Analysis of the Intertie Deviation Adder Used in the Capacity Test

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Prepared by

Market Analysis and Forecasting

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Introduction

The energy imbalance market (EIM) provides an opportunity for Balancing Authority Areas (BAAs) to serve their load while realizing the benefits of increased resource diversity. Since the EIM does not include resource adequacy requirements or obligations for resources to submit bids, the CAISO performs a series of resource sufficiency tests comprised of: (i) a balancing test, (ii) a capacity test, and (iii) a flexible ramping sufficiency test. These tests occur before the real-time market. The capacity test determines whether a balancing authority area participates in the energy imbalance market with sufficient supply to meet its fifteen-minute demand forecast. Furthermore, the capacity test includes two additional requirements to account for i) the net load forecast uncertainty and ii) net-schedule interchange uncertainty.

Each EIM entity must submit a balanced base schedule by forty minutes before the trading hour, and any deviation from these base schedules is settled in the fifteen-minute and five-minute market as imbalances. All EIM BAAs rely on hourly imports and exports to balance their system for each trading hour which is part of the hourly base schedules used in the balancing test. These hourly imports and exports are fixed schedules that are not optimized by the market. However, all EIM entities need to provide energy tags twenty minutes before the trading hour based on the NERC/NAESB deadline. The hourly imports and exports are netted together to calculate the Net Scheduled Interchange (NSI) for each hour. If there is any deviation between the base-scheduled NSI and the tagged NSI, then the EIM BAAs must rely on the real-time market to manage these imbalances. So the real-time market application uses a histogram approach to calculate the incremental requirements for the capacity test to account for the NSI uncertainties.

This report provides analysis on the impact of the adder used in the capacity test to account for the potential of intertie deviations based on historical deviations. The report also analyzes how well the adder covers for the deviations actually accrued in each EIM area.

Intertie Deviation Adder

The CAISO calculates and publishes, for each EIM Entity BAA, the absolute and the relative hourly NSI deviation whose final tagged schedules differ from either the EIM base schedule or, in the case of the CAISO BAA, the CAISO hourly schedules. The CAISO calculates two histograms: one based on absolute hourly scheduling deviation and another based on relative hourly scheduling deviation. The hourly scheduling deviations over each month between the 15th day of the third prior month and the 15th day of the current month. The histogram percentiles are set to ensure the requirement covers 95% confidence intervals such that 97.5 percentile and 2.75 percentiles are used from this histogram. The CAISO calculates the histograms and the additional capacity requirement as follows:

1. The CAISO nets imports and exports against each other in each Operating Hour.
2. The CAISO includes only data for hourly Scheduled imports and exports and base EIM Transfers in the histogram. The following schedules will be excluded from the histogram: 15-minute intertie schedules, dynamic inter-tie schedules, and pseudo-tie schedules.
3. Three months of production data is required to calculate the histogram. Thus, for all new EIM entities, the histogram percentiles will be set to zero until this information is available.

Histogram Calculations:

The CAISO calculates the data samples for the absolute and relative histogram for the NSI deviation at T-40 (NSI base schedules) and the final tagged net imports at T-20 (NSI tagged values) as:

Data sample for relative deviation: (net tagged NSI – net base NSI) / net base NSI

Data sample for absolute deviation: net tagged NSI– net base NSI.

The CAISO provides each EIM Entity the low-end and high-end cutoff percentiles for both the absolute and the relative NSI deviation. If either the relative high-end cutoff percentile or the absolute high-end cutoff value based on the histogram data is below zero, then it will be set to zero. Similarly, if either the low cutoff relative percentile or the low cutoff absolute value based on the histogram data is above zero, then they will be set to zero. This is what defines the additional up and down requirements for the capacity test.

This section introduces the calculation of the incremental up requirement. The CAISO calculates additional upward capacity requirement using data from both the absolute and relative histograms. First, consider a scenario with net imports for a trade hour. In this case, the application considers the minimum of the highest expectation of the net import or the minimum of the absolute difference in net imports for the past 90 days. Second, consider a scenario with net exports for the hour under consideration. In this case, the application considers the minimum of the highest expectation of the net export or the minimum of the absolute difference in net imports for the past 90 days. The calculations for both these scenarios are captured in the equation below.

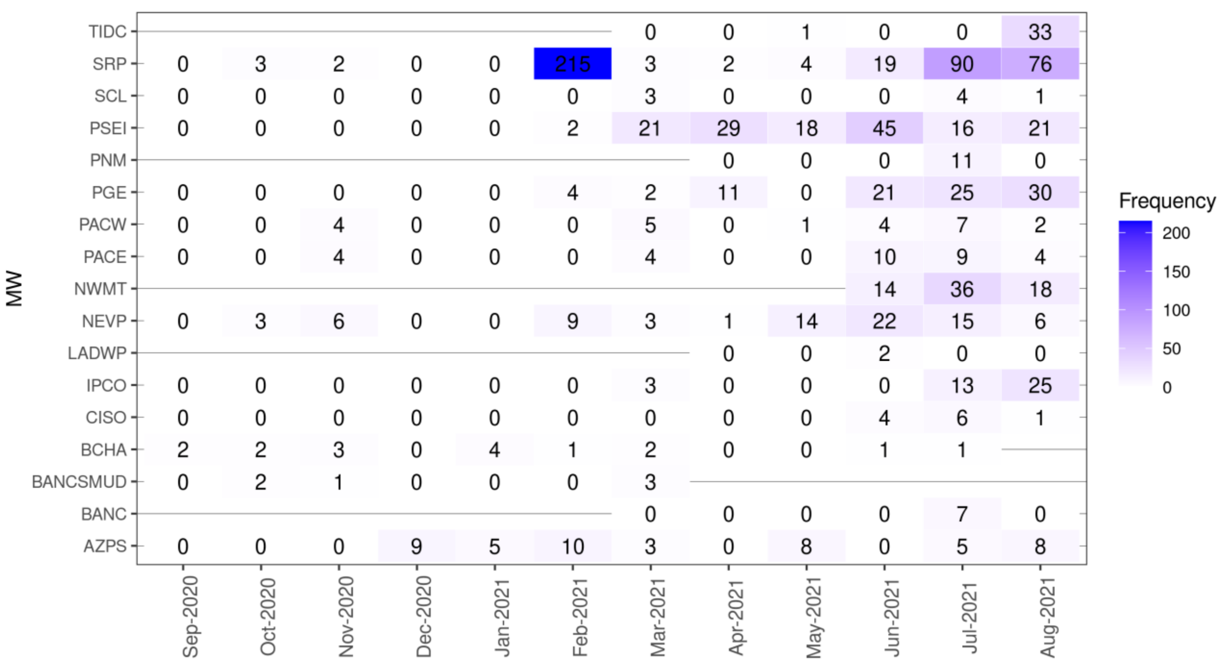
For Net Import:
Additional upward capacity requirement = min(–1*relative low percentile * net base intertie schedule, -1*absolute low percentile)

For Net Export:
Additional upward capacity requirement = min (–1*relative high percentile * net base intertie schedule, absolute high percentile)

Impact of the deviation adder on test results

The ISO analyzed the historical performance of the capacity test for all EIM BAAs participating in the ISO market from September 2020 until August 2021. Figure 1 shows the monthly frequency of the Up capacity test failures for all EIM BAAs. During this period, there were minimal Up capacity test failures between September 2020 and March 2021. Two software defects affected the capacity test results for all EIM BAAs.[1] Most balancing areas passed the test more frequently than they would have if the system did not have these defects. A fix for these two software defects was put in production in February 2021. Also, In February 2021, SRP BAA had 215 capacity test failures due to a gas price spike event, when SRP stopped submitting bids in the ISO market which drove the majority of capacity test failures.

Figure 1 Monthly Frequency of Up-Capacity Test failures

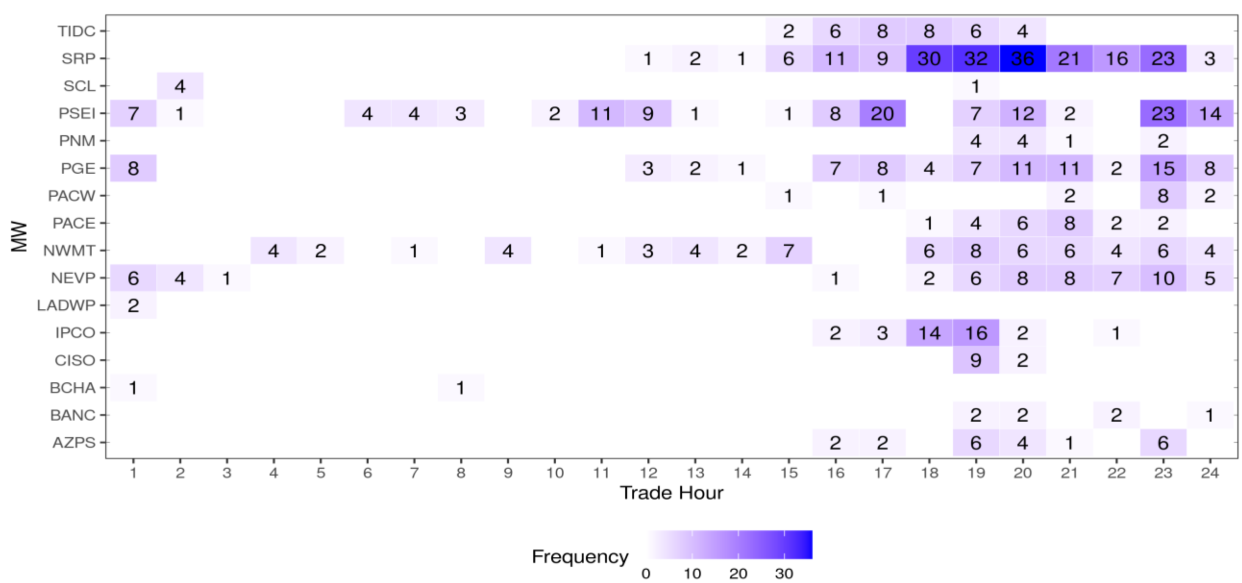


[1] During its review of the August 2020 events, the CAISO identified two defects relating to the implementation of the bid range capacity test. The first defect related to resource rerates and derates not being reflected in the capacity available for the test. The second defect related to inadvertent double counting of "mirror resources," which the CAISO market uses to model transfers between balancing authority areas.

The majority of the Up capacity test failures occurred between April 2021 and August 2021. With this context, the ISO selected this timeframe to analyze further the frequency of capacity test failure across the 24 hours. Figure 2 shows the frequency of the Up capacity test failure across 24 hours from April 2021 until August 2021[2]. There were 845 fifteen-minute intervals with the Up capacity test failures for all EIM BAAs. The ISO performed a counterfactual analysis to identify the impact of the incremental NSI uncertainty requirement on the Up capacity test results by excluding this additional requirement from the test. The total number of capacity test failures without the adder for intertie deviation reduced to 475 from the original count of 845 when the intertie deviation adder is included. Therefore, the inclusion of the intertie deviation adder represented over a half of the overall failures.

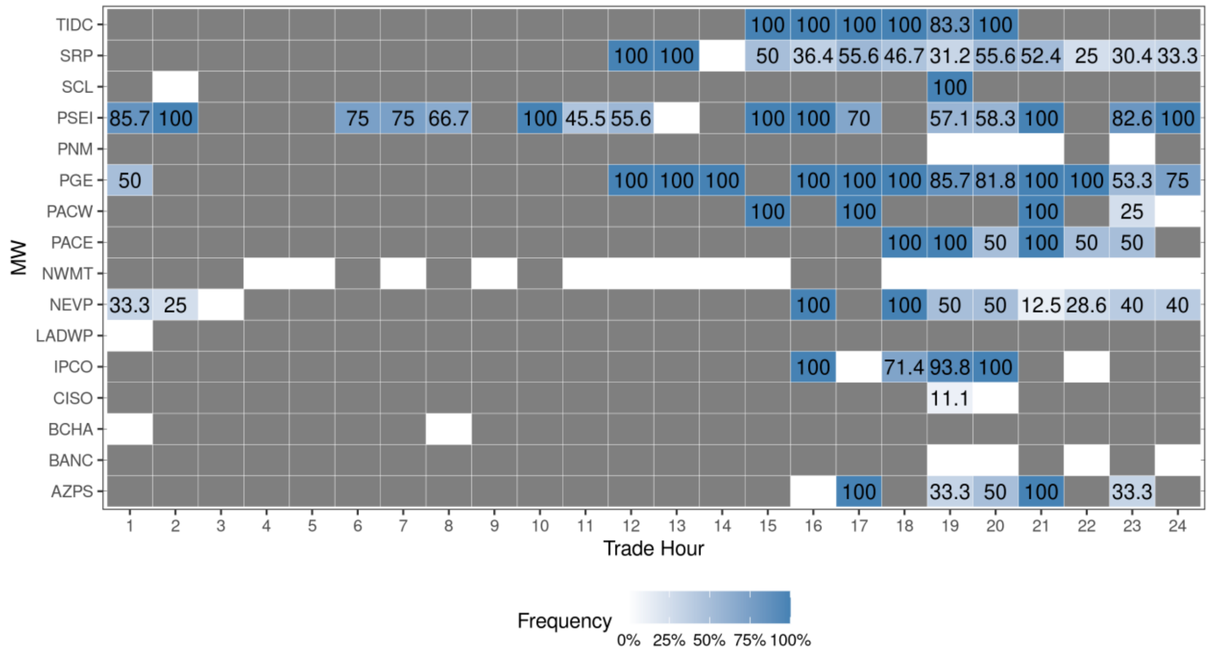
Figure 3 shows the impact of the NSI Uncertainty requirement on the capacity test for all the BAAs across the 24 hours. The impact is measured as the percentage of increased failure of the test when the deviation adder is considered as part of the capacity test requirement. There were four EIM BAAs: Idaho Power (IPCO), Pacificorp East (PACE), Portland General Electric (PGE) and Turlock Irrigation District (TIDC) whose capacity test failures reduced by more than 75% in the counterfactual capacity test compared to the original capacity test results. On the other hand, there were six EIM BAAs including Balancing Authority of Northern California (BANC), Powerex (BCHA), Los Angeles Department of water and power (LADWP), Public Service Company of New Mexico (PNM) and California ISO (CAISO) that had a reduction of capacity test failure by less than 10 percent. As expected, the majority of the capacity test failures accrue on the peak hours.

