EIM Resource Sufficiency Evaluation Metrics
Report covering September 2021

October 14, 2021

Prepared by: Department of Market Monitoring

California Independent System Operator

1 Report overview

As part of the Energy Impact Market (EIM) resource sufficiency evaluation stakeholder initiative, DMM has agreed to provide additional information and analysis about resource sufficiency evaluation performance, accuracy, and impacts in regular reports.[1] This report highlights existing metrics and analysis covering September 2021.

This report is organized as follows:

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

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 area, including the California ISO, is subject to a resource sufficiency evaluation. The evaluation is performed prior to each hour to ensure that generation in each area is sufficient without relying on transfers from other balancing areas. The evaluation is made up of four tests: the power flow feasibility test, the balancing test, the flexible ramping sufficiency test, and the bid range capacity test. Two of these tests have the same outcome of constraining transfer capability following a failure:

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

If an area fails either the flexible ramping sufficiency test or bid range capacity test in the upward direction, energy imbalance market transfers into that area cannot be increased.[2] Similarly, if an area fails either test in the downward direction, transfers out of that area cannot be increased.

Flexible ramping sufficiency test

The flexible ramping sufficiency test requires that each area has enough ramping resources to meet expected upward and downward ramping needs in the real-time market without relying on transfers from other balancing areas. Each area must show sufficient ramping capability from the start of the hour to each of the four 15-minute intervals within the hour.

Equation 1 shows the different components and mathematical formulation of the flexible ramping sufficiency test. As shown in Equation 1, the requirement for the flexible ramping sufficiency test is calculated as the *forecasted change in load* plus the *uncertainty component* minus two components: (1) the *diversity benefit* and (2*) flexible ramping credits*.

Equation 1. Flexible Ramping Sufficiency Test Formulation

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

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

Change in load forecast

Net load uncertainty

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 individual balancing area flexible ramping needs because of reduced uncertainty across a larger

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

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 to increase upward ramping capability or reduce imports to increase downward ramping capability.

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

The uncertainty component currently used in the flexible ramping sufficiency test is calculated from the historical net load error observation. The 2.5th percentile of historical net load error observations is used for the downward requirement and the 97.5th percentile if used for the upward requirement.[3] As part of the flexible ramping product refinements stakeholder initiative, the uncertainty component is expected to be enhanced in Spring 2022 to scale and account for net load currently in the system.[4]

Bid range capacity test

The bid range capacity test requires that each area provide incremental (or decremental) bid-in capacity to meet the imbalance between load, intertie, and generation base schedules. Equation 2 shows the different components and mathematical formulation of the bid range capacity test. As shown in Equation 2, the requirement for the bid range capacity test is calculated as the *load forecast* plus *export base schedules* minus *import and generation base schedules*.

Equation 2. Bid Range Capacity Test Formulation

$$Requirement = Load + Export_{base} - Import_{base} - Generation_{base} + Intertie\ Deviation + Uncertainty$$

Load forecast

Intertie and generation base schedules

Additional requirement to account for historical intertie deviation

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.

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[3] Net load error in the 15-minute market is calculated from the difference between binding net load forecasts in the 5-minute market and the advisory net load forecast in the 15-minute market. Weekdays use data for the same hour from the last 40 weekdays. For weekends, the last 20 weekend days are used.

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

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

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

Since the bid range capacity is calculated relative to the base schedules, the upward capacity test can generally be expressed as follows:[6]

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

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

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

3 Summary metrics

This section provides existing summary metrics on the resource sufficiency evaluation.[7] DMM is in the process of developing additional metrics including coverage of the uncertainty component used in the tests, test comparisons to actual availability, and counterfactual analysis of changes proposed in the resource sufficiency evaluation enhancements initiative.

Frequency and size of bid-range capacity test and flexible ramping sufficiency test failure

Figure 1 through Figure 4 show the percent of intervals in which each EIM area failed the upward capacity or sufficiency tests as well as the average shortfall of those test failures. Figure 5 through Figure 8 provide the same information for the downward direction. The dash indicates the area did not fail the test during the month. The flexible ramping sufficiency test and bid-range capacity test failures reported below reflect results independent of the other test.

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

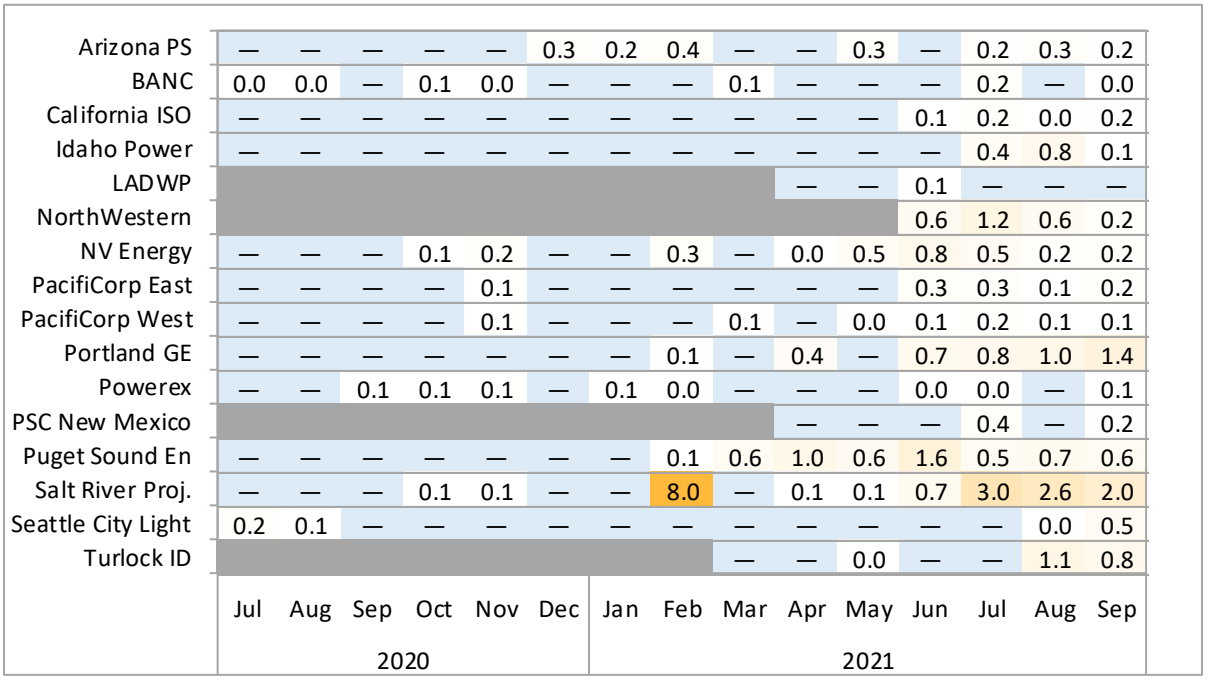
Figure 9 summarizes the overlap between failure of the upward capacity and sufficiency tests during the month. The black horizontal line (right axis) shows the number of 15-minute intervals with either a capacity or sufficiency test failure for each energy imbalance market area. The areas are shown in descending number of failure intervals. The bars (left axis) show the percent of the failure intervals that meet the condition.

Figure 10 shows the same information for the downward direction. Areas that did not fail either the capacity or sufficiency test during this period were omitted from the figure.

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

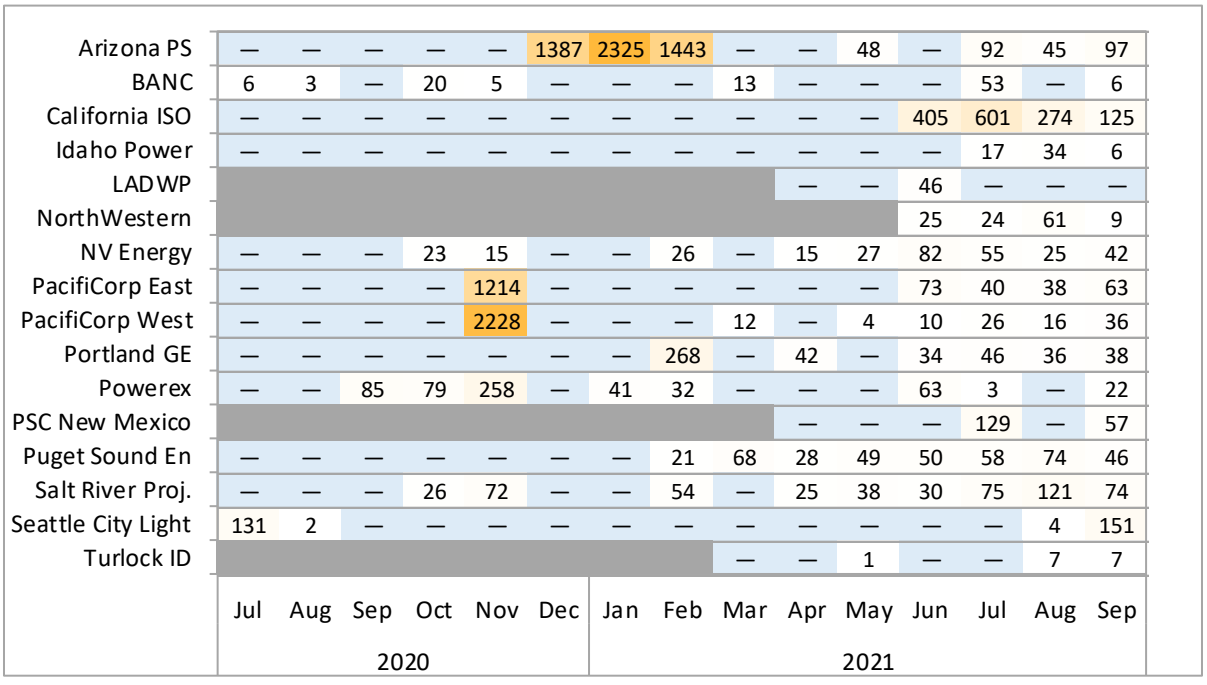
[8] For additional information on these errors and the impact on bid-range capacity test failures, see DMM's May report: http://www.caiso.com/Documents/Report-on-Resource-Sufficiency-Tests-in-the-Energy-Imbalance-Market-May-20-2021.pdf

