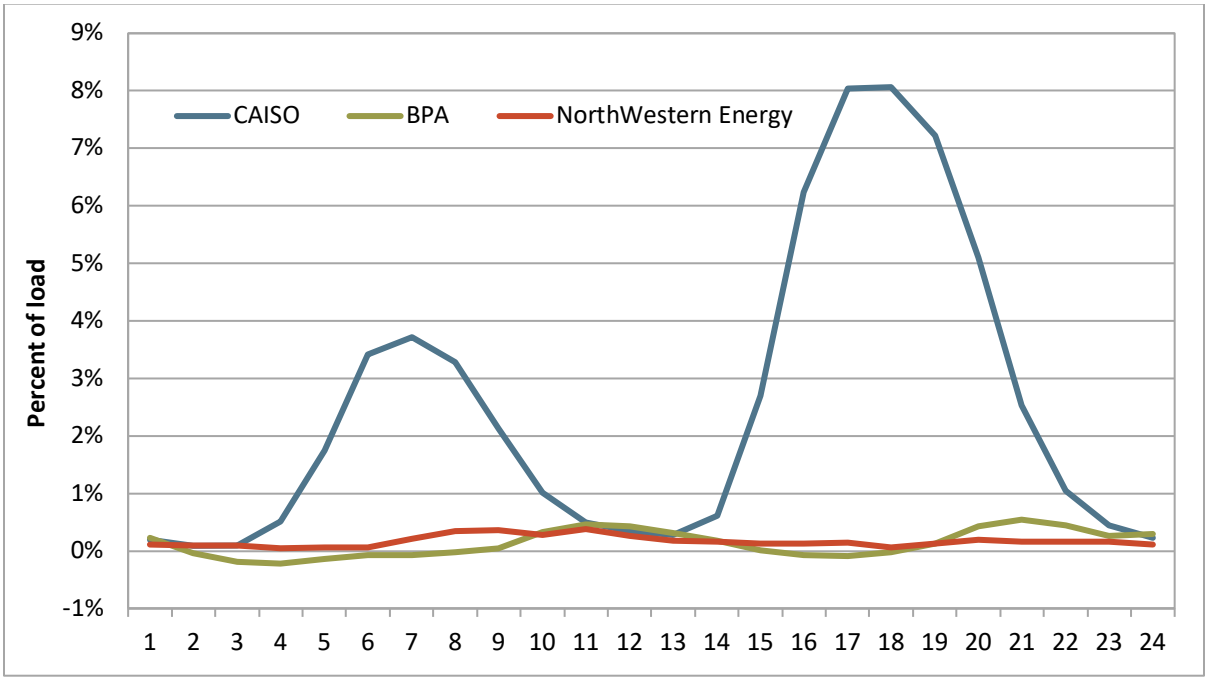



**Figure 6.4 Average hourly 15-minute market load conformance *as a percent of load* (December 2022)**



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

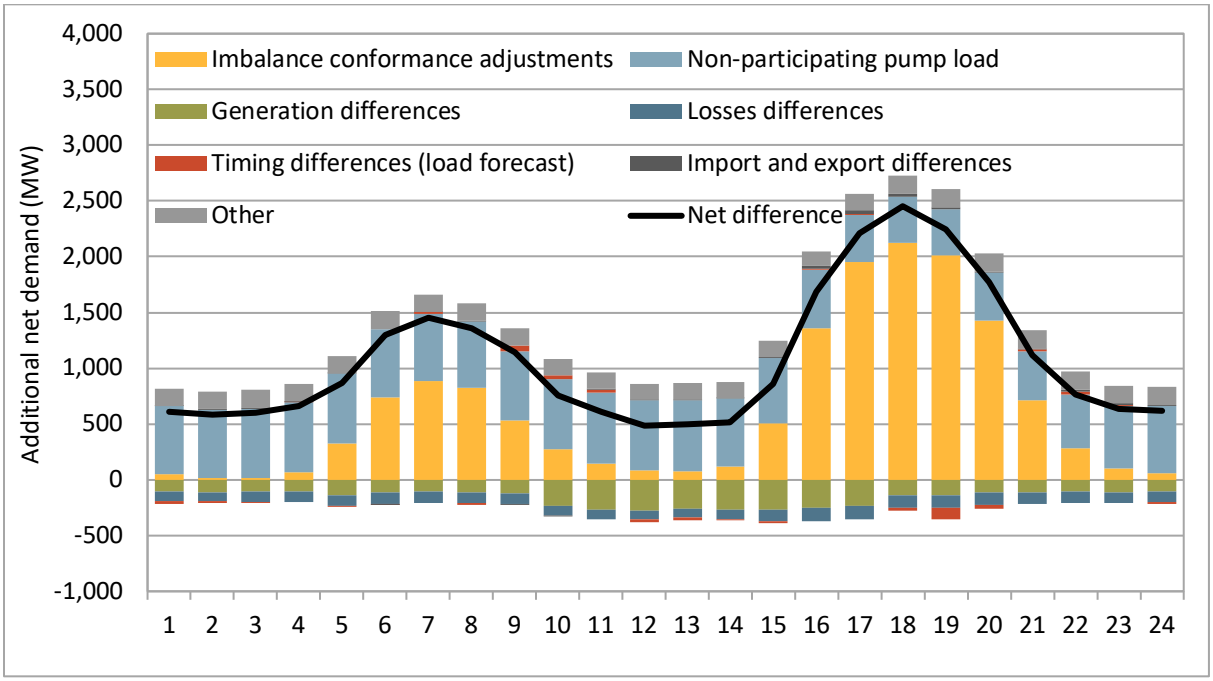
| Balancing area | Market | Positive load conformance | | | Negative load conformance | | | Average hourly adjustment MW |
|---|---|---|---|---|---|---|---|---|
| | | Percent of intervals | Average MW | Percent of total load | Percent of intervals | Average MW | Percent of total load | |
| *Arizona Public Service* | 15-minute market | 0% | N/A | N/A | 0% | N/A | N/A | 0 |
| | 5-minute market | 53% | 63 | 2.0% | 14% | -47 | 1.7% | 26 |
| *Avista* | 15-minute market | 0.03% | 10 | 0.6% | 0.2% | -66 | 3.6% | 0 |
| | 5-minute market | 1% | 12 | 0.8% | 34% | -20 | 1.3% | -7 |
| *Balancing Authority of Northern California* | 15-minute market | 0.2% | 54 | 3.4% | 0.2% | -37 | 2.1% | 0 |
| | 5-minute market | 0.3% | 54 | 3.4% | 0.5% | -35 | 2.0% | 0 |
| *Bonneville Power Administration* | 15-minute market | 61% | 33 | 0.4% | 38% | -26 | 0.3% | 10 |
| | 5-minute market | 61% | 33 | 0.4% | 38% | -26 | 0.3% | 10 |
| *California ISO* | 15-minute market | 50% | 1243 | 5.1% | 0.2% | -200 | 0.9% | 621 |
| | 5-minute market | 84% | 355 | 1.5% | 4% | -222 | 1.0% | 292 |
| *Idaho Power* | 15-minute market | 0% | N/A | N/A | 0% | N/A | N/A | 0 |
| | 5-minute market | 21% | 40 | 1.9% | 8% | -53 | 2.5% | 4 |
| *Los Angeles Department of Water and Power* | 15-minute market | 0% | N/A | N/A | 0% | N/A | N/A | 0 |
| | 5-minute market | 5% | 49 | 2.0% | 27% | -58 | 2.4% | -13 |
| *NorthWestern Energy* | 15-minute market | 18% | 14 | 0.9% | 0.2% | -10 | 0.6% | 3 |
| | 5-minute market | 38% | 16 | 1.0% | 2% | -23 | 1.5% | 6 |
| *NV Energy* | 15-minute market | 0% | N/A | N/A | 0% | N/A | N/A | 0 |
| | 5-minute market | 45% | 87 | 2.2% | 4% | -90 | 2.4% | 35 |