Figure 2: Hourly Frequency of UP Capacity Test failures for April-2021 through August 2021



[2]All capacity test results are included in this metric except for some capacity test failures for BCHA in August 2021, which were impacted by a software issue.

Figure 3: Impact of NSI Uncertainty Requirement on Up Capacity Test results

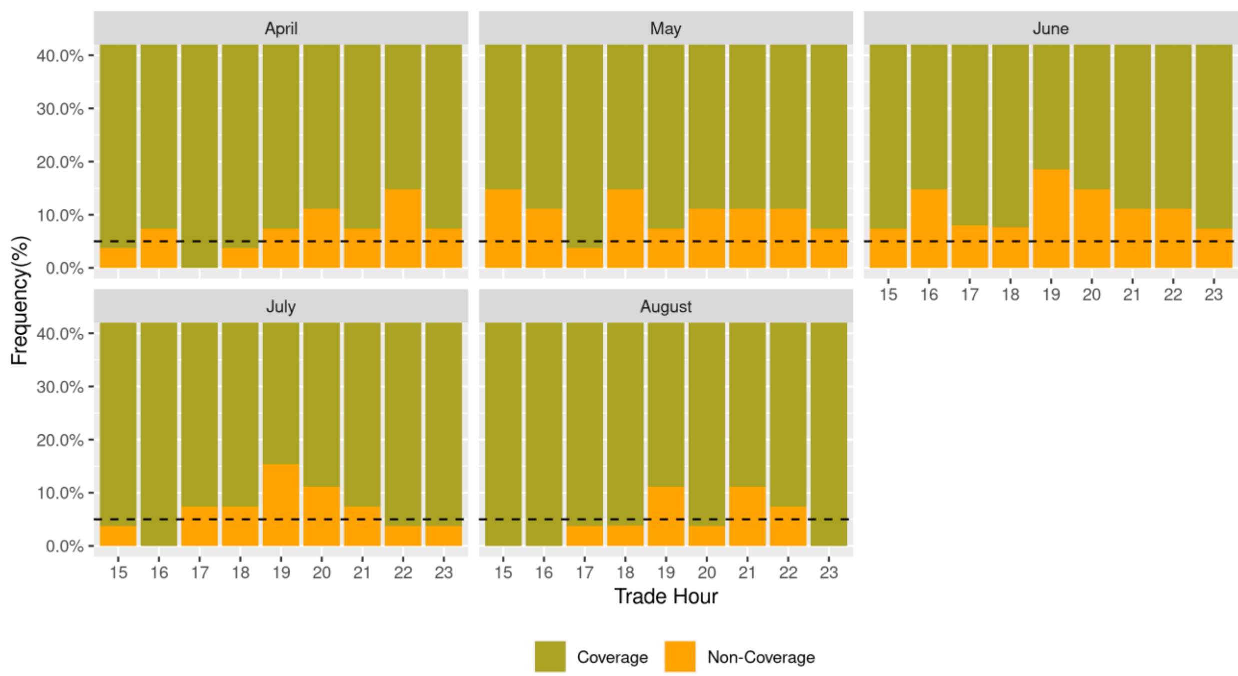


Coverage provided by the deviation adder

The ISO analyzed the performance of the incremental requirement for the NSI uncertainty. As mentioned before, the capacity test adds an incremental requirement to the Up capacity test to account for the historical deviation between the base scheduled NSI and the tagged values of NSI. The ISO compared the incremental requirement due to historical NSI deviation to the actual NSI deviation for each trade hour for all EIM BAAs. Figure 2 shows the frequency of capacity test failure across 24 hours from April 2021 until August 2021. There were 845 fifteen-minute intervals with capacity test failures for all EIM BAAs. Of all the capacity test failures, 649 or 77 percent occurred between hours ending 15 and ending 23. Since most capacity test failures occur between hours ending 15 through 23, these hours were selected for this analysis. The NSI absolute deviation and the NSI relative deviation percentiles are based on the 2.75 percentile and 97.5 percentile to ensure we cover 95 percent of the confidence intervals. Naturally, it is expected that the incremental requirement for the net-schedule interchange uncertainty would cover 95% of the actual deviations observed for each trading hour for all the EIM BAAs.

The ISO also compared the NSI uncertainty requirement versus the actual deviation between the NSI base schedules, and the NSI tagged values for each trading hour for all the balancing areas. The performance of the NSI uncertainty requirement is analyzed using two metrics: first, each hour was classified into two buckets, Coverage and Non-Coverage. For an hour in which the NSI uncertainty requirement was greater than the actual absolute deviation between the base schedules and tagged NSI, the hour is classified as Coverage because the requirement was able to cover the deviation that realized. On the other hand, if the net-schedule interchange uncertainty requirement is less than the actual deviation between the NSI base schedules and tagged NSI tags, the hour is classified as Non-Coverage because the requirement was not able to cover the actual deviation. Since the absolute deviation and relative deviation percentiles are set to ensure we cover 95% of the confidence interval, we expect that frequency of intervals in which the EIM BAA was short is less than 5% of each trading hour for each month. Second, the ISO analyzed the magnitude and frequency of deviation between the NSI uncertainty requirement and actual deviations. The combined magnitude and frequency of deviations are visualized using a violin plot that depicts the distribution of the numeric data using the density curves. Figure 4 through Figure 14[3] shows an hourly stacked bar chart classified into Coverage and Non-Coverage. A separate bar chart is created for April 2021, until August 2021 for all the EIM BAAs except some areas which are not included in this analysis. The reason BANC, PNM, LDAWP and TIDC BAAs are not included in this analysis is because these EIM joined after March 2021, so their incremental NSI uncertainty requirement was introduced in the capacity test starting with August 1, 2021. Northwestern Energy (NWMT) joined the EIM in June 2021, so it does not have three months data available for the histogram data samples which are used to calculate the net-schedule interchange uncertainty. There were no balancing areas between April 2021 and August 2021, which had the net-schedule uncertainty requirement covering the actual deviation for more than 95% of intervals in all hours.

Figure 4 Performance of Capacity Test Net-Schedule Interchange Uncertainty Requirement- APS



[3] The ISO identified a software issue that affected the incremental NSI uncertainty requirement calculation used in the capacity test for the 28th through the end of each month. During these days, the capacity test did not include incremental NSI uncertainty requirements, so these days were excluded from this analysis.

Figure 5 Performance of Capacity Test Net-Schedule Interchange Uncertainty Requirement- BCHA

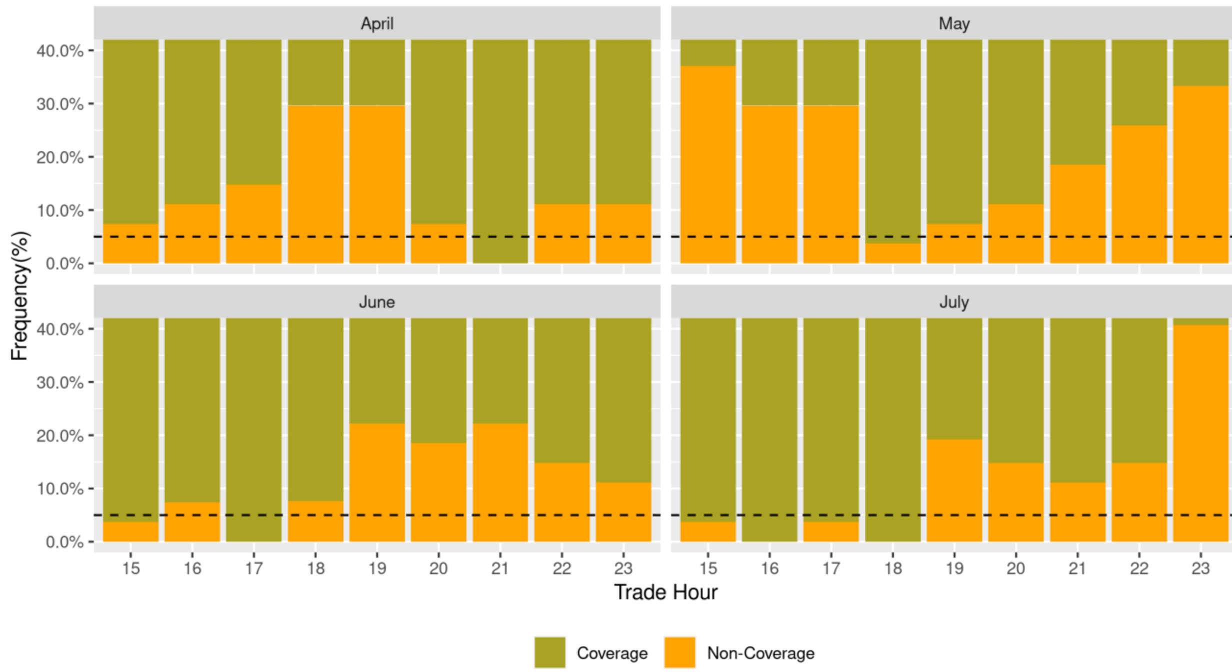


Figure 6 Performance of Capacity Test Net-Schedule Interchange Uncertainty Requirement- CAISO

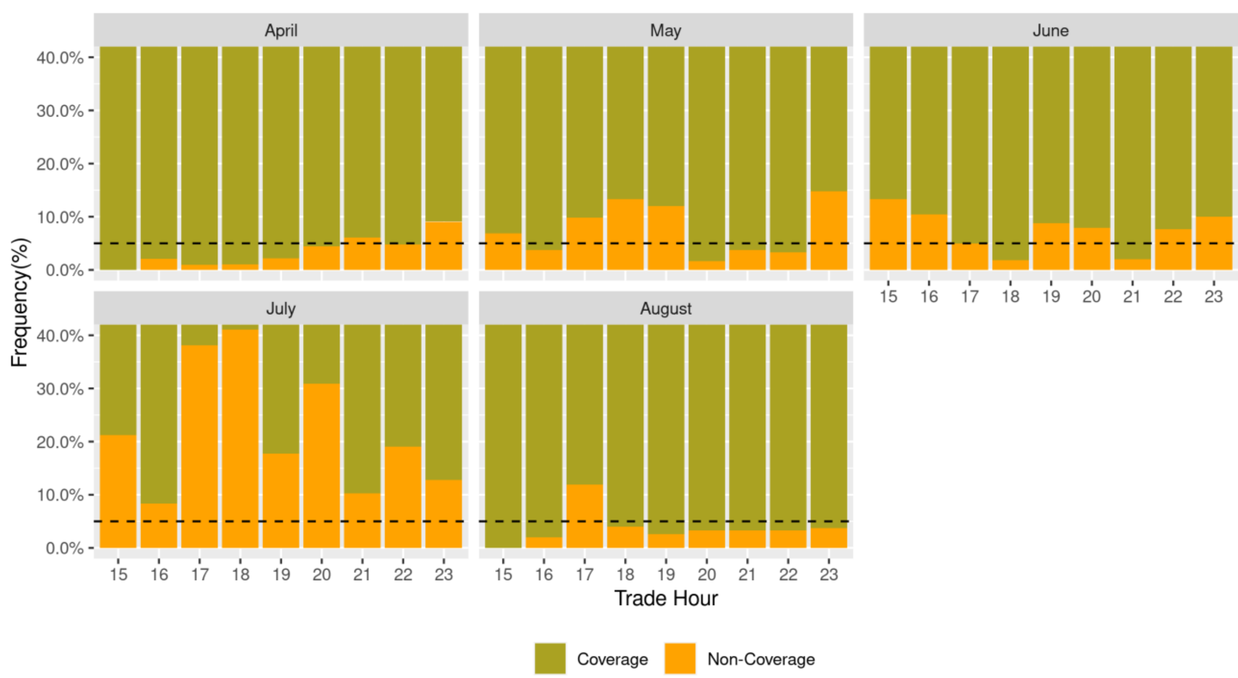


Figure 7 Performance of Capacity Test Net-Schedule Interchange Uncertainty Requirement- IPCO

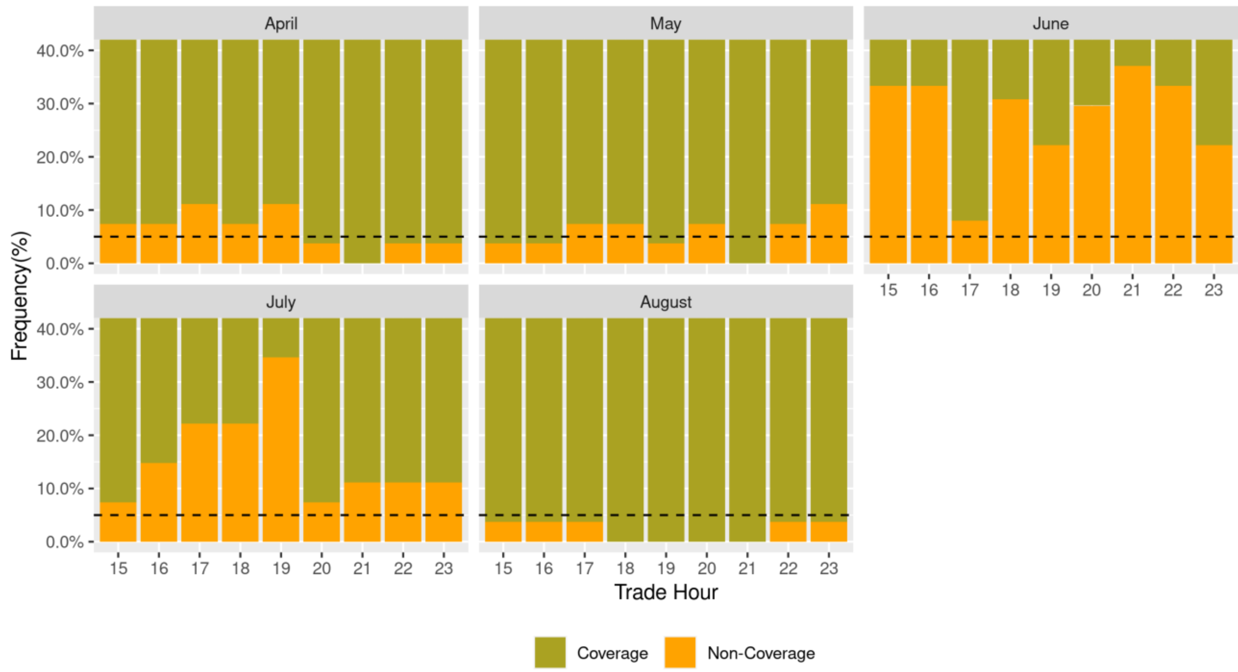


Figure 8 Performance of Capacity Test Net-Schedule Interchange Uncertainty Requirement- NEVP