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



	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	2020						2021								
Arizona PS	—	—	—	—	—	0.3	0.2	0.4	—	—	0.3	—	0.2	0.3	0.2
BANC	0.0	0.0	—	0.1	0.0	—	—	—	0.1	—	—	—	0.2	—	0.0
California ISO	—	—	—	—	—	—	—	—	—	—	—	0.1	0.2	0.0	0.2
Idaho Power	—	—	—	—	—	—	—	—	—	—	—	—	0.4	0.8	0.1
LADWP										—	—	0.1	—	—	—
NorthWestern												0.6	1.2	0.6	0.2
NV Energy	—	—	—	0.1	0.2	—	—	0.3	—	0.0	0.5	0.8	0.5	0.2	0.2
PacifiCorp East	—	—	—	—	0.1	—	—	—	—	—	—	0.3	0.3	0.1	0.2
PacifiCorp West	—	—	—	—	0.1	—	—	—	0.1	—	0.0	0.1	0.2	0.1	0.1
Portland GE	—	—	—	—	—	—	—	0.1	—	0.4	—	0.7	0.8	1.0	1.4
Powerex	—	—	0.1	0.1	0.1	—	0.1	0.0	—	—	—	0.0	0.0	—	0.1
PSC New Mexico										—	—	—	0.4	—	0.2
Puget Sound En	—	—	—	—	—	—	—	0.1	0.6	1.0	0.6	1.6	0.5	0.7	0.6
Salt River Proj.	—	—	—	0.1	0.1	—	—	8.0	—	0.1	0.1	0.7	3.0	2.6	2.0
Seattle City Light	0.2	0.1	—	—	—	—	—	—	—	—	—	—	—	0.0	0.5
Turlock ID									—	—	0.0	—	—	1.1	0.8

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



	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	2020						2021								
Arizona PS	—	—	—	—	—	1387	2325	1443	—	—	48	—	92	45	97
BANC	6	3	—	20	5	—	—	—	13	—	—	—	53	—	6
California ISO	—	—	—	—	—	—	—	—	—	—	—	405	601	274	125
Idaho Power	—	—	—	—	—	—	—	—	—	—	—	—	17	34	6
LADWP										—	—	46	—	—	—
NorthWestern												25	24	61	9
NV Energy	—	—	—	23	15	—	—	26	—	15	27	82	55	25	42
PacifiCorp East	—	—	—	—	1214	—	—	—	—	—	—	73	40	38	63
PacifiCorp West	—	—	—	—	2228	—	—	—	12	—	4	10	26	16	36
Portland GE	—	—	—	—	—	—	—	268	—	42	—	34	46	36	38
Powerex	—	—	85	79	258	—	41	32	—	—	—	63	3	—	22
PSC New Mexico										—	—	—	129	—	57
Puget Sound En	—	—	—	—	—	—	—	21	68	28	49	50	58	74	46
Salt River Proj.	—	—	—	26	72	—	—	54	—	25	38	30	75	121	74
Seattle City Light	131	2	—	—	—	—	—	—	—	—	—	—	—	4	151
Turlock ID									—	—	1	—	—	7	7

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

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
			2020						2021						
Arizona PS	—	—	0.3	0.8	0.7	0.6	0.5	0.5	0.2	—	0.6	—	0.0	—	0.2
BANC	—	0.2	0.0	0.1	—	0.1	—	—	—	—	—	—	—	—	—
California ISO	0.1	1.1	0.5	0.4	0.5	—	—	—	—	—	—	0.0	0.3	0.1	0.4
Idaho Power	0.1	0.2	—	—	—	—	—	0.1	—	—	—	—	—	—	—
LADWP										0.0	0.1	—	0.1	—	—
NorthWestern												1.3	3.6	0.7	1.6
NV Energy	4.5	7.1	2.6	1.4	0.8	—	0.1	0.5	0.4	0.4	0.7	0.9	0.4	0.5	0.1
PacifiCorp East	0.2	0.2	0.1	0.5	0.0	—	0.1	0.1	0.1	0.1	0.0	0.1	0.0	—	0.1
PacifiCorp West	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.2	0.1	0.1	0.0	—	0.0	0.1	—
Portland GE	0.2	0.2	0.6	0.1	0.1	0.2	0.3	0.6	0.1	0.2	0.2	0.3	0.5	0.2	—
Powerex	0.2	0.1	0.3	0.1	0.6	0.2	0.2	0.1	0.1	0.1	—	0.1	0.5	—	—
PSC New Mexico										0.4	0.0	0.1	0.5	—	0.1
Puget Sound En	0.6	0.4	—	0.2	—	—	—	—	—	—	0.1	0.1	0.0	0.0	—
Salt River Proj.	0.7	1.8	1.1	1.7	0.9	0.3	0.2	7.1	0.3	0.5	0.2	0.9	1.9	1.7	0.8
Seattle City Light	0.1	—	0.1	0.2	0.2	0.1	—	—	—	—	—	—	0.0	—	0.1
Turlock ID									—	—	0.3	—	—	—	0.1

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

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
			2020						2021						
Arizona PS	—	—	232	56	60	716	913	1140	57	—	33	—	38	—	42
BANC	—	52	8	15	—	18	—	—	—	—	—	—	—	—	—
California ISO	111	710	1031	872	516	—	—	—	—	—	—	404	585	400	735
Idaho Power	5	19	—	—	—	—	—	8	—	—	—	—	—	—	—
LADWP										32	59	—	70	—	—
NorthWestern												45	36	18	25
NV Energy	65	77	94	82	99	—	87	56	59	60	47	39	45	36	94
PacifiCorp East	38	33	95	64	20	—	62	26	61	67	47	53	44	—	21
PacifiCorp West	28	74	38	58	17	15	27	20	21	18	8	—	2	33	—
Portland GE	13	20	20	11	31	27	30	33	77	105	20	36	33	19	—
Powerex	30	664	48	64	115	65	82	64	26	69	—	137	111	—	—
PSC New Mexico										21	58	19	112	—	47
Puget Sound En	38	31	—	27	—	—	—	—	—	—	47	24	6	24	—
Salt River Proj.	66	69	46	56	49	52	20	64	27	75	27	69	61	53	50
Seattle City Light	11	—	10	9	6	4	—	—	—	—	—	—	7	—	14
Turlock ID									—	—	6	—	—	—	2