| *PacifiCorp East* | 15-minute market | 0% | N/A | N/A | 0% | N/A | N/A | 0 |
| | 5-minute market | 11% | 85 | 1.5% | 28% | -105 | 1.8% | -20 |
| *PacifiCorp West* | 15-minute market | 0% | N/A | N/A | 0% | N/A | N/A | 0 |
| | 5-minute market | 2% | 52 | 1.9% | 9% | -48 | 1.8% | -3 |
| *Portland General Electric* | 15-minute market | 0% | N/A | N/A | 0% | N/A | N/A | 0 |
| | 5-minute market | 11% | 31 | 1.0% | 0.1% | -20 | 0.7% | 3 |
| *Public Service Company of New Mexico* | 15-minute market | 0% | N/A | N/A | 0% | N/A | N/A | 0 |
| | 5-minute market | 25% | 62 | 4.2% | 4% | -100 | 6.9% | 12 |
| *Puget Sound Energy* | 15-minute market | 1% | 49 | 1.3% | 2% | -51 | 1.3% | 0 |
| | 5-minute market | 2% | 48 | 1.3% | 31% | -39 | 1.1% | -11 |
| *Salt River Project* | 15-minute market | 2% | 56 | 1.8% | 0.03% | -100 | 3.4% | 1 |
| | 5-minute market | 14% | 65 | 2.1% | 0.5% | -145 | 5.0% | 9 |
| *Seattle City Light* | 15-minute market | 0.3% | 20 | 1.1% | 4% | -16 | 1.3% | -1 |
| | 5-minute market | 6% | 13 | 0.9% | 61% | -22 | 1.7% | -12 |
| *Tacoma Power* | 15-minute market | 0.3% | 15 | 2.0% | 0% | N/A | N/A | 0 |
| | 5-minute market | 5% | 12 | 1.7% | 2% | -12 | 1.9% | 0 |
| *Tucson Electric Power* | 15-minute market | 0% | N/A | N/A | 0.5% | -48 | 4.0% | 0 |
| | 5-minute market | 2% | 48 | 3.8% | 21% | -56 | 4.9% | -11 |
| *Turlock Irrigation District* | 15-minute market | 0% | N/A | N/A | 0% | N/A | N/A | 0 |
| | 5-minute market | 0% | N/A | N/A | 0% | N/A | N/A | 0 |

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

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

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

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




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

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

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

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