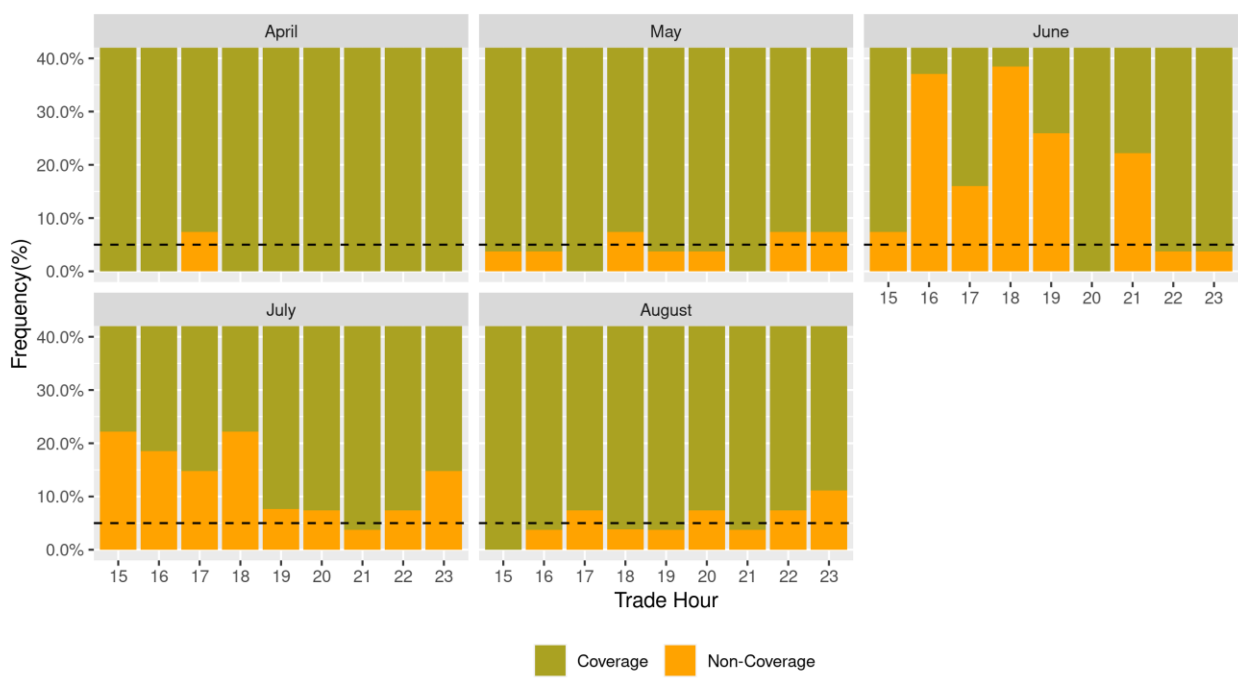


Figure 9 Performance of Capacity Test Net-Schedule Interchange Uncertainty Requirement- PACE

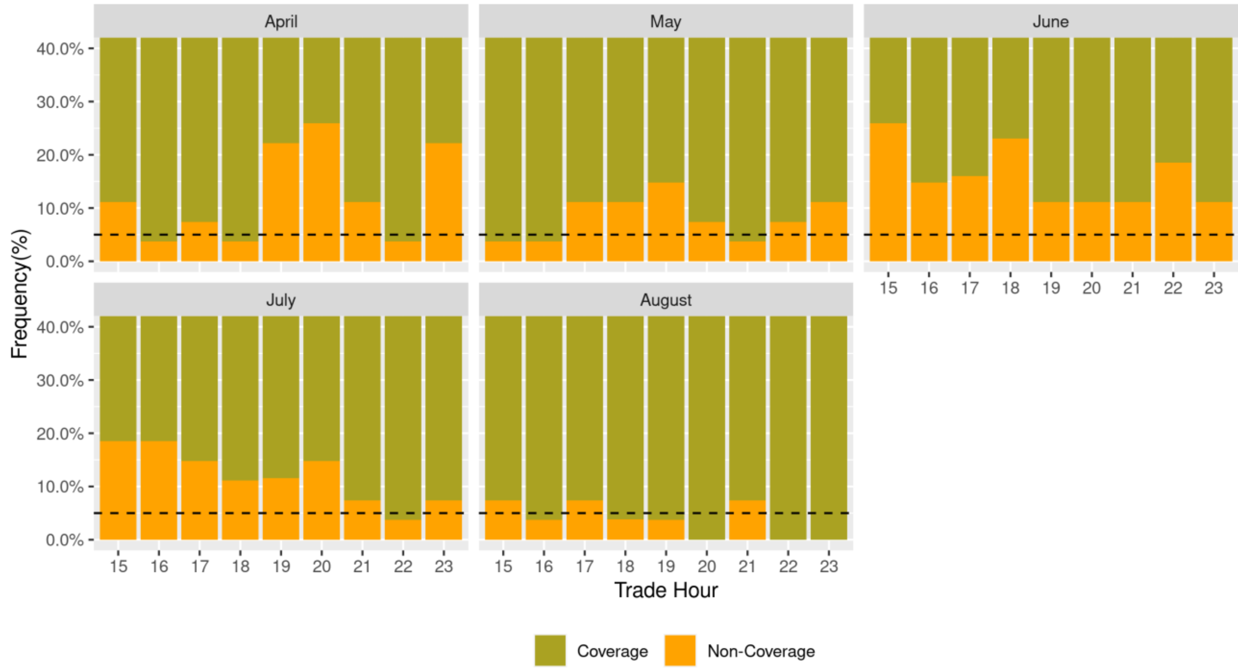


Figure 10 Performance of Capacity Test Net-Schedule Interchange Uncertainty Requirement- PACW

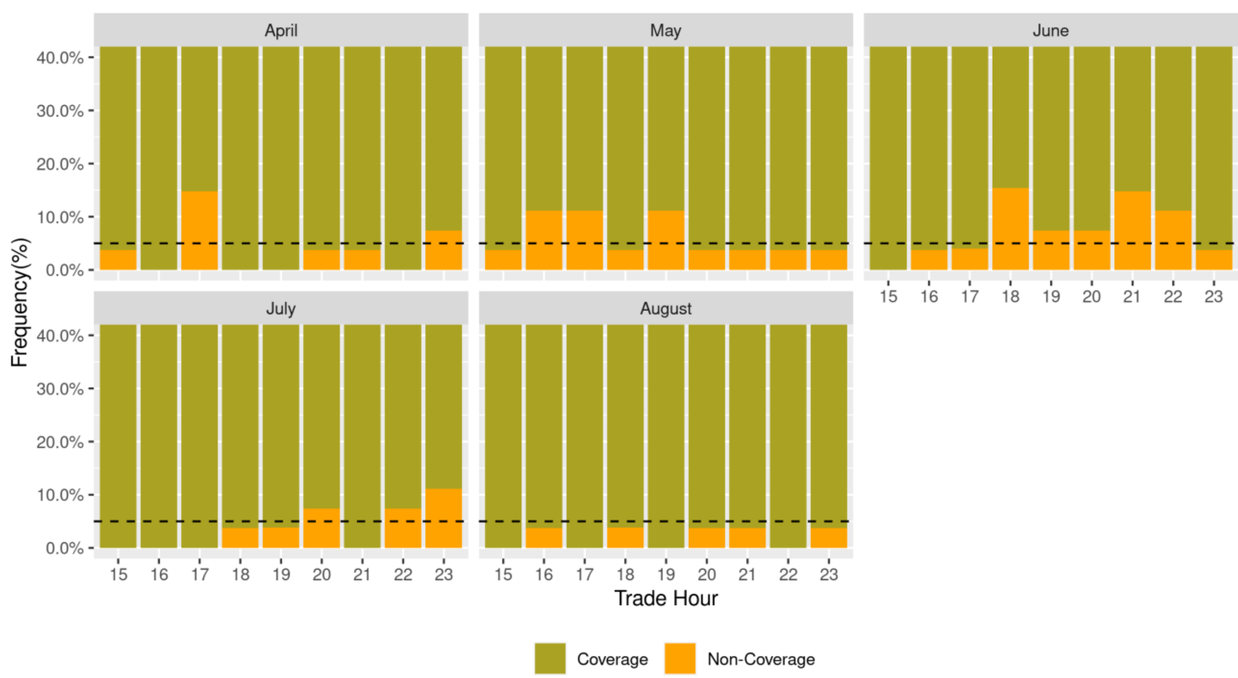


Figure 11 Performance of Capacity Test Net-Schedule Interchange Uncertainty Requirement- PGE

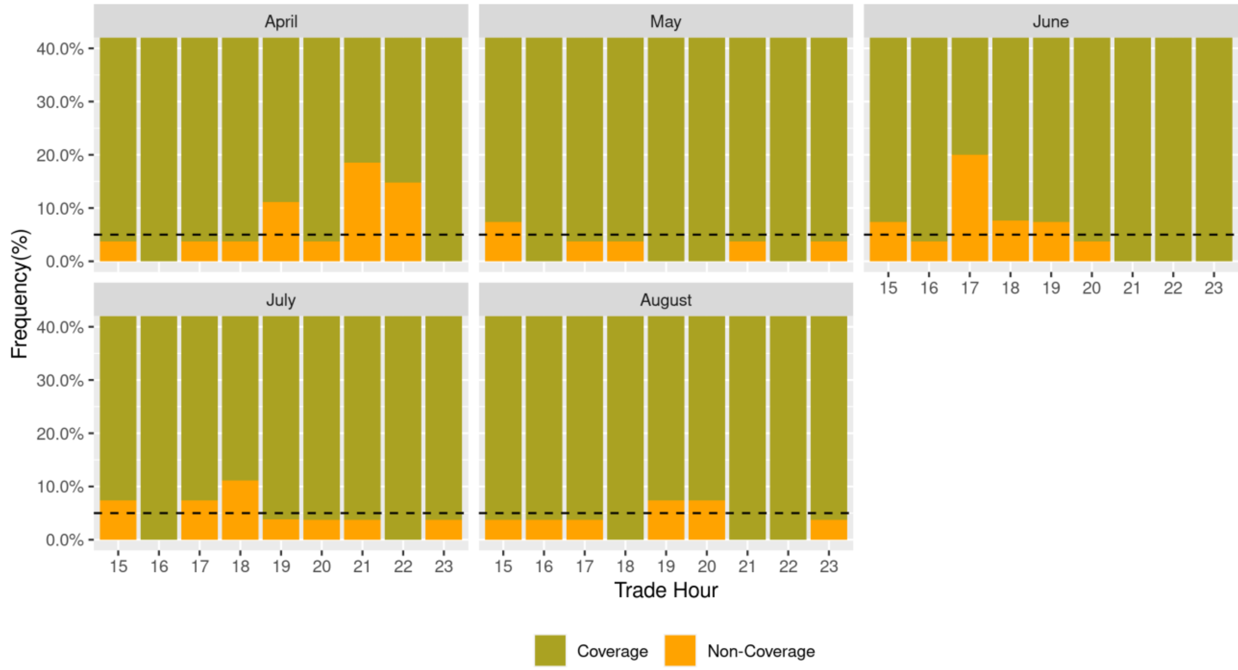


Figure 12 Performance of Capacity Test Net-Schedule Interchange Uncertainty Requirement- PSEI

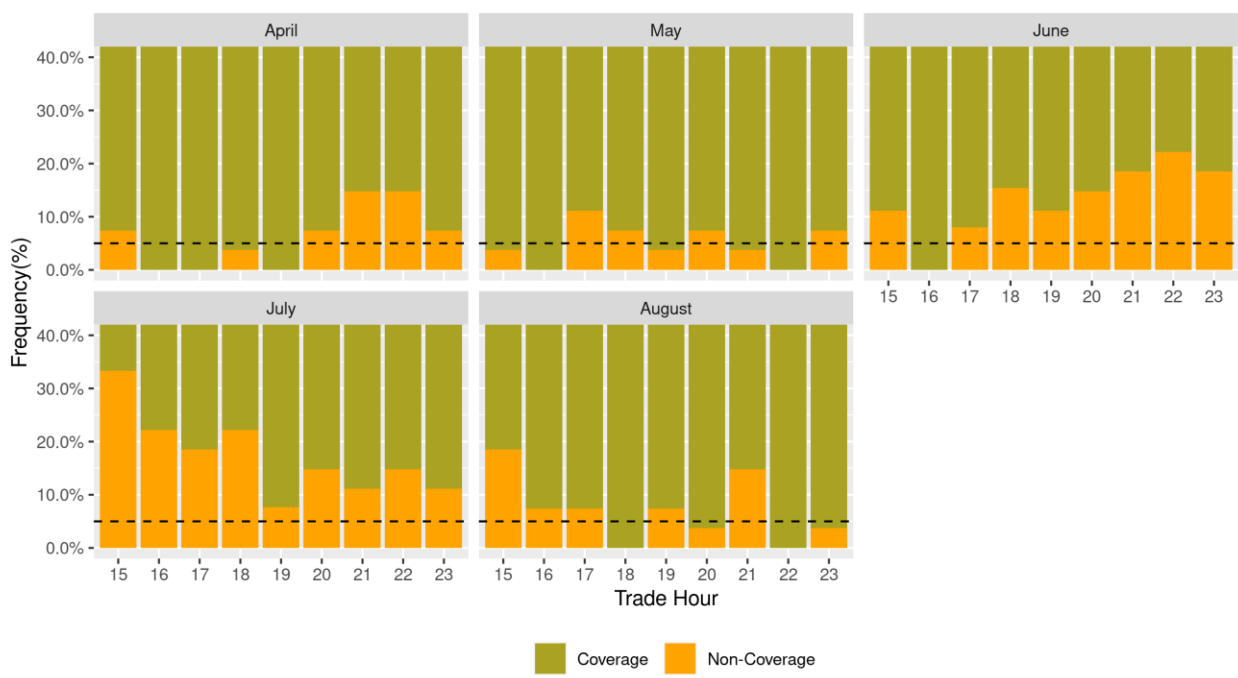


Figure 13 Performance of Capacity Test Net-Schedule Interchange Uncertainty Requirement- SCL