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

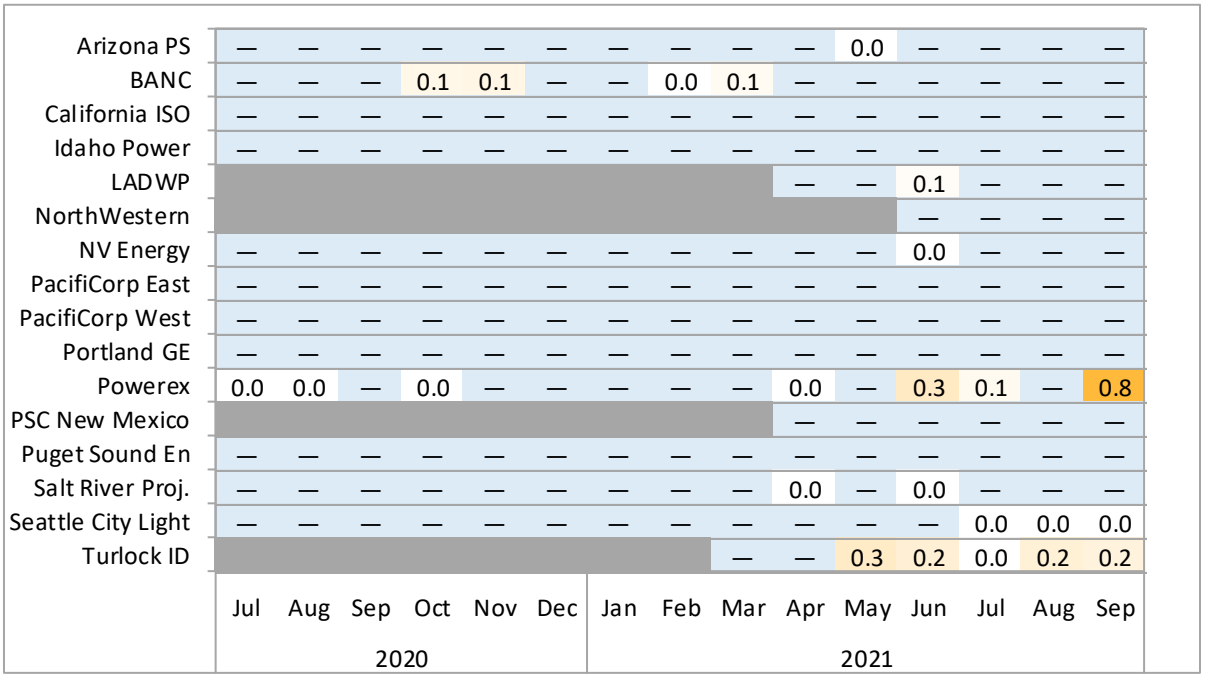


Figure 6. Average shortfall of downward capacity test failures (MW)

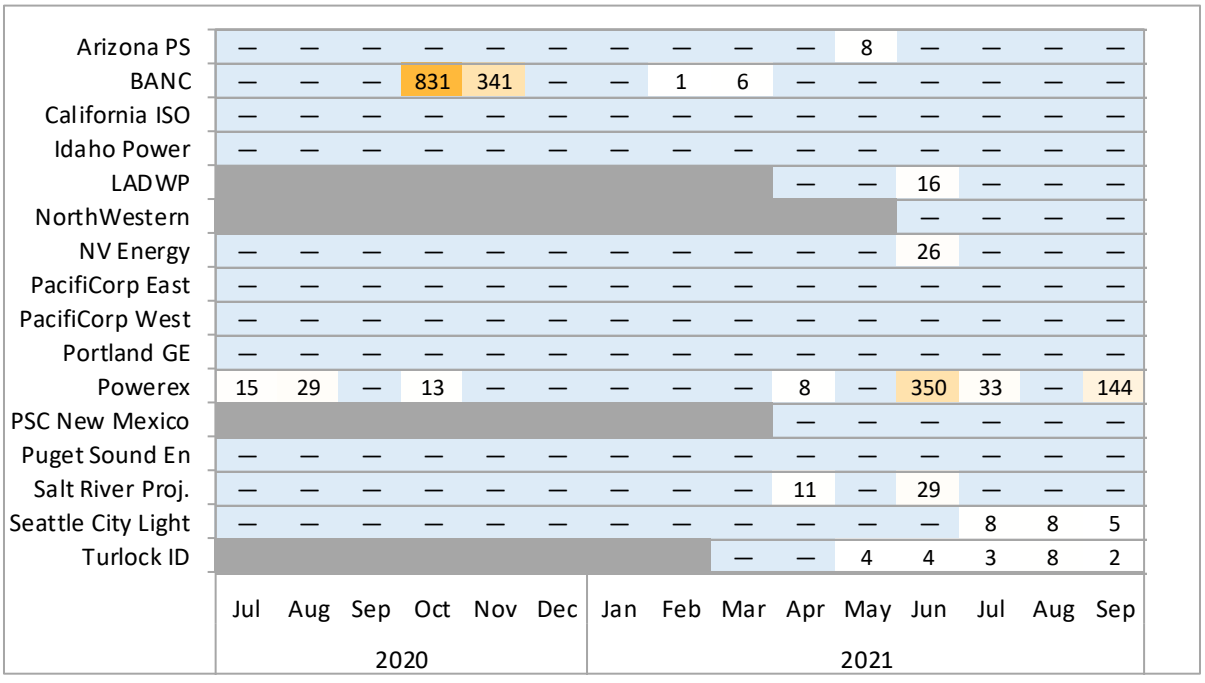


Figure 7. Frequency of downward sufficiency test failures (percent of intervals)

	Jul 2020	Aug 2020	Sep 2020	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mar 2021	Apr 2021	May 2021	Jun 2021	Jul 2021	Aug 2021	Sep 2021
Arizona PS	0.1	—	0.1	1.9	0.9	2.5	2.2	2.3	4.3	1.9	0.3	0.1	—	0.1	0.1
BANC	—	—	—	0.1	0.3	—	—	0.6	0.4	—	—	—	—	—	—
California ISO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Idaho Power	0.0	—	—	0.0	0.0	—	—	—	—	—	0.0	—	—	—	—
LADWP										—	—	0.1	—	—	—
NorthWestern												0.7	0.6	0.4	1.2
NV Energy	0.7	0.8	2.2	0.5	1.4	1.1	0.2	6.1	1.4	0.5	4.3	2.0	3.0	2.5	1.7
PacifiCorp East	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PacifiCorp West	—	—	—	—	—	—	—	—	0.1	—	—	0.1	—	—	—
Portland GE	—	—	—	—	—	—	0.0	—	—	—	—	—	—	—	—
Powerex	0.0	0.1	0.1	0.1	—	—	0.4	—	1.4	0.2	0.9	1.3	0.4	0.2	1.0
PSC New Mexico										1.4	—	0.0	—	—	0.1
Puget Sound En	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Salt River Proj.	—	0.0	0.1	0.1	0.2	0.8	1.1	1.6	1.2	0.2	0.1	0.2	—	0.1	0.0
Seattle City Light	0.1	0.2	0.2	0.1	0.1	0.1	—	—	—	—	—	—	0.2	—	—
Turlock ID									0.4	0.1	0.5	—	—	0.0	—

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

	Jul 2020	Aug 2020	Sep 2020	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mar 2021	Apr 2021	May 2021	Jun 2021	Jul 2021	Aug 2021	Sep 2021
Arizona PS	51	—	36	73	44	55	63	94	52	73	38	26	—	50	27
BANC	—	—	—	63	98	—	—	16	13	—	—	—	—	—	—
California ISO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Idaho Power	45	—	—	5	10	—	—	—	—	—	9	—	—	—	—
LADWP										—	—	14	—	—	—
NorthWestern												259	14	29	17
NV Energy	55	71	87	30	31	32	150	49	56	64	74	65	141	70	83
PacifiCorp East	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PacifiCorp West	—	—	—	—	—	—	—	—	9	—	—	140	—	—	—
Portland GE	—	—	—	—	—	—	10	—	—	—	—	—	—	—	—
Powerex	19	54	47	71	—	—	95	—	64	26	38	199	83	44	121
PSC New Mexico										124	—	12	—	—	102
Puget Sound En	43	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Salt River Proj.	—	118	92	58	26	33	57	45	55	47	65	44	—	25	100
Seattle City Light	10	8	7	25	20	88	—	—	—	—	—	—	2	—	—
Turlock ID									2	6	7	—	—	4	—