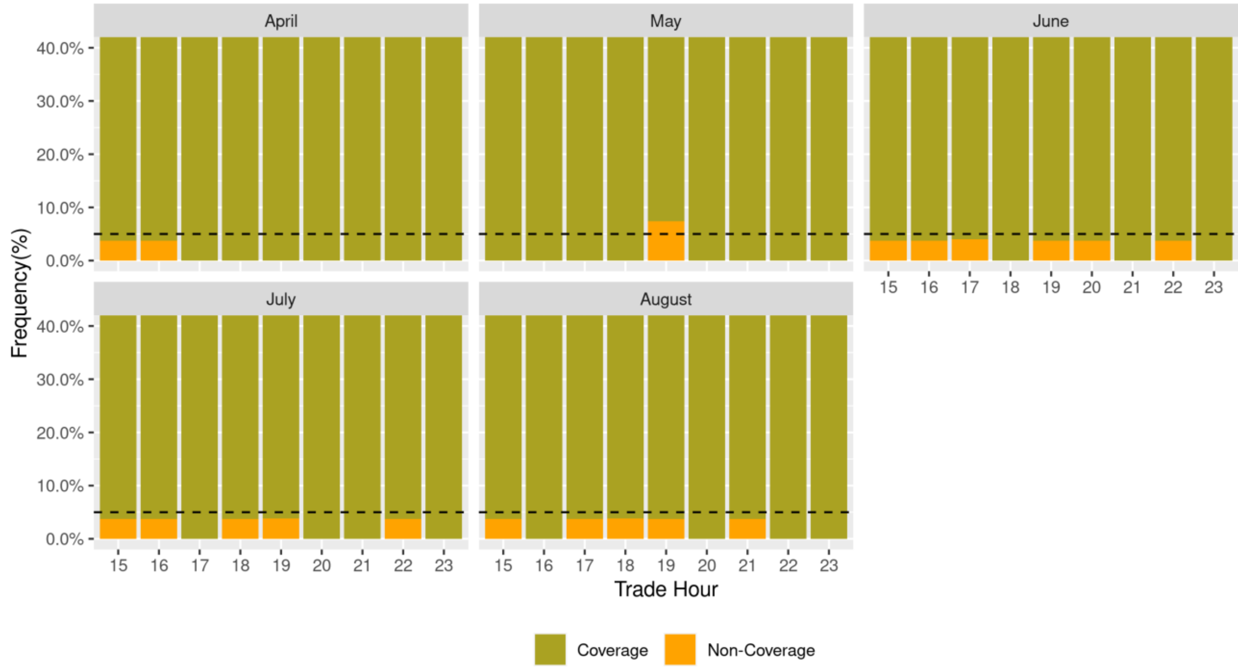
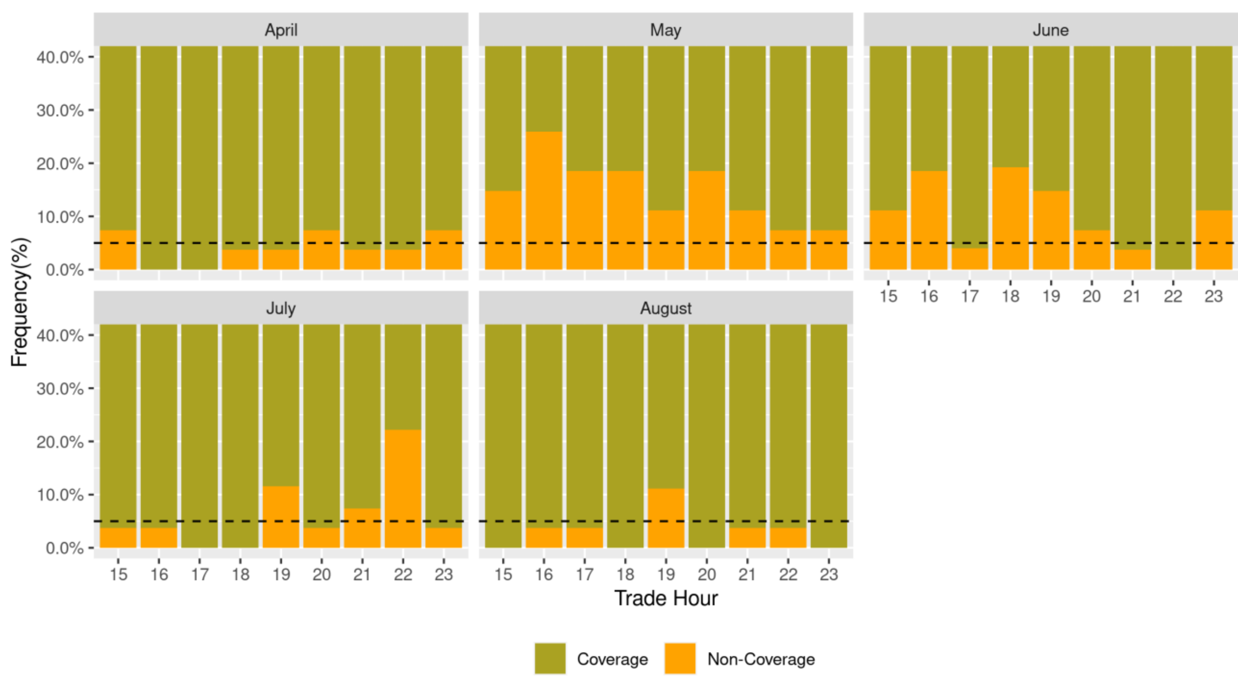


Figure 14 Performance of Capacity Test Net-Schedule Interchange Uncertainty Requirement- SRP



The second metric to assess the incremental NSI uncertainty requirement performance is to compare the difference between the NSI uncertainty incremental requirement and the actual deviation between NSI base schedules and NSI tags.

The plots between Figure 15 through Figure 25 highlights various aspects of the NSI uncertainty requirement in the bid range capacity test. The highest point in the positive direction represents the magnitude of a BAA's additional requirement when it has no deviation between the NSI base schedule and the NSI tags. The lowest point of the density plot shows the amount by which the NSI uncertainty requirement fell short of capturing the actual deviation. In an ideal scenario, if historically a BAA has zero deviation in all hours of the month, the density plot would be a flat line on the 0 MW each hour. If the BAA incremental NSI uncertainty requirement is set to 100 MW for a specific month, but the BAA tagged NSI values were always equal to the base schedule for all hours in the month, then the density plot would show a flat horizontal line at 100 MW for that hour. Conversely, if the BAA NSI uncertainty requirement is 0 MW because the deviation was historically zero from histogram samples, but for a given month in all hours, there was a persistent deviation of 100 MW in each hour, the plot would show a horizontal line at -100 MW for that hour.

There are two general trends observed from these density plots. First, some EIM entities tend to have zero to small deviations between their NSI base schedules and NSI tagged values for most hours, but in some hours, they have a significant divergence between their NSI base schedules and tagged NSI. Since the NSI uncertainty requirement is based on a three-month look-back period using the 95 percent confidence interval, its incremental NSI uncertainty requirement would increase in future months. This trend is evident from Figure 18, which shows the NSI uncertainty requirement performance for Idaho Power (IPCO). The hour ending 19 has significant tails in June and July, which drives up the NSI uncertainty requirement for the hour ending 19 for August. A similar trend is observed for PACE in Figure 20 and SRP in Figure 25.

Second, some BAAs have persistent deviation between their base schedule NSI and the tagged value but no significant variation in the divergence across the hours for the month. As a result, their NSI uncertainty requirement accurately captures the NSI deviation between the base schedule and tags. The difference distribution is not centered on one point but distributed evenly across the maximum and minimum difference. This trend is observed in the distribution for PGE and PSEI in Figure 22 and Figure 23, respectively.

Figure 15 Distribution of deviation between NSI uncertainty requirement and deviation between base-schedule NSI versus tagged NSI- APS

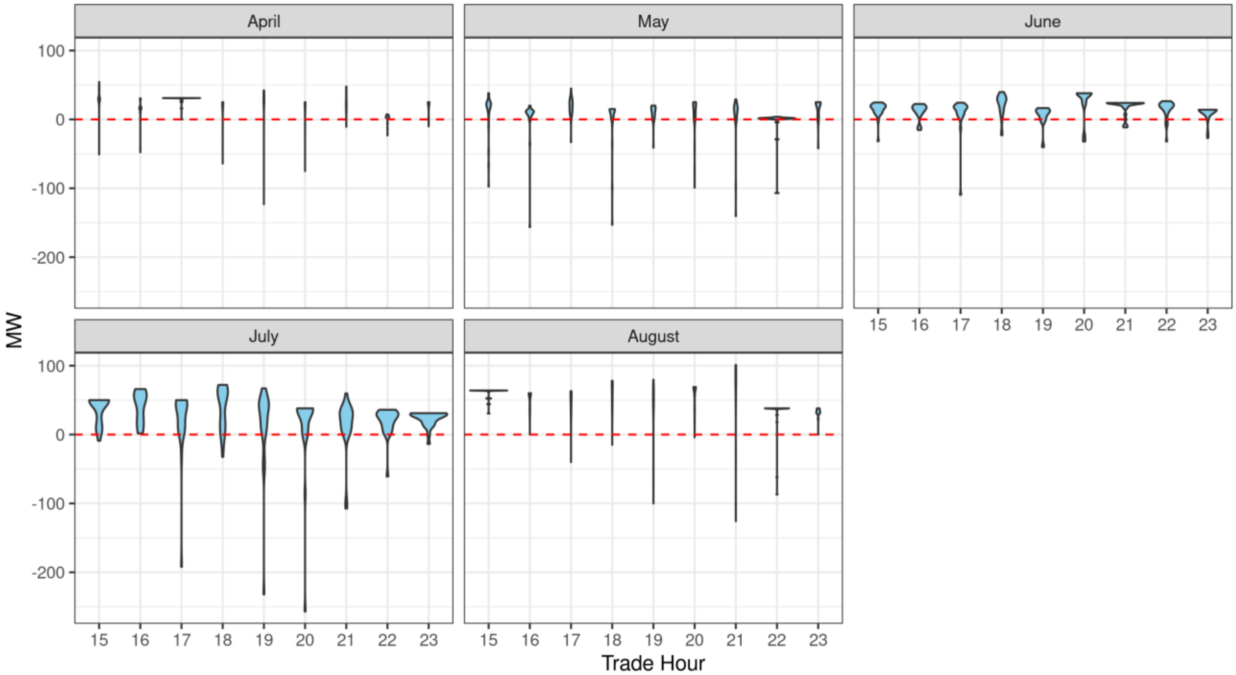


Figure 16 Distribution of deviation between NSI uncertainty requirement and deviation between base-schedule NSI versus tagged NSI- BCHA

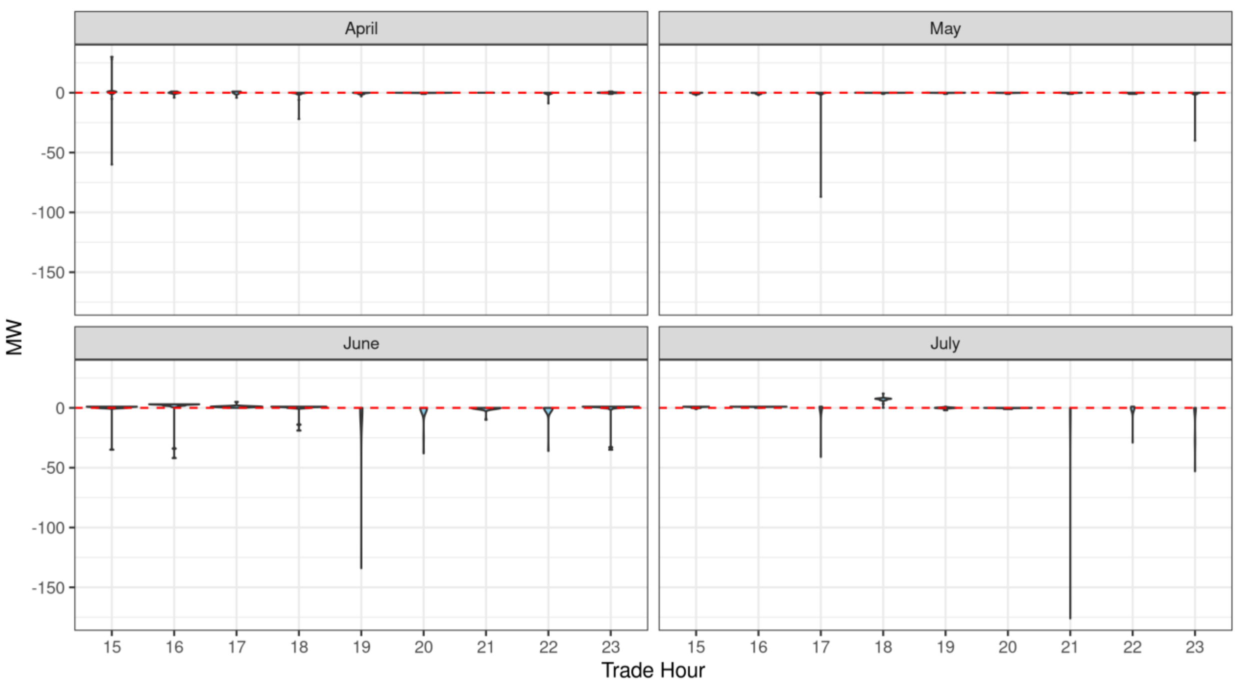


Figure 17 Distribution of deviation between NSI uncertainty requirement and deviation between base-schedule NSI versus tagged NSI- CAISO

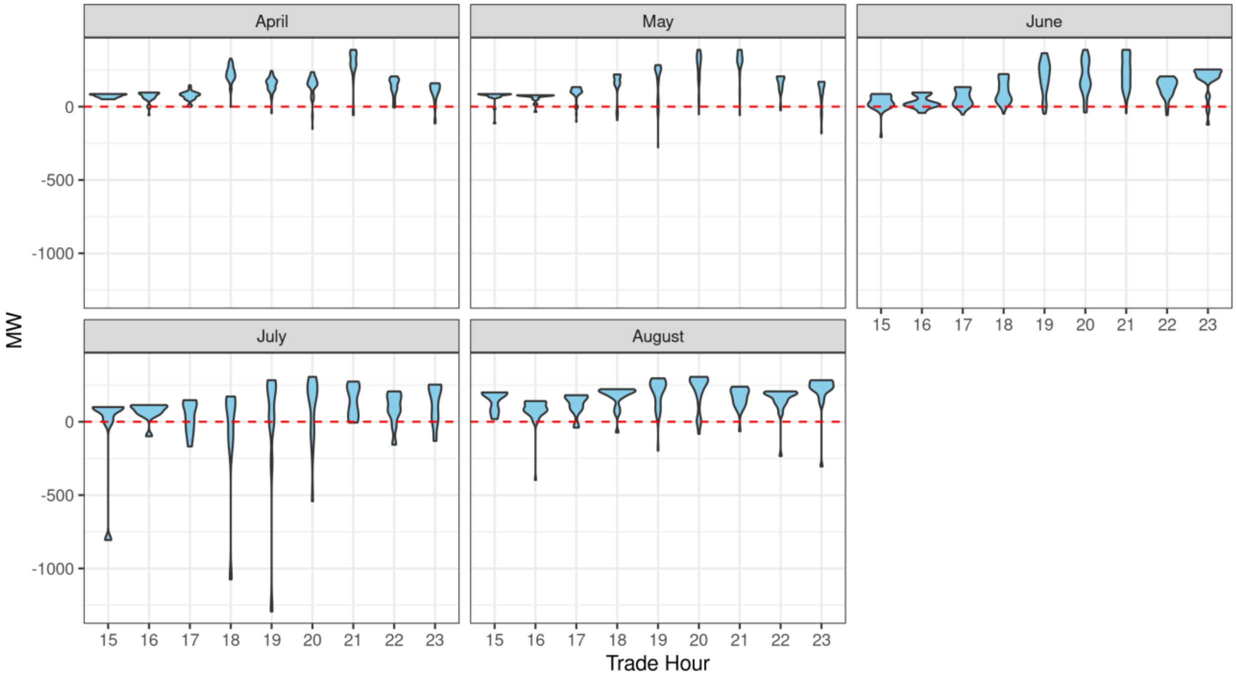


Figure 18 Distribution of deviation between NSI uncertainty requirement and deviation between base-schedule NSI versus tagged NSI- IPCO

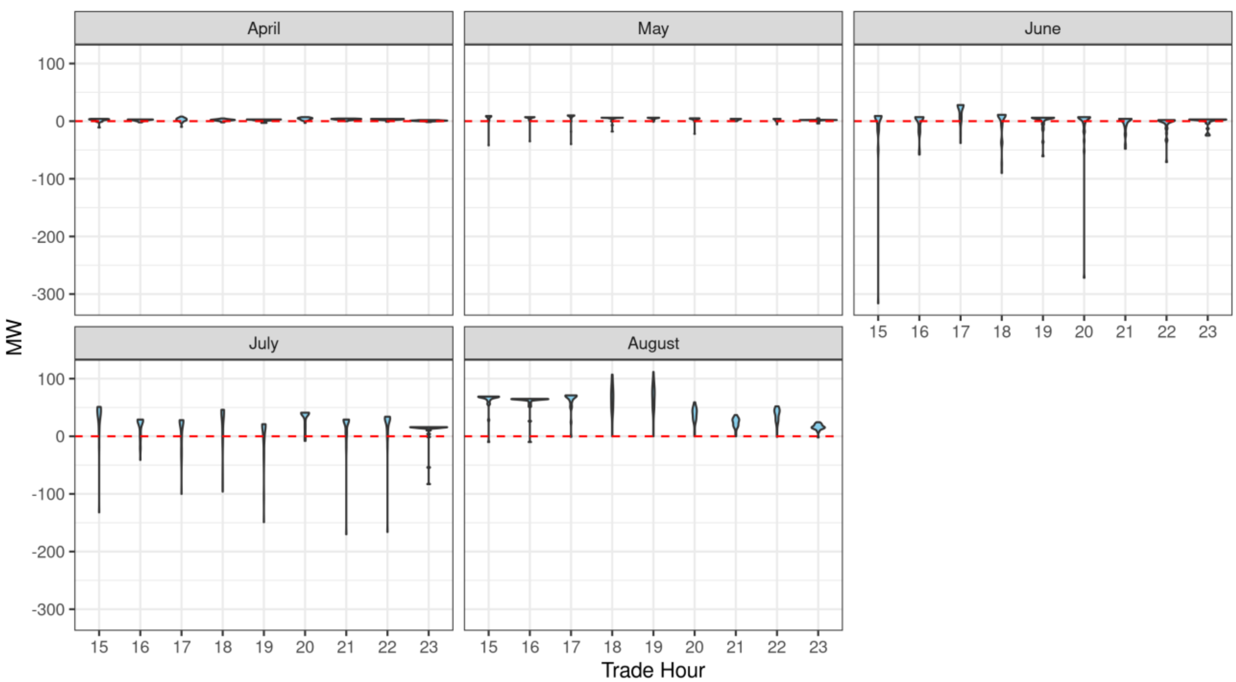


Figure 19 Distribution of deviation between NSI uncertainty requirement and deviation between base-schedule NSI versus tagged NSI- NEVP

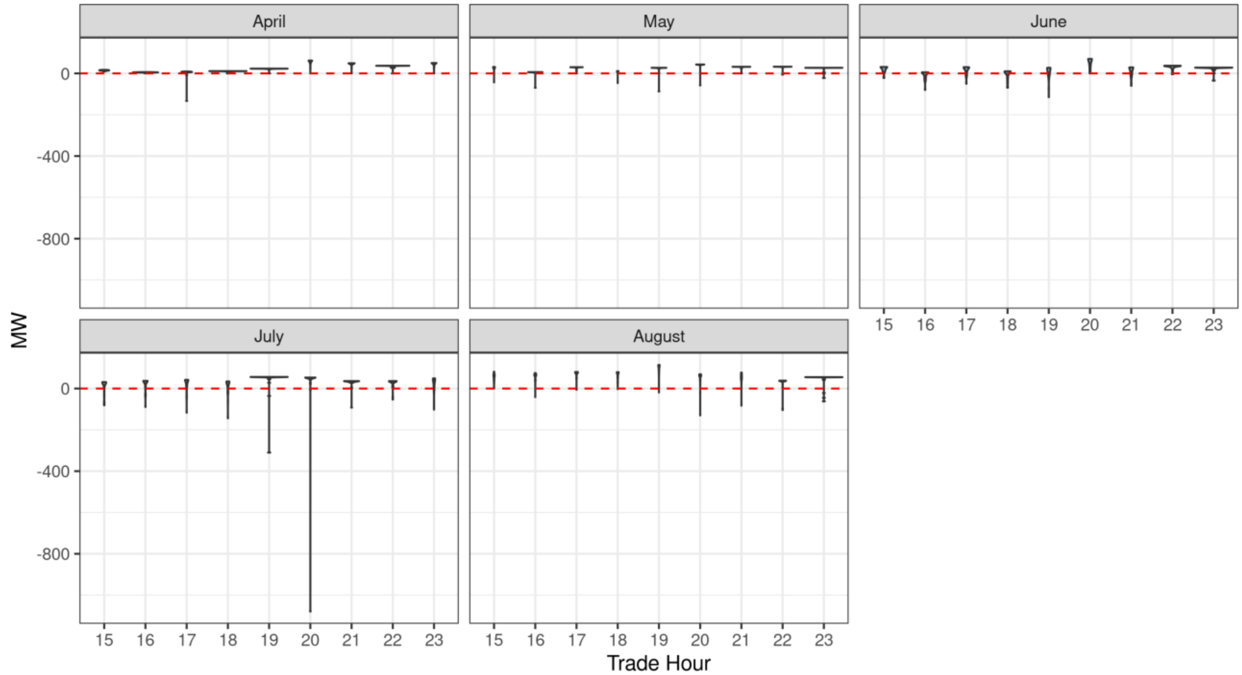


Figure 20 Distribution of deviation between NSI uncertainty requirement and deviation between base-schedule NSI versus tagged NSI- PACE

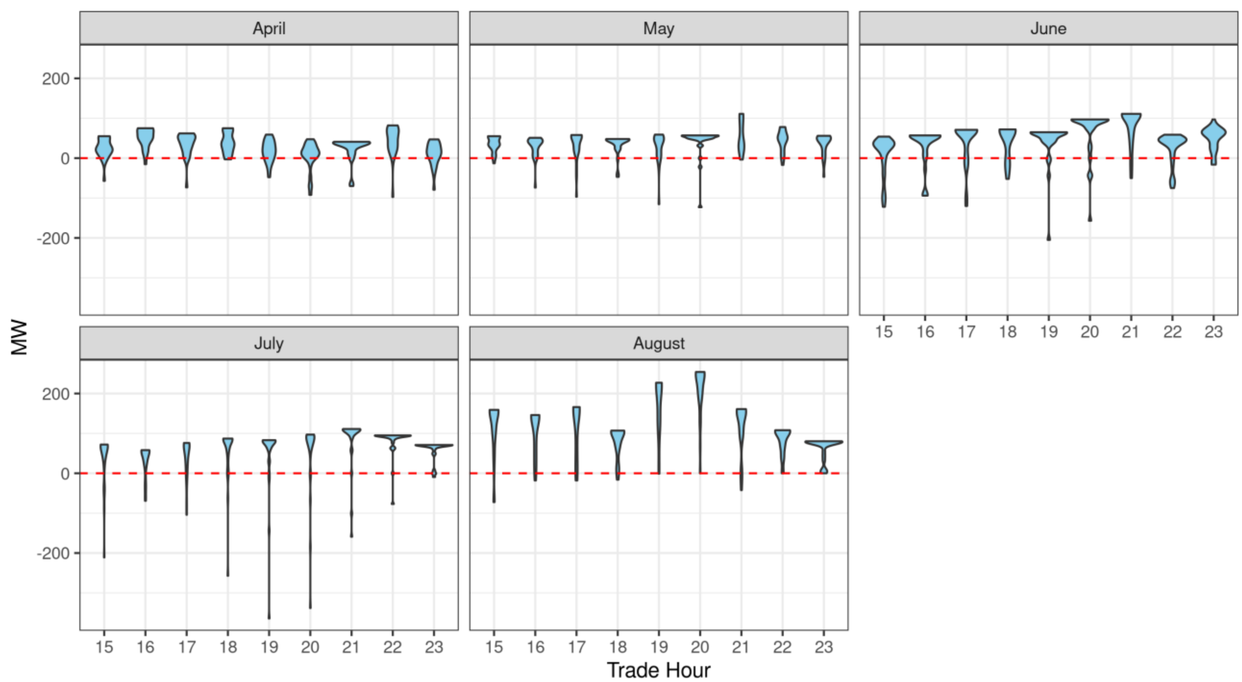


Figure 21 Distribution of deviation between NSI uncertainty requirement and deviation between base-schedule NSI versus tagged NSI- PACW

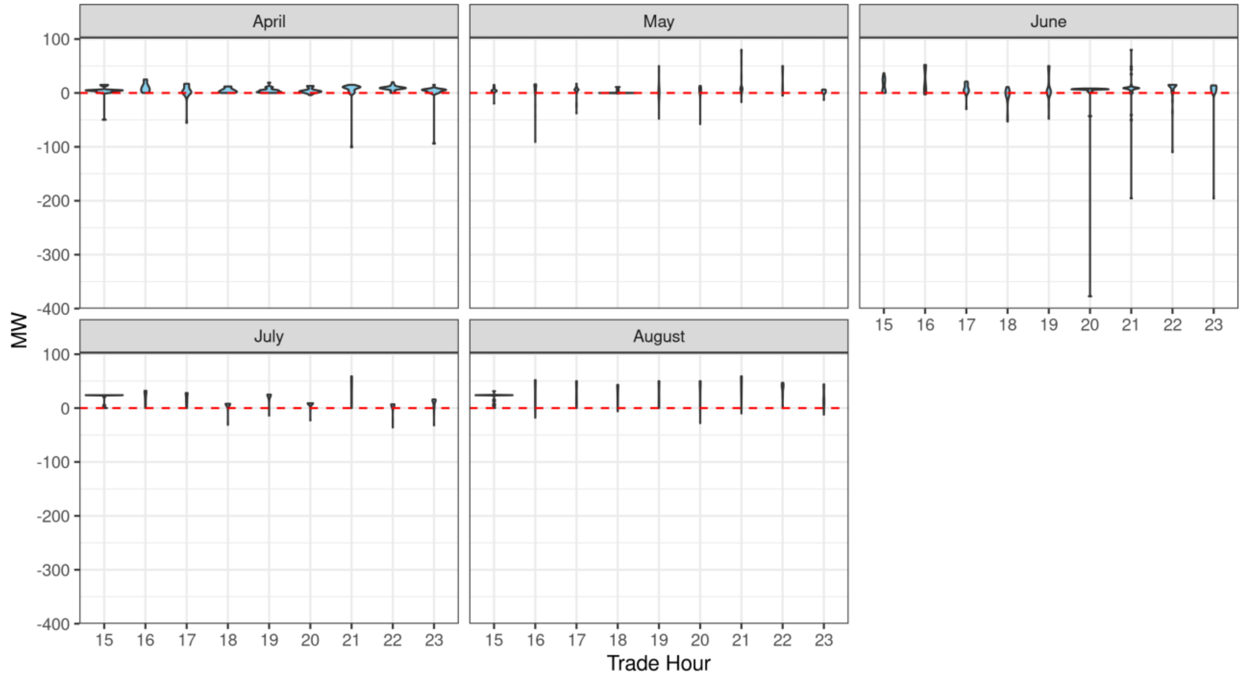


Figure 22 Distribution of deviation between NSI uncertainty requirement and deviation between base-schedule NSI versus tagged NSI- PGE