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

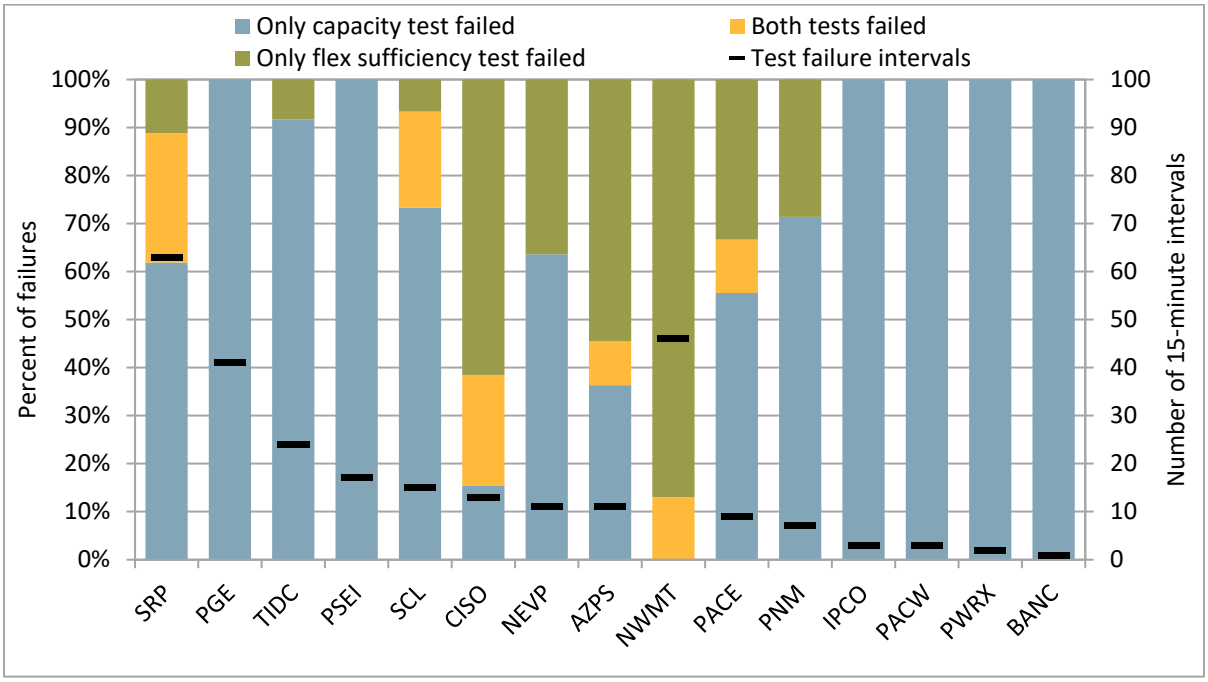
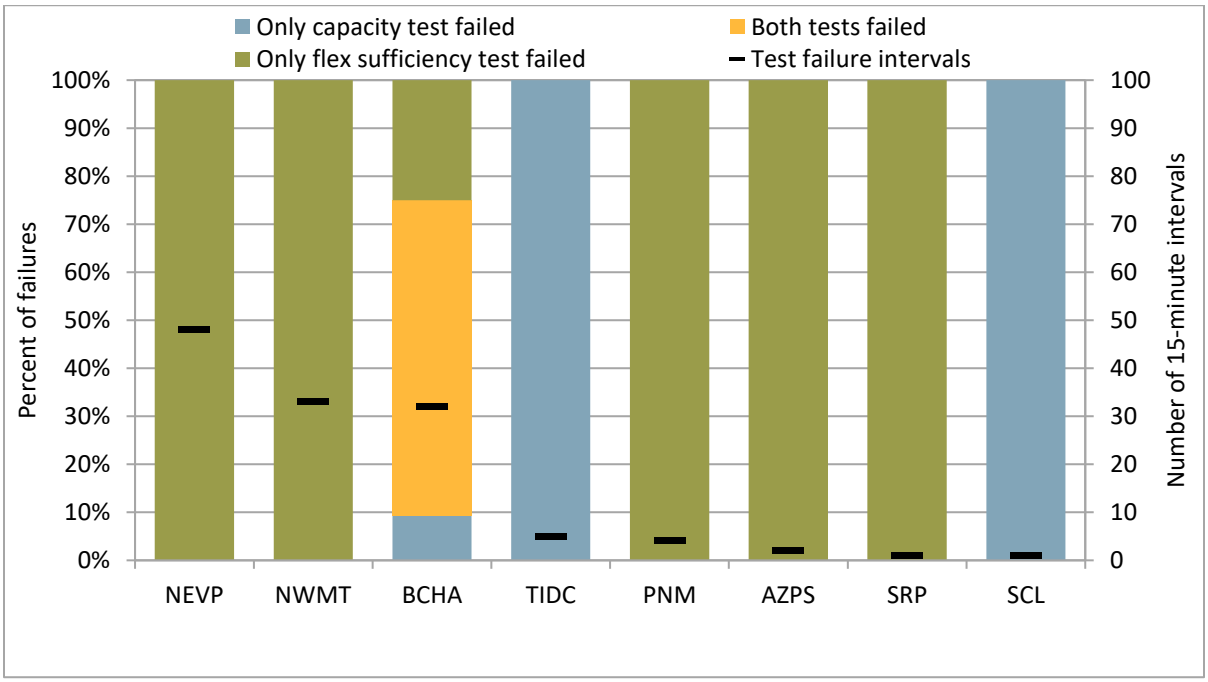


Figure 10. Downward capacity/sufficiency test failure intervals by concurrence (September, 2021)



Impact of adding uncertainty to the capacity test

On June 16, the ISO added net load uncertainty to the requirement of the bid range capacity test as part of a package of market enhancements for Summer 2021 readiness. The uncertainty component is net of the diversity benefit, similar to that already in effect for the flexible ramping sufficiency test.[9]

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

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

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

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

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

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

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

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

Transfer consequences of failing resource sufficiency evaluation

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

When either test is failed in the upward direction, imports will be capped at the greater of (1) the base transfer or (2) the transfer from the last 15-minute market interval. If both the base transfer and the last 15-minute transfer are in a net export position, the cap will be imposed on the export side (i.e. the balancing area cannot export less than the cap).

Figure 13 summarizes the import limits that were imposed after failing either test by balancing area and cap position (i.e. import or export). The black horizontal line (right axis) shows the number of 15-minute intervals with either a capacity or sufficiency test failure. The energy imbalance market 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 14 summarizes the same information with the import limit categorized by various levels of import limits.

Figure 15 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 separated between energy imbalance market transfers in the 15-minute (FMM) and 5-minute (RTD) markets.

Figure 13. Upward capacity/sufficiency test failure intervals by import limit position (September, 2021)

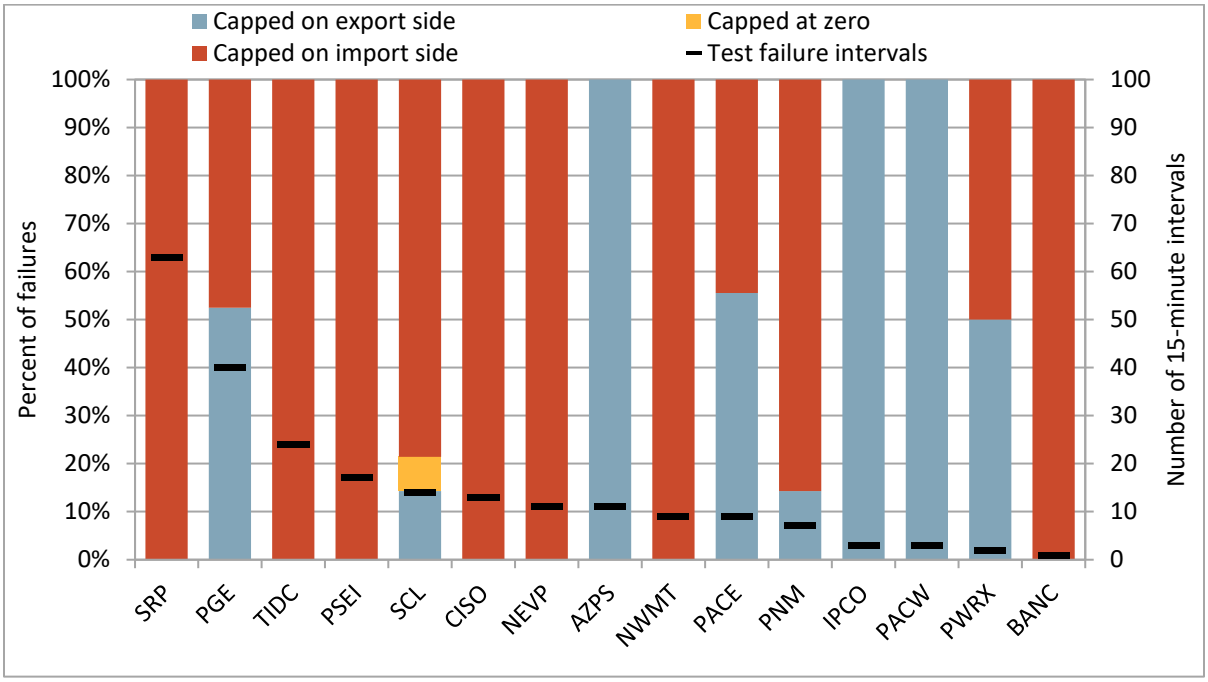


Figure 14. Upward capacity/sufficiency test failure intervals by import limit amount (September, 2021)