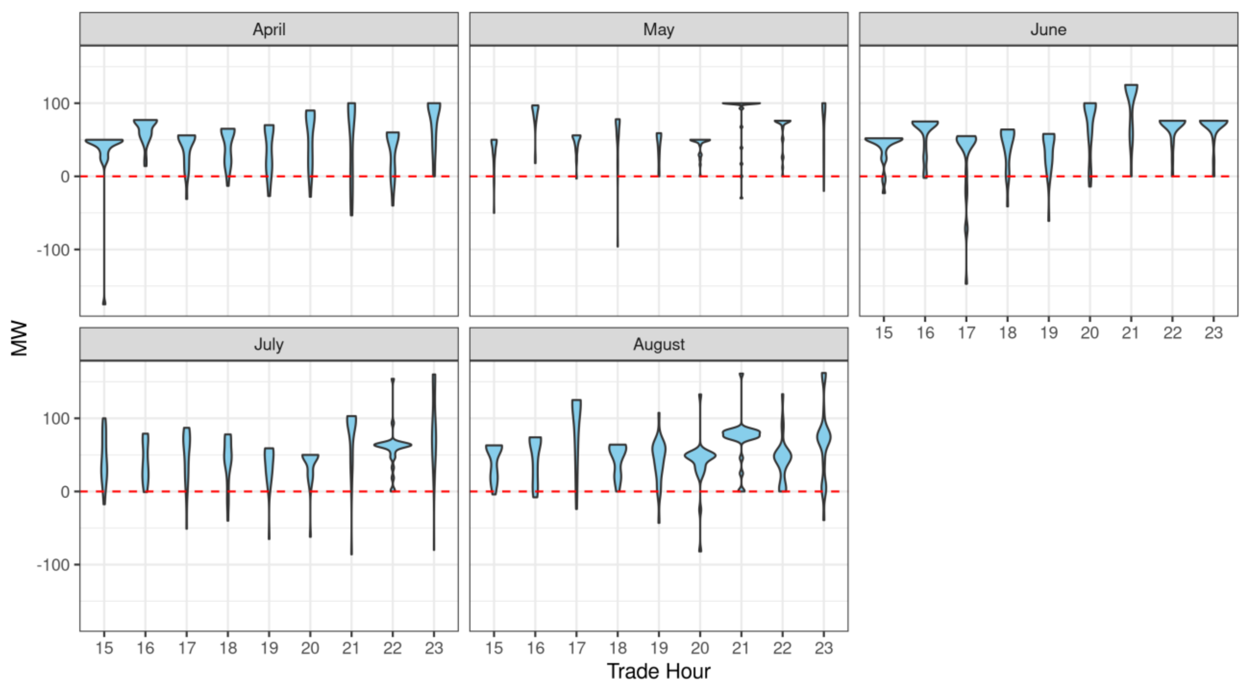


Figure 23 Distribution of deviation between NSI uncertainty requirement and deviation between base-schedule NSI versus tagged NSI- PSEI

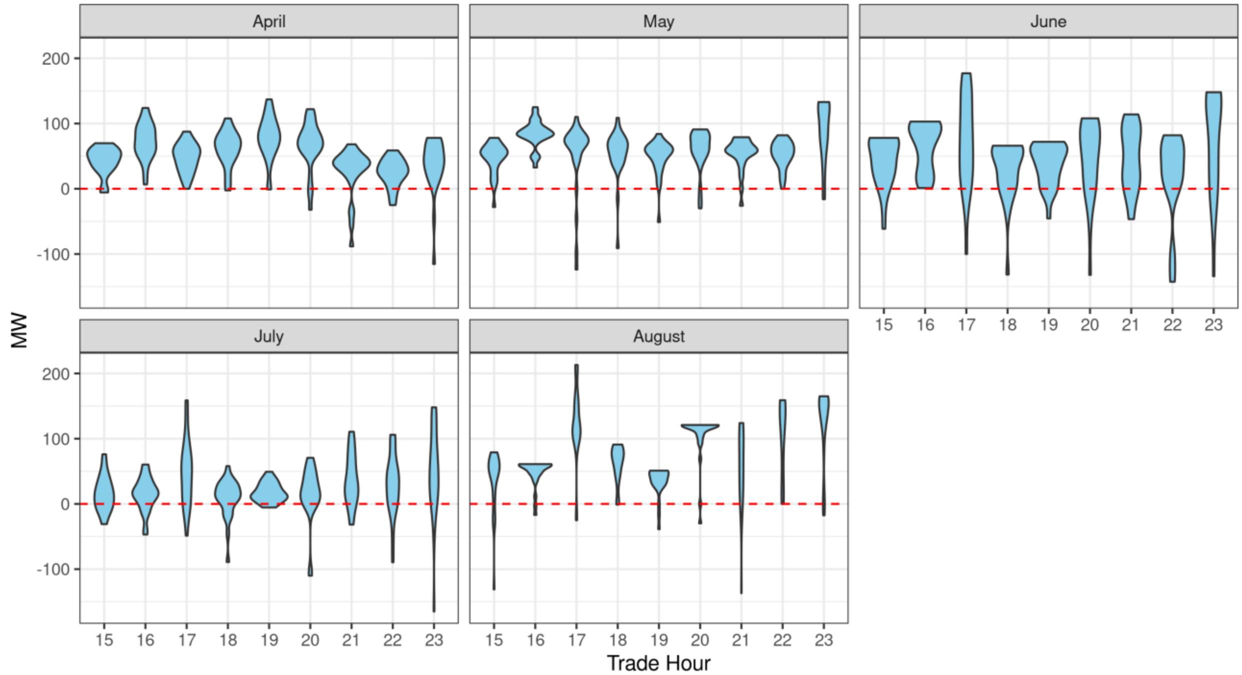


Figure 24 Distribution of deviation between NSI uncertainty requirement and deviation between base-schedule NSI versus tagged NSI- SCL

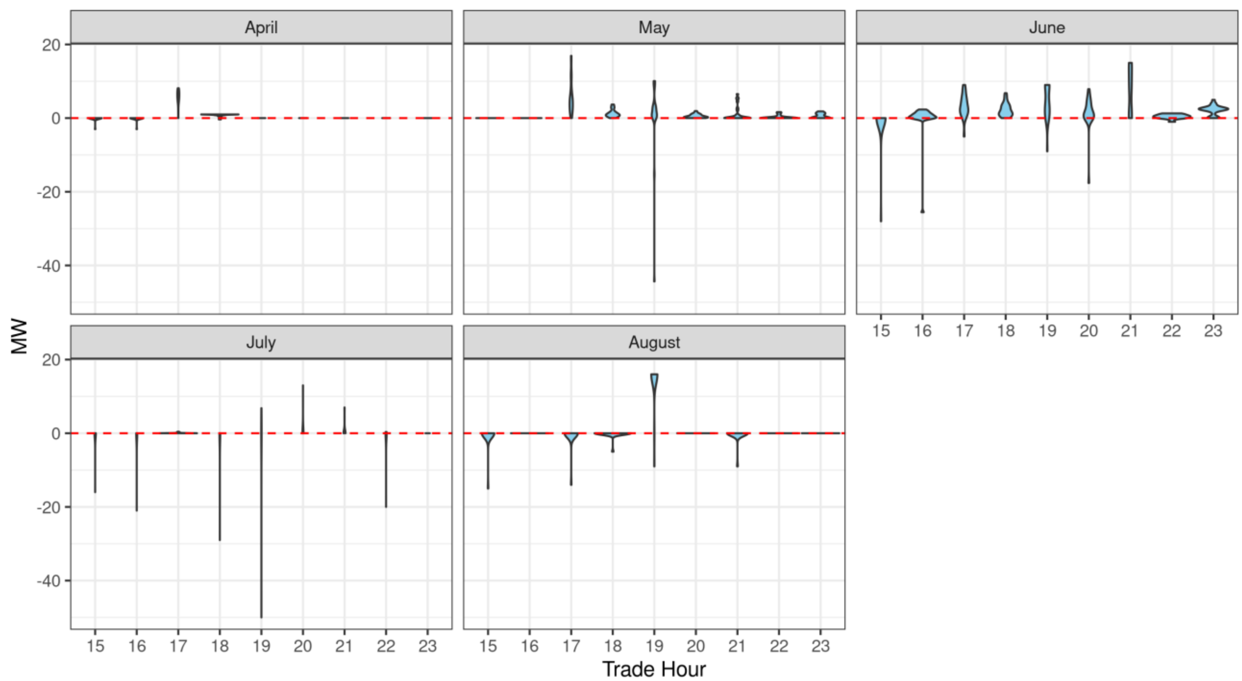
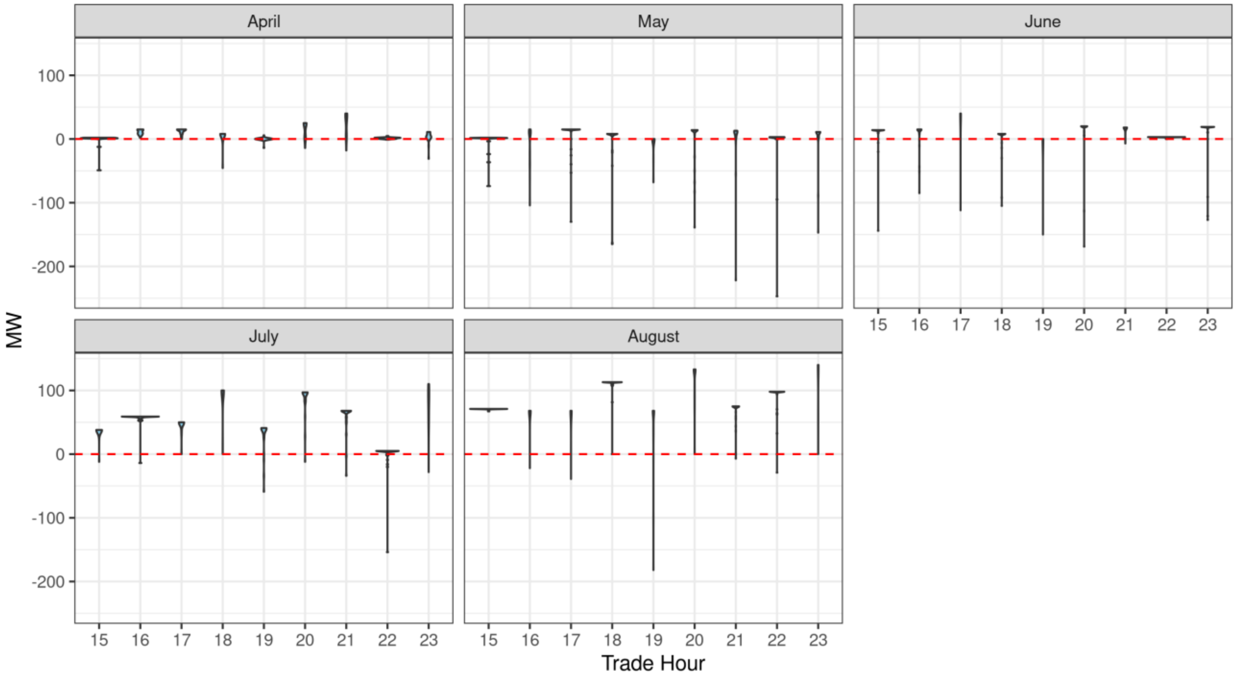


Figure 25 Distribution of deviation between NSI uncertainty requirement and deviation between base-schedule NSI versus tagged NSI- SRP



The ISO also analyzed the correctness of using the 97.5 Percentile to cover for actual deviations and compare that against other percentile. Figure 26 through Figure 36 shows the hourly distribution of absolution deviation between NSI base and NSI tags by month for all the EIM BAAs except for the same set of BAAs which were excluded from Figure 4 through Figure 14. These charts also show the 2.75th percentile, 10th percentile and the 15th percentile for each hour by month for all the BAAs. A lower percentile will lead to lower deviation requirements, which in turn may cover less amount of deviations. For most BAAs, their median difference between base NSI and tagged NSI is zero, with a slight variation around zero for the first and the third quartiles, represented by the box. On the other hand, specific intervals beyond the first and third quartiles drive the uncertainty requirements. A path derate driven by a transmission outage could drive the deviations between the base NSI and tagged NSI derate or forced generation outages, or lack of firm transmission could also drive these deviations. The ISO has implemented several policies to penalize deviation between hour schedules from its HASP process and the tagged NSI. Similarly, the ISO would request all the EIM entities to analyze this information to identify the root cause of the deviation between base NSI and tagged NSI. Based on that review, the ISO could either reduce the 95% confidence interval to either 90% confidence interval used for the incremental bid-range capacity test to naturally exclude the outlier data from the requirement or develop a process to eliminate data from the histogram that represents an extreme outcome.