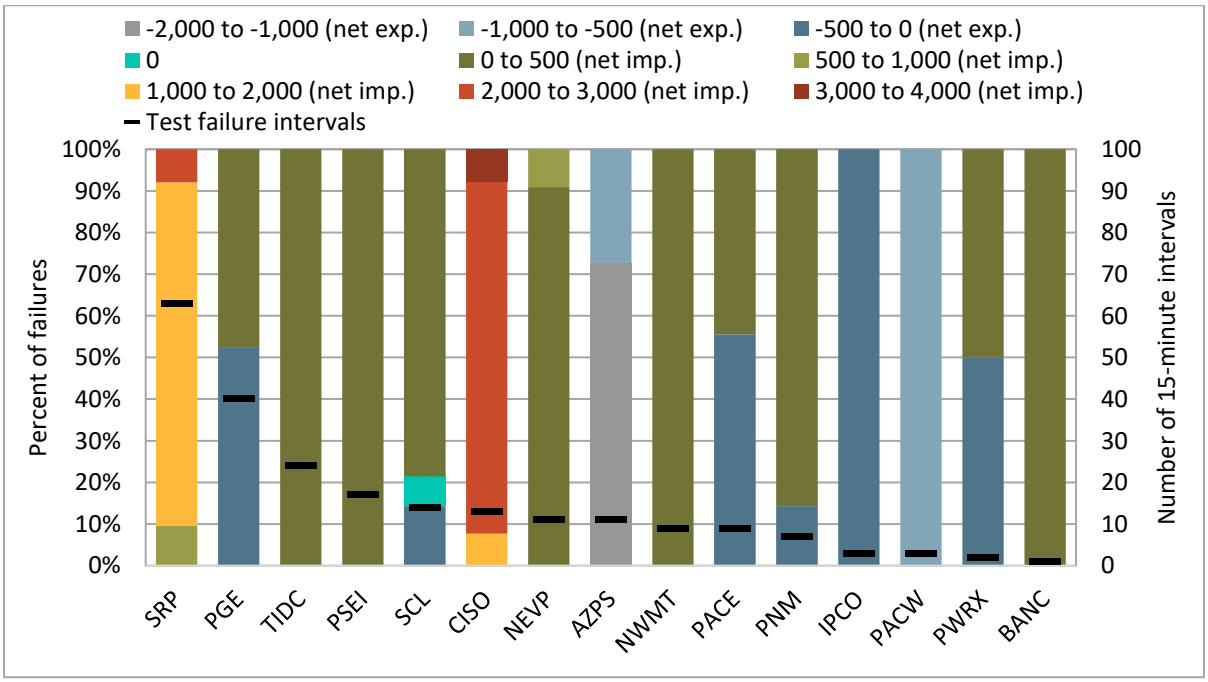
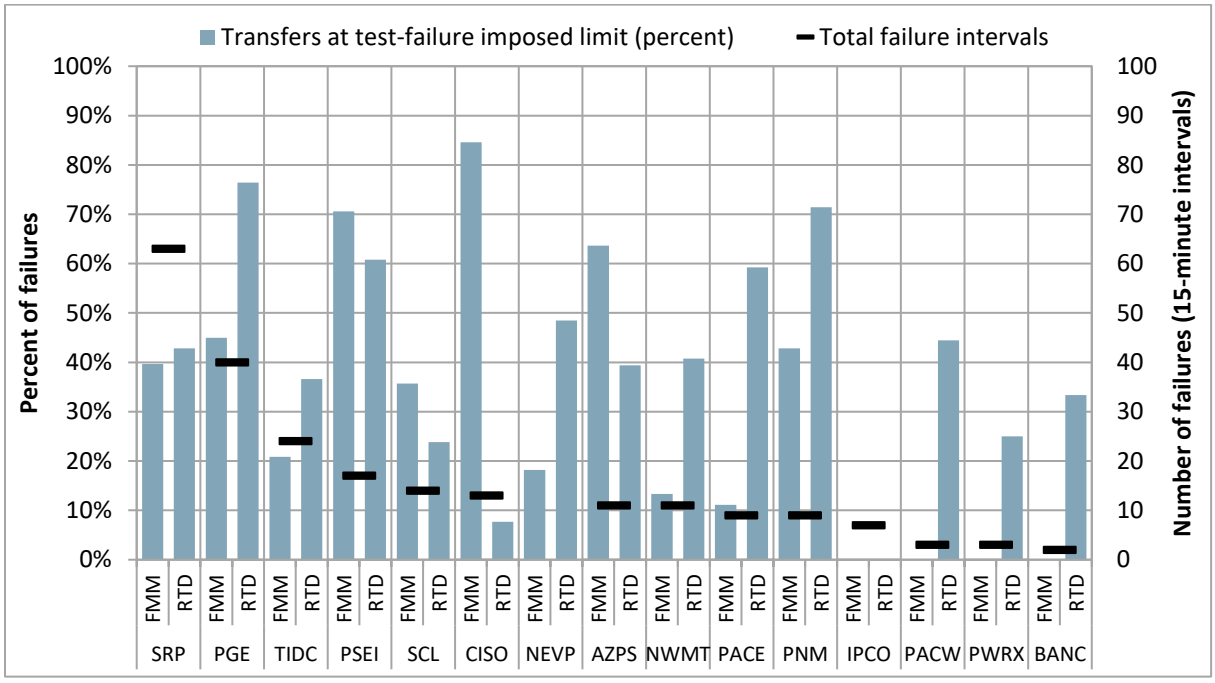


Figure 15. Percent of upward test failure intervals with market transfers at the imposed cap (September, 2021)



Imbalance conformance in the energy imbalance market

Operators in every EIM balancing area, including the California ISO, can manually adjust the load through imbalance conformance adjustments. These adjustments are not used directly in either the bid range capacity or flexible ramping sufficiency tests. However, they can impact test results indirectly in at least several ways.

- The flexible ramping sufficiency test measures ramping capacity from the start of the hour (i.e. last binding 15-minute interval) against 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] *15-minute-dispatchabale* imports and exports relative to these base schedules are then included as incremental or decremental capacity. So, 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.
- Further, the penalty for failing either the upward capacity or sufficiency test is that EIM transfers are capped by the greater of the transfer in the last 15-minute interval prior to the hour or base EIM transfers. Due to this, a higher imbalance conformance adjustment entered prior to the hour can increase EIM transfers into the balancing area resulting in higher transfer limits following a failure than would have occurred otherwise.

In the EIM 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.[11]

Figure 16 summarizes average hour-ahead and 15-minute market imbalance conformance entered by operators in the ISO during the month. Figure 17 shows the same information for each of the EIM entities with substantial imbalance conformance.[12] Table 1 summarizes the average frequency and size of 15-minute and 5-minute market imbalance conformance for all balancing authority areas.

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

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

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

Figure 16. Average hourly ISO hour-ahead and 15-minute market imbalance conformance (September, 2021)

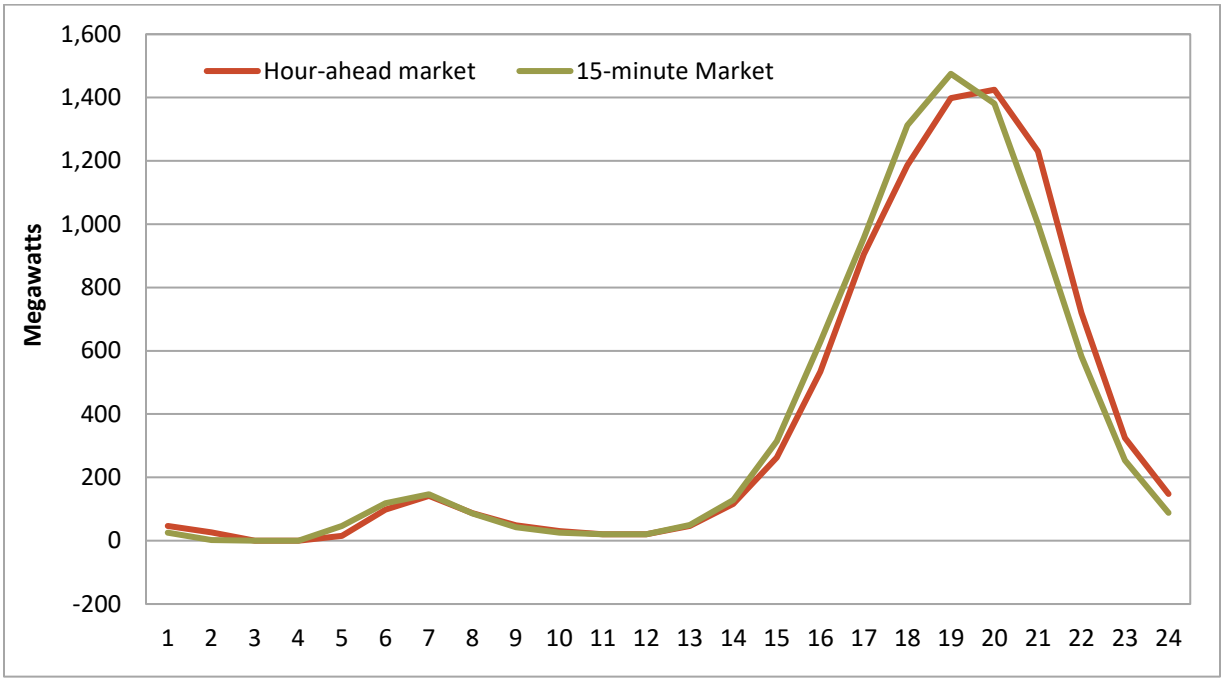


Figure 17. Average hourly non-ISO 15-minute market imbalance conformance (September, 2021)

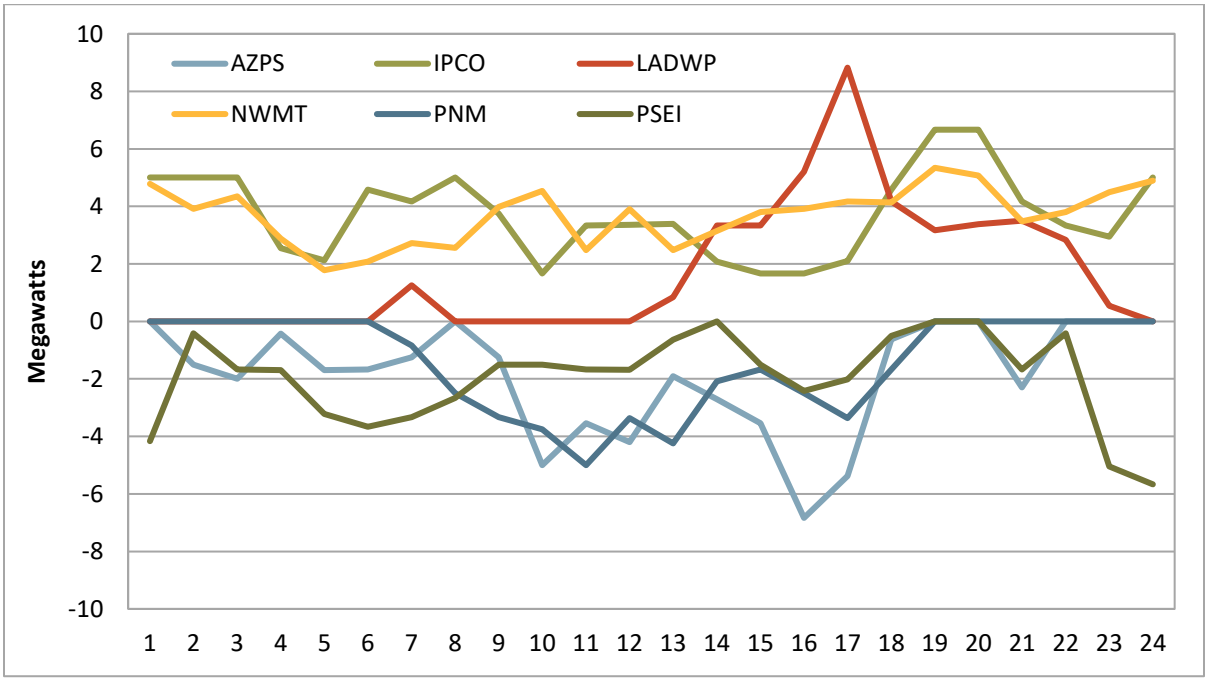


Table 1. Average frequency and size of imbalance conformance (September, 2021)

	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	2%	-88	2.4%	-2
5-minute market	14%	56	1.2%	65%	-78	2.0%	-43
BANC							
15-minute market	0.6%	71	2.4%	0.03%	-100	4.9%	0
5-minute market	1%	67	2.6%	0.2%	-48	2.9%	1
California ISO							
15-minute market	39%	920	2.9%	0.2%	-250	1.1%	363
5-minute market	42%	248	0.8%	21%	-227	0.9%	56
Idaho Power							
15-minute market	7%	50	2.4%	0%	N/A	N/A	4
5-minute market	19%	50	2.4%	1%	-50	2.7%	9
Los Angeles Dept. of Water and Power							
15-minute market	2%	70	1.9%	0%	N/A	N/A	2
5-minute market	36%	58	1.8%	4%	-54	1.9%	19
NorthWestern Energy							
15-minute market	29%	14	1.2%	2.6%	-15	1.4%	4
5-minute market	41%	16	1.4%	3%	-21	1.9%	6
NV Energy							
15-minute market	0.2%	75	1.8%	0.1%	-50	0.7%	0
5-minute market	5%	102	1.6%	8%	-99	2.2%	-3
PacifiCorp East							
15-minute market	0%	N/A	N/A	0.1%	-375	7.4%	0
5-minute market	17%	113	2.0%	26%	-113	2.2%	-10
PacifiCorp West							
15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
5-minute market	5%	52	2.5%	18%	-55	2.4%	-7
Portland General Electric							
15-minute market	0%	N/A	N/A	0%	N/A	N/A	0
5-minute market	6%	27	1.1%	3%	-30	1.4%	1
Public Service Company of New Mexico							
15-minute market	0.1%	75	3.5%	1.4%	-109	8.1%	-1
5-minute market	1%	88	4.8%	3%	-122	9.2%	-3
Puget Sound Energy							
15-minute market	0.03%	70	2.6%	4%	-46	2.1%	-2
5-minute market	1%	35	1.3%	43%	-36	1.5%	-15
Salt River Project							
15-minute market	0.0%	N/A	N/A	0%	N/A	N/A	0
5-minute market	6%	68	1.4%	6%	-59	1.5%	1
Seattle City Light							
15-minute market	0%	N/A	N/A	5%	-17	2.0%	-1
5-minute market	2%	29	3.2%	63%	-22	2.5%	-13
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

4 Metrics for key time periods

The following section highlights test results and outcomes during specific periods of interest. The metrics below shows resource sufficiency evaluation results and outcomes for the California ISO on September 8. This day included the highest load peak load of the year as well as the only day during the month in which the ISO failed the bid-range capacity test (five intervals). DMM is seeking input on (1) thresholds to produce similar period specific and area specific metrics and (2) additional metrics to include.

Figure 18 shows 15-minute and 5-minute market energy imbalance market imports coming into the California ISO during peak hours on September 8. The red and green lines shows the intervals in which the ISO failed the sufficiency or capacity test, limiting transfers to the transfer level of the last binding 15-minute interval.

Figure 19 summarizes the bid-range capacity test for the California ISO in the same period. The red line shows the actual capacity test requirement including the recent addition of uncertainty. The gray line shows the requirement without uncertainty. The bars show the bid range capacity that was used to meet capacity test requirements. The blue and yellow bars are for 15-minute dispatchable incremental imports and decremental exports. The green bars reflect incremental generation capacity above base schedules. The dark green bars reflect capacity that was considered available for the bid range capacity test but unavailable for the flexible ramping sufficiency test because of resource constraints. Resource constraints include start-up times, transition times, ramp rates and other intertemporal constraints. Figure 20 provides the same information except with the total incremental generation capacity broken out by fuel type.

Figure 21 shows the requirement components in the ISO's upward flexible ramping sufficiency test against total ramping capacity. The requirement is calculated as the *forecasted change in load* plus *uncertainty* minus two discounts, *diversity benefit and flexible ramping credits*. Upward credits are net EIM exports prior to the hour, reflecting the ability to reduce exports to increase internal upward ramping capability. For this peak period, the ISO was importing on net in every 15-minute interval so no credits were applied to the upward sufficiency test.

Figure 22 instead shows total ramping capacity by fuel type against the requirement. Ramping capacity accounts for both economic energy bids (constrained by unit limitations such as ramp rates) as well as fixed changes in schedules or renewable forecasts from the previous hour to the next. Thus, an increase in imports (or decrease in exports) will contribute to positive ramping capacity.

Figure 18. Limits on EIM imports into CAISO due to resource sufficiency evaluation failure (September 8, 2021)

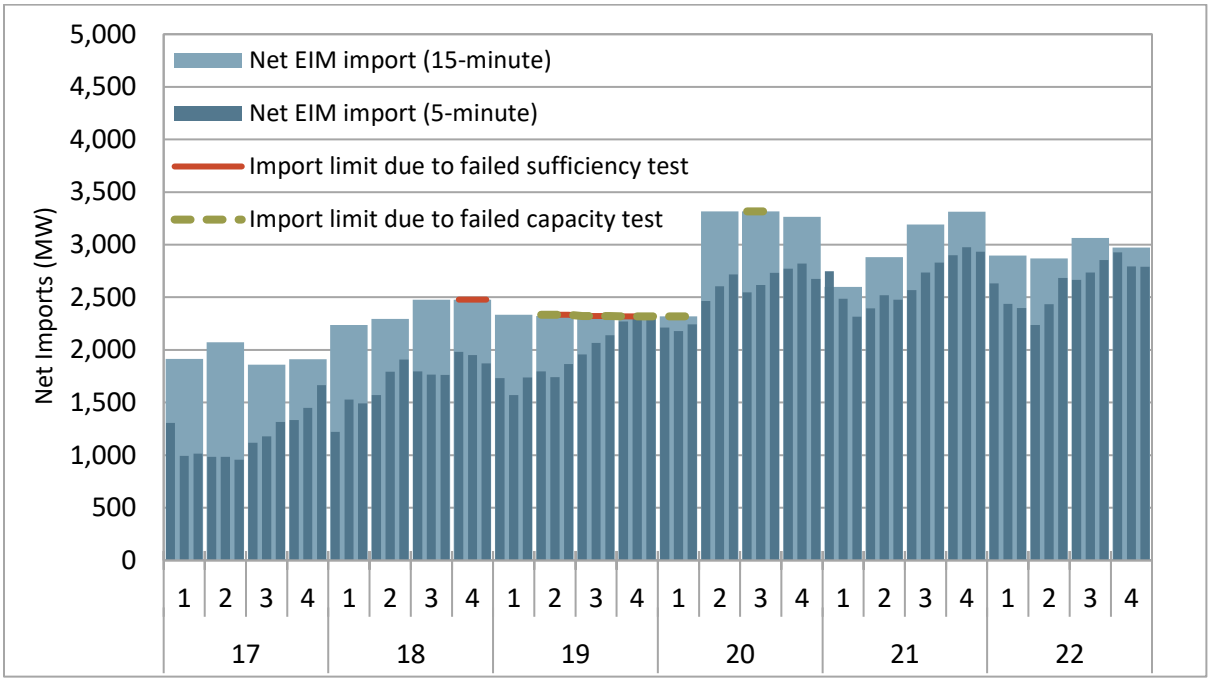


Figure 19. CAISO upward bid range capacity test requirement and capacity (September 8, 2021)