Figure 26 Distribution of deviation between base-schedule NSI versus tagged NSI- APS

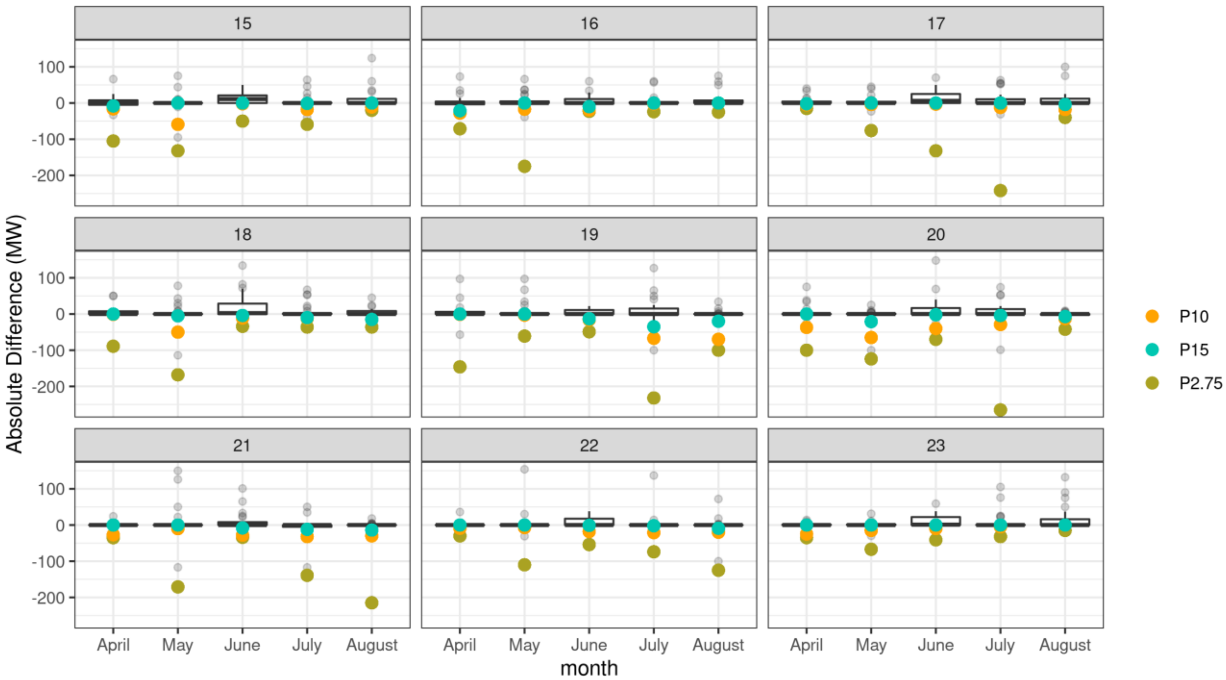


Figure 27 Distribution of deviation between base-schedule NSI versus tagged NSI - BCHA

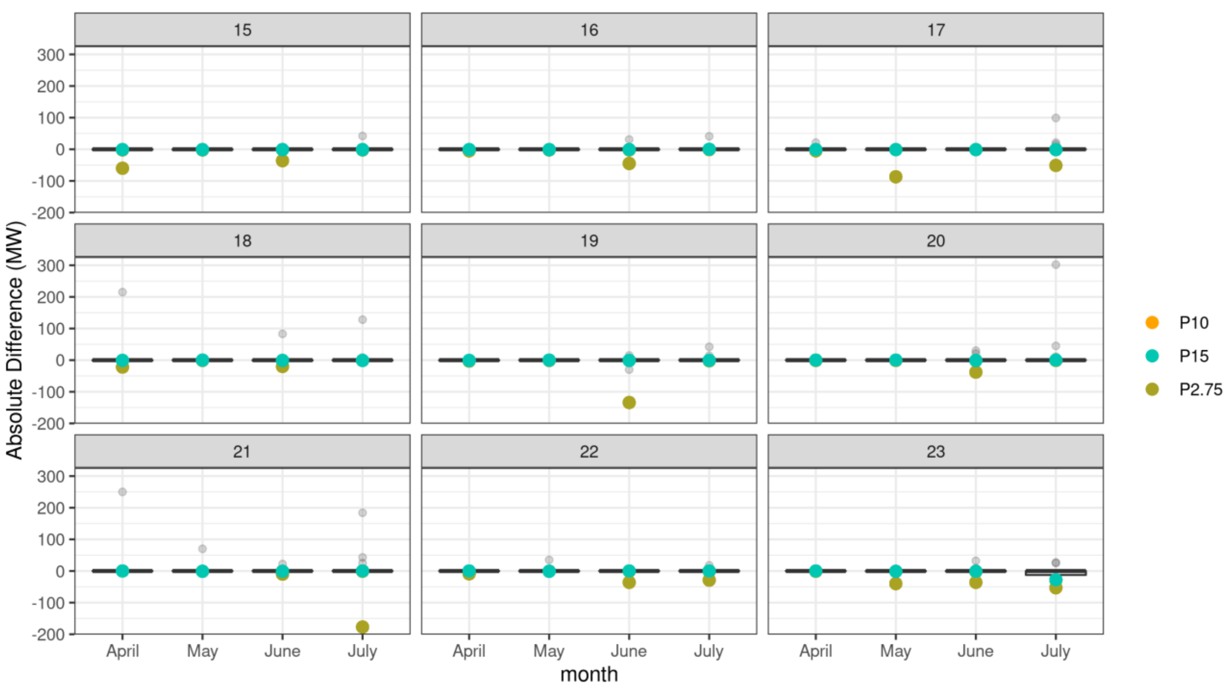


Figure 28 Distribution of deviation between base-schedule NSI versus tagged NSI - CISO

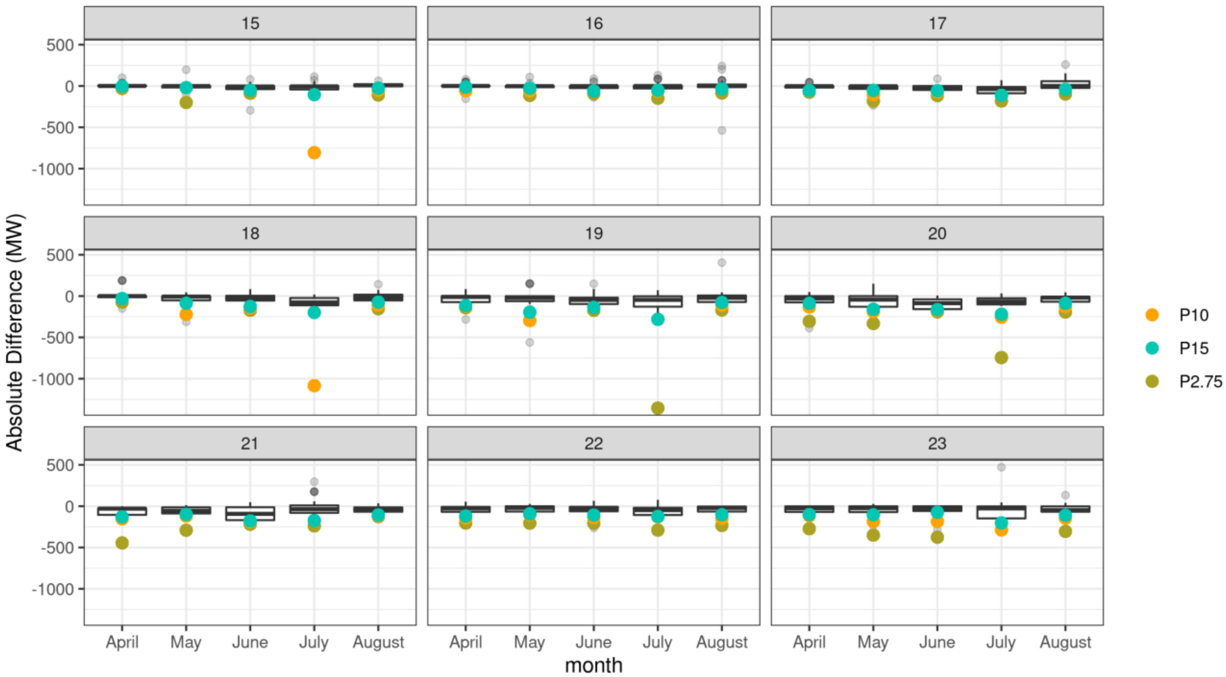


Figure 29 Distribution of deviation between base-schedule NSI versus tagged NSI - IPCO

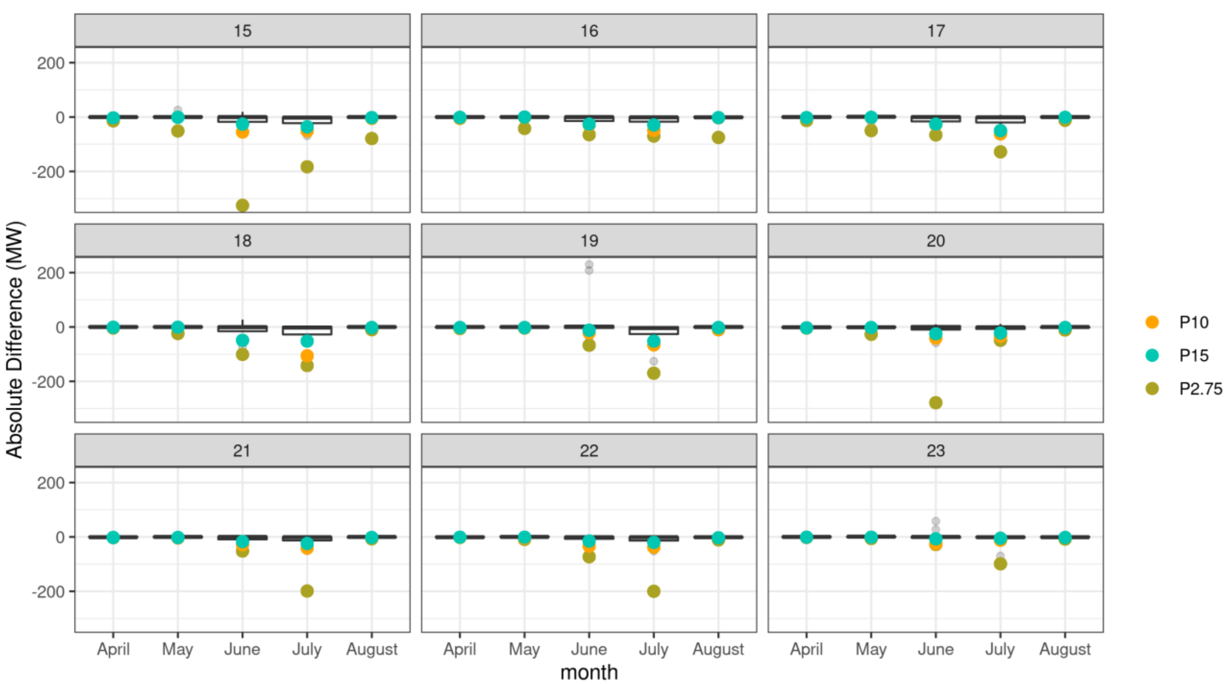


Figure 30 Distribution of deviation between base-schedule NSI versus tagged NSI - NEVP

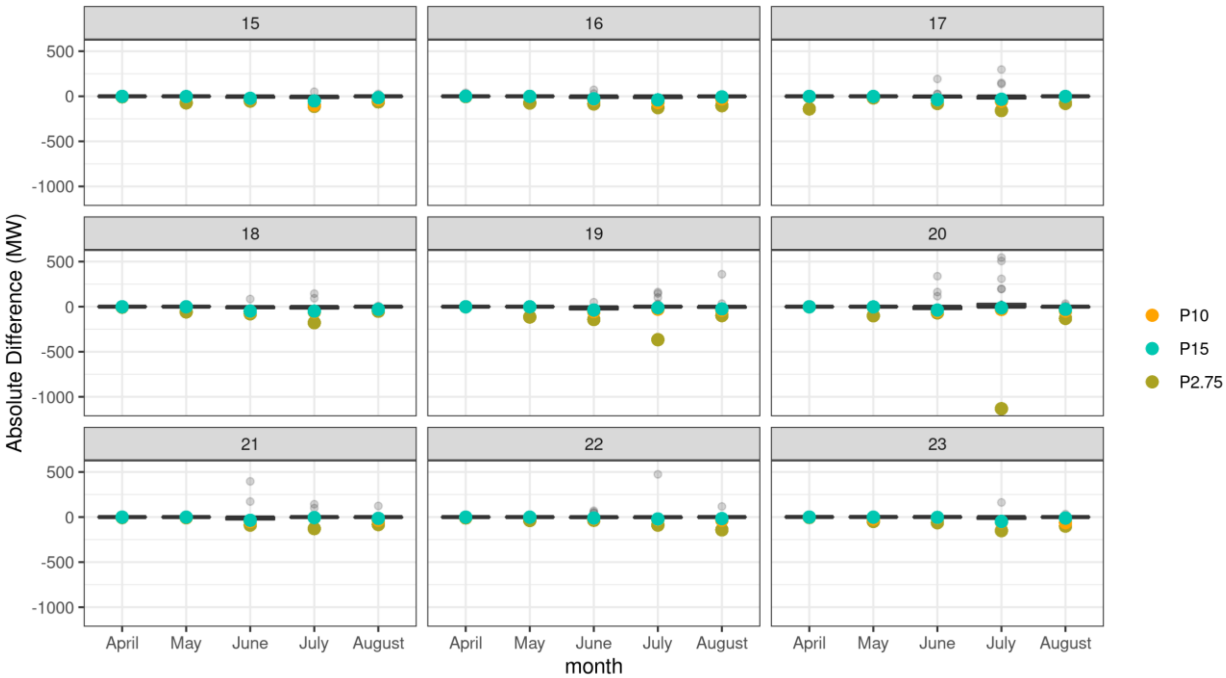


Figure 31 Distribution of deviation between base-schedule NSI versus tagged NSI- PACE