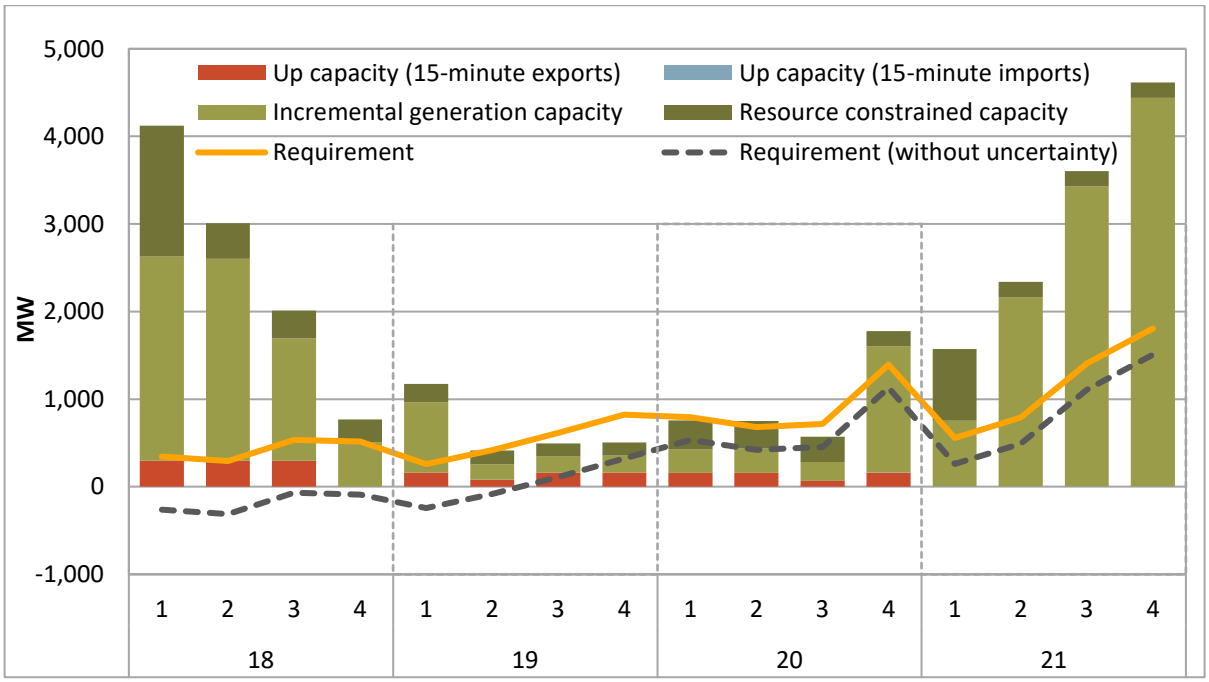


Figure 20. CAISO Upward bid range capacity test requirement and capacity by fuel type (September 8, 2021)

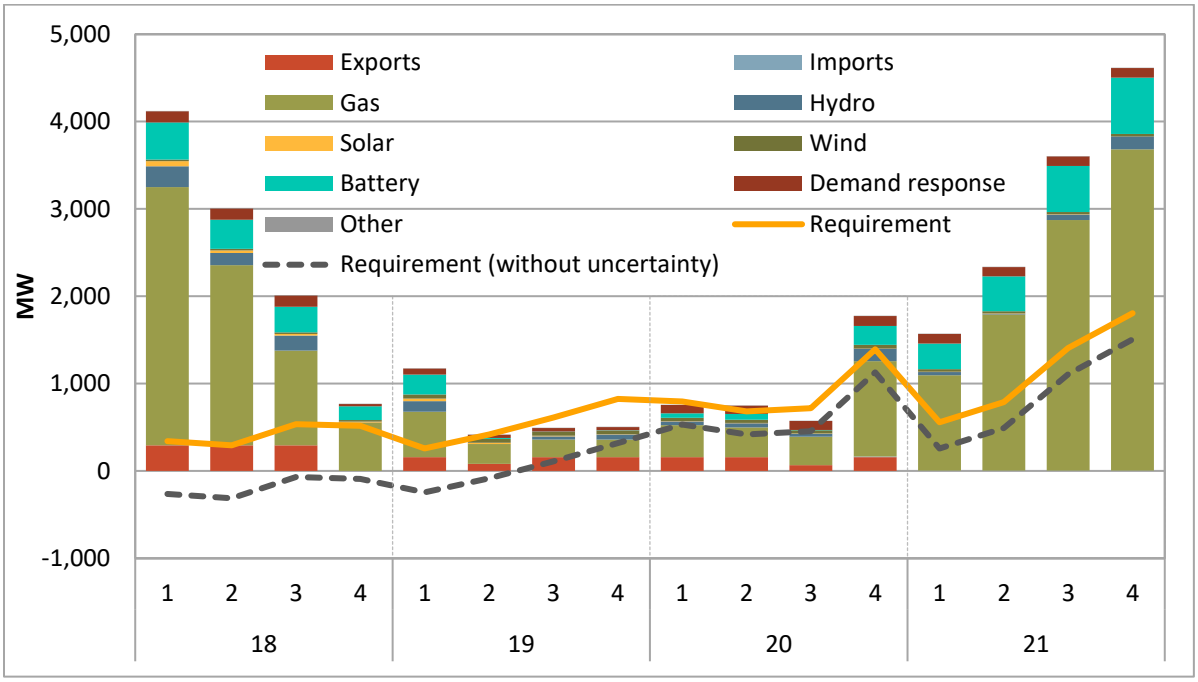


Figure 21. CAISO upward flexible ramping sufficiency test requirement by component (September 8, 2021)