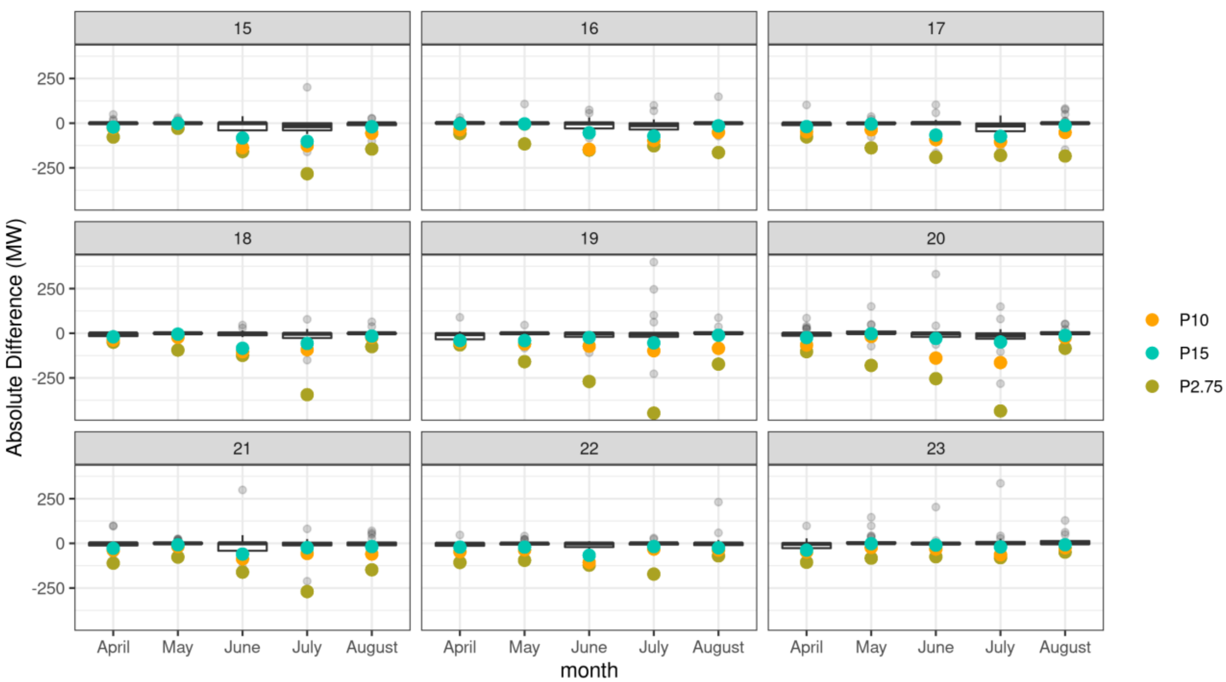


Figure 32 Distribution of deviation between base-schedule NSI versus tagged NSI - PACW

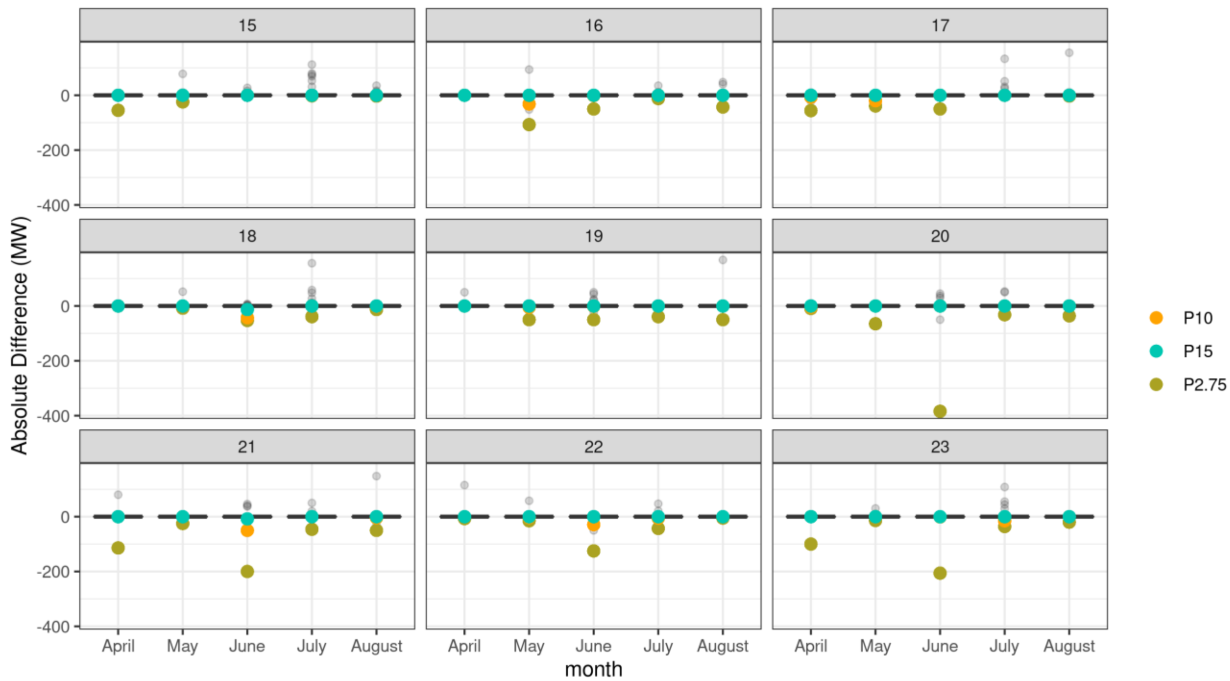


Figure 33 Distribution of deviation between base-schedule NSI versus tagged NSI - PGE

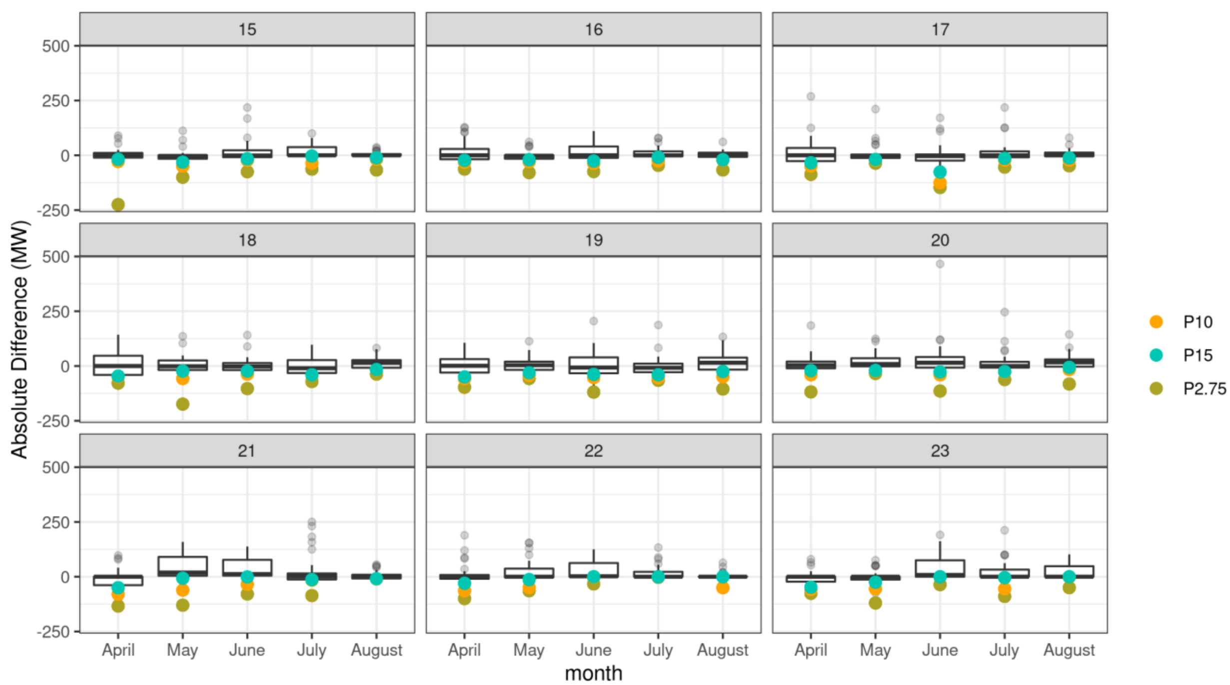


Figure 34 Distribution of deviation between base-schedule NSI versus tagged NSI - PSE

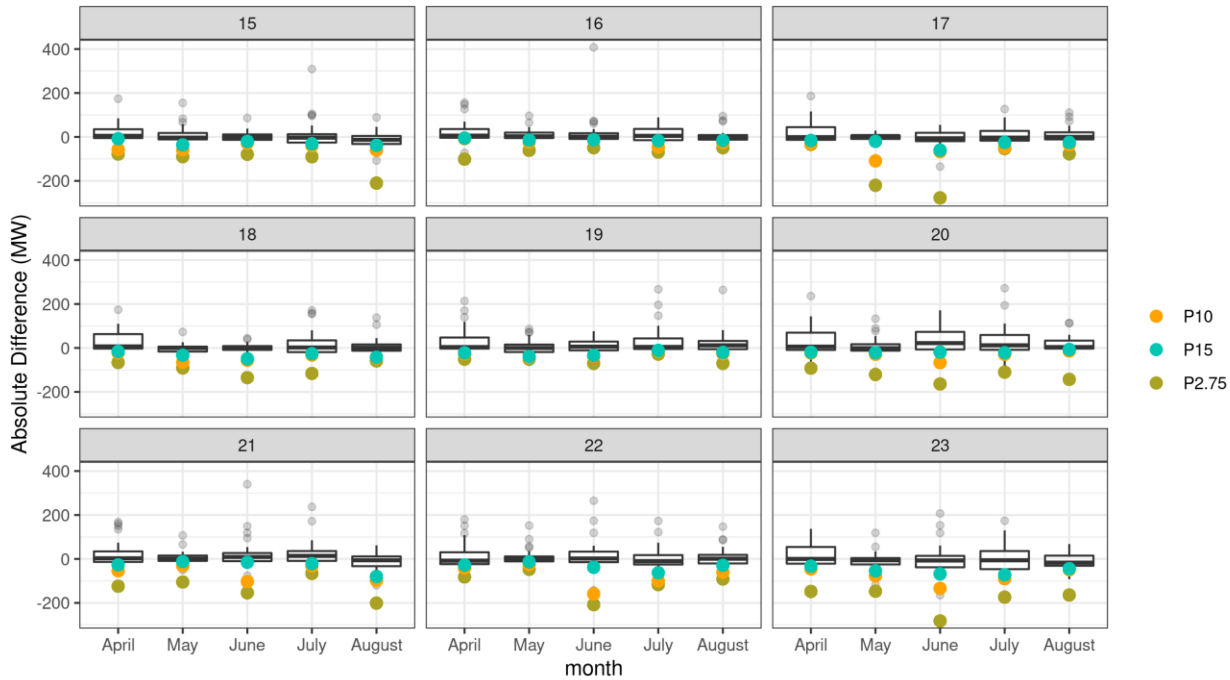


Figure 35 Distribution of deviation between base-schedule NSI versus tagged NSI - SCL

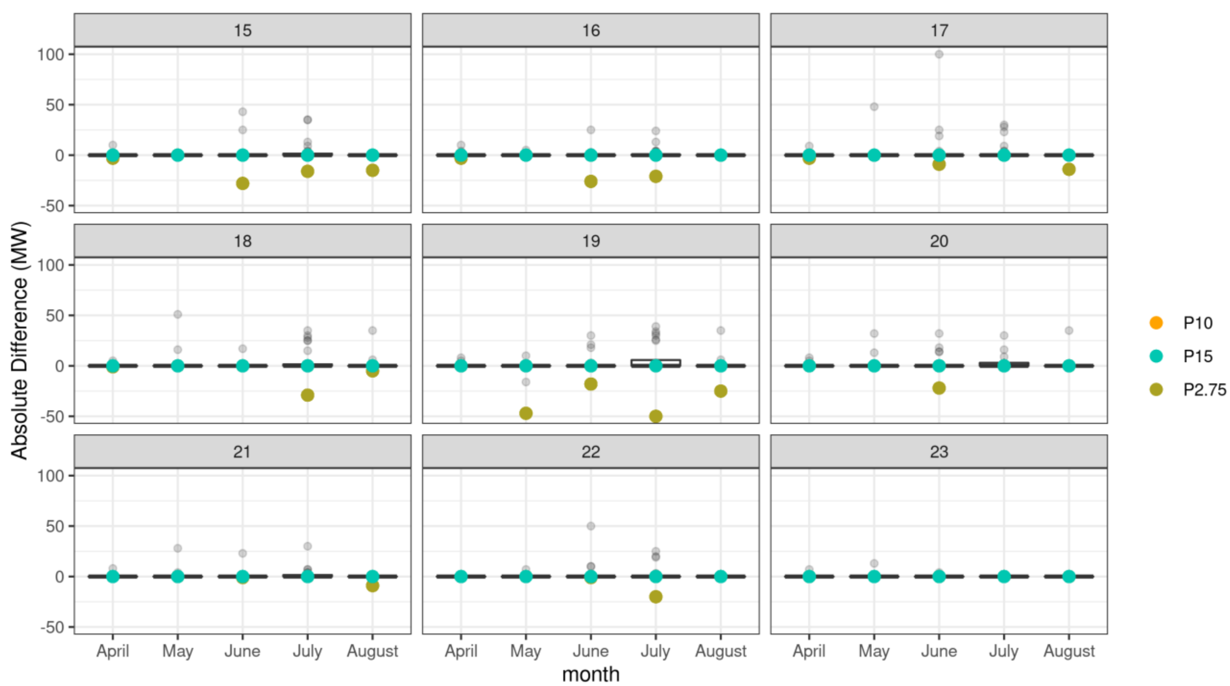


Figure 36 Distribution of deviation between base-schedule NSI versus tagged NSI - SRP