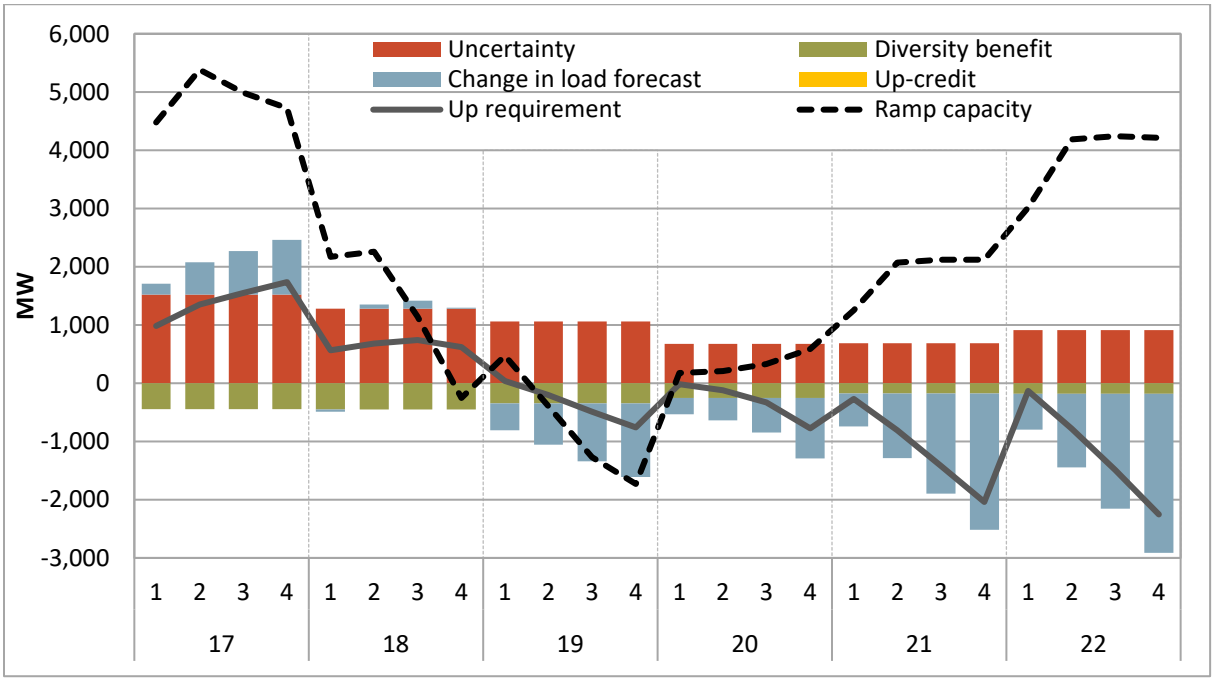
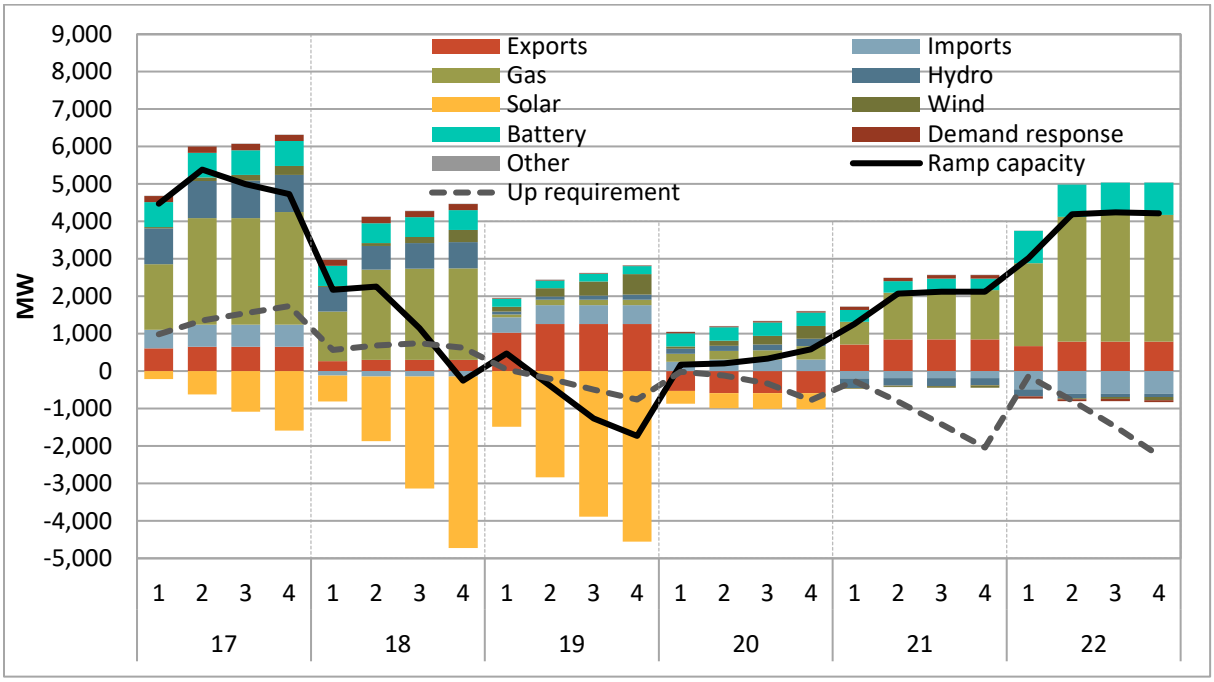


Figure 22. CAISO upward flexible ramping sufficiency test ramping capacity by type (September 8, 2021)



5 Unloaded capacity and EIM imports

This section includes a special discussion on the comparison between unloaded capacity and net EIM imports. The capacity test requires that each area provide incremental bid-in capacity (unloaded capacity) to meet the internal imbalance between load, intertie, generation base schedules, and uncertainty without relying on EIM transfers. DMM has been reviewing cases in which optimized net EIM imports significantly exceeded the unloaded capacity and the bid-range capacity test still passed.

Figure 23 shows this comparison during the peak load hours on July 9, 2021, a period in which the California ISO hit a Stage 2 Energy Emergency. The blue line shows the actual incremental unloaded capacity used in the bid-range capacity test to meet imbalance requirements. The red bars show the imbalance requirement including intertie and net load uncertainty while the yellow bars show the same requirement without the uncertainty components.

The green bars show advisory net EIM imports in the 15-minute market. These reflect the latest results optimized in the market at the time of the resource sufficiency evaluation for the upcoming hour.[13] When supply and demand is balanced (no shortage), this can also be considered as the imbalance needed to meet internal demand without EIM transfers. For that reason, DMM draws a comparison between the advisory net EIM imports output from the market optimization (green bars) and the imbalance requirement used in the bid-range capacity test without the uncertainty components (yellow bars).

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

It is important to understand each of the supply and demand components, and how they differ between (1) those used in the market optimization resulting in the EIM transfers we see in the chart and (2) those used in the bid-range capacity test imbalance requirement. This is key to understanding the periods when net EIM exports exceed unloaded capacity without a test failure and for flagging potential accuracy issues. The list below summarizes some of the differences that have been identified between these two perspectives.

- **Imbalance conformance adjustments.** This accounted for the large majority of the differences. These adjustments are included in the market optimization as changes in load, but are not included in the bid-range capacity test. Figure 24 illustrates this by comparing the net EIM imports with 15-minute market imbalance conformance adjustments entered by ISO operators for the same July 9th period.

- **Non-participating pump load.** This is pumping load, bid and scheduled as non-participating load in the day-ahead market, and included as a component of total load in the market optimization. This is not included in the bid-range capacity test requirement.

- **Intertie intertemporal ramp or block schedule.** The bid-range capacity test imbalance requirement uses the hourly block schedules for import and export resources. The market optimization uses more granular values to account for ramp between hours. This can impact the start and end of the hour.

- **Losses differences.** The bid-range capacity test uses the raw load forecast directly which already factors in losses. The market optimization uses this instead as an input, removes the estimated portion of losses, and allows the market to solve for it. There can therefore be differences between the estimated losses considered in the bid-range capacity test and the market losses.

- **Timing differences.** There are slight timing differences between the latest 15-mintue market run (that produced the net EIM imports shown in the figure) and the binding resource sufficiency evaluation, which can impact some of the generation and load inputs.

- **Uncertainty.** The bid-range capacity test includes two components to account for intertie and net load uncertainty. The difference between the red and yellow bars in Figure 23 reflects this.

DMM plan to quantify and summarize these differences in a future report. DMM recommends that the ISO and stakeholders review some of these differences to potentially improve the accuracy of the test.

Figure 23. Unloaded capacity, net EIM imports, and imbalance requirement (July 9, 2021)

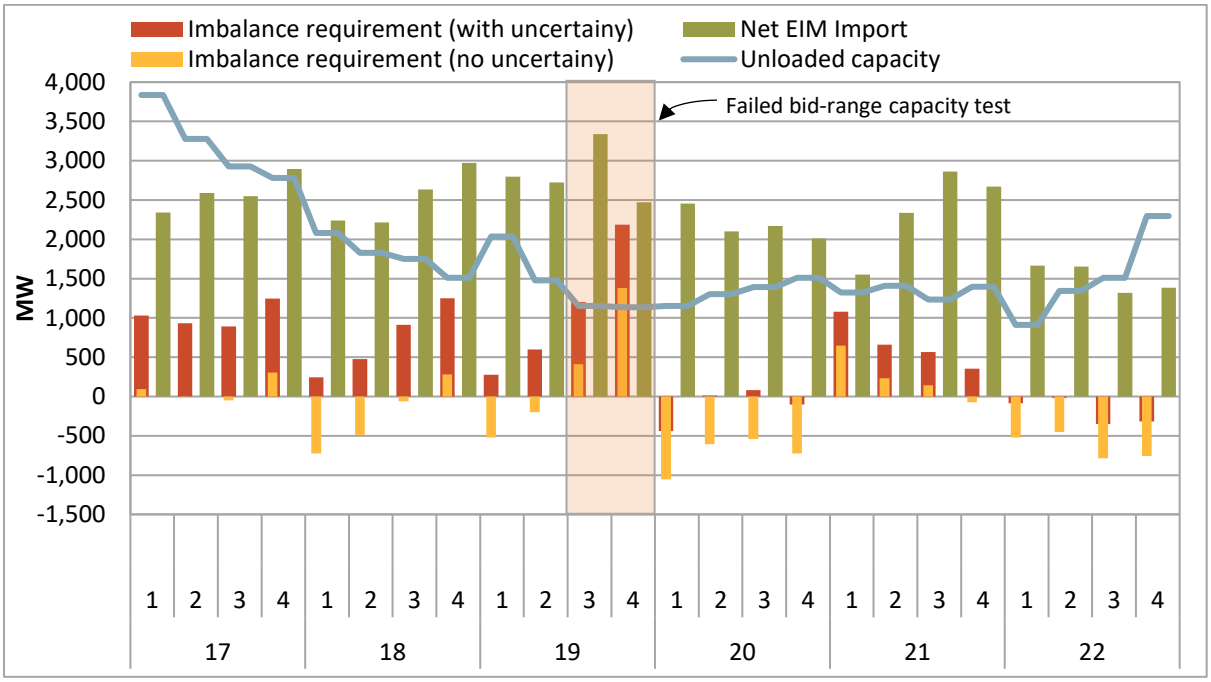


Figure 24. Net EIM imports and imbalance conformance adjustments (July 9, 2021)