California ISO

Draft Flexible Capacity Needs Assessment for 2024

April 26, 2023

Table of Contents

1. Introduction

Each year, the ISO conducts an annual flexible capacity technical study to determine the flexible capacity needs of the system for up to three years into the future. This helps to ensure the ISO maintains system reliability as specified in the ISO Tariff section 40.10.1. The ISO developed and evolved the study process in the ISO's Flexible Resource Adequacy Criteria and Must-Offer Obligation ("FRAC-MOO") stakeholder initiative and in conjunction with the CPUC annual Resource Adequacy proceeding (R.11-10-023). This report presents the ISO's flexible capacity needs assessment specifying the ISO's forecast monthly flexible capacity needs in year 2024.

The ISO calculates the overall flexible capacity need of the ISO system and the relative contributions to this need attributable to the load serving entities (LSEs) under each local regulatory authority (LRA). This report details the system-level flexible capacity needs and the aggregate flexible capacity need attributable to CPUC jurisdictional load serving entities (LSEs). This report does not break-out the flexible capacity need by LSE attributable to individual local regulatory authorities (LRAs) other than the CPUC.

The ISO will use the results from the study to allocate shares of the system flexible capacity needs to each LRA with LSEs responsible for load in the ISO Balancing Authority area consistent with the allocation methodology set forth in the ISO's Tariff section 40.10.2. Based on that allocation, the ISO will advise each LRA of its MW share of the ISO's flexible capacity needs.

Also as a part of the annual Flex RA process, the ISO calculates the annual Availability Assessment Hours (AAH). The AAH are used to determine the hours of greatest need to maximize the effectiveness of the RA Avaialbity Incentive Mechanism (RAAIM), rewarding resources for being available during these hours. The AAH are updated annually and published in the BPM.

2. Summary of Overall Process

The ISO determines the quantity of flexible capacity needed each month to reliably address its flexibility and ramping needs for the upcoming resource adequacy year and publishes its findings in this flexible capacity needs assessment. The ISO calculates flexible capacity needs using the calculation method codified in the ISO Tariff. This methodology includes calculating the seasonal amounts of three flexible capacity categories and determining seasonal must-offer obligations for two of these flexible capacity categories. The key results of the ISO's flexible capacity needs assessment for 2024 are based on the CEC's 1-in-2 hourly IEPR forecast

Managed Total Energy for Load[1], which looks at the following components provided by the California Energy Commission for 2024:

a. Baseline Consumption Load
b. Behind the meter photo voltaic (PV)
c. Behind the meter storage residential (RES) and non-residential (NONRES)
d. Electric vehicle (EV) charging
e. Additional achievable energy efficiency (AAEE)

In addition to the flexible capacity and ramping needs, the calculation of the annual availability assessmet hours (AAH) are also completed as a part of the Flex RA study process using the IEPR data described above, as well as the most recent year of actuals.

2.1 Summary of Overall Results

1) Expected system-wide flexible capacity needs for 2024 are greatest in March with 24,446 MW and lowers in July at 20,651 MW.

2) The calculated flexible capacity needed from the "base flexibility" category is 37 percent of the total amount of installed or available flexible capacity in the summer months (May – September) and 27 percent of the total amount of flexible capacity for the non-summer months (October – April). See Section 6 for detailed description of the method used.

3) The "peak flexibility" categories are the highest for both seasons in three years reflecting the trend toward the dominance of the primary net load ramp in the afternoon when the sun goes down.

4) The ISO established in this year's assessment for 2024 the time period of the must-offer obligation for resources counted in the "Peak" and "Super-Peak" flexible capacity categories as the five-hour periods of hour ending HE15 to HE19 for November through February and HE17 to HE21 for March through August, the shoulder months September and October will use HE16-HE20. Section 8 discusses the monthly pattern of the must-offer obligation hours in 2024.

5) The ISO also published advisory requirements for two additional years (2025 and 2026) following the upcoming Resource Adequacy (RA) year at the ISO system total levels is shown in Figure 8.

6) The determined draft AAH for 2024 are HE17-21 for the winter and summer months (January – February and June – December) and HE18-22 for the spring months (March –

[1] https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2022-integrated-energy-policy-report-update-2

May). This includes a shift for the month of May to the spring season, which has historically been a part of the summer AAH.

3. Calculation of the ISO System-Wide Flexible Capacity Need

Based on the methodology described in the ISO's Tariff and the business practice manual[2], the ISO calculated the ISO system-wide flexible capacity needs as follows:

$$Flexibility\ Need_{MTH_y} = Max\left[\left(3RR_{HR_x}\right)_{MTH_y}\right] + Max\left(MSSC, 3.5\% * E\left(PL_{MTH_y}\right)\right) + \varepsilon$$

Where:

$Max[(3RR_{HRx})_{MTHy}]$ = Largest three hour contiguous ramp starting in hour x for month y
E(PL) = Expected peak load
MTHy = Month y
MSSC = Most Severe Single Contingency[3]
ε = Annually adjustable error term to account for load forecast errors and variability methodology

For the 2024 RA compliance year, the ISO will continue to set epsilon (ε) equal to zero.

In order to determine the flexible capacity needs, including the quantities needed in each of the defined flexible capacity categories, the ISO conducted a six-step assessment process:

1) Generated one minute net load forecast for years 2024 through 2026 using all expected[4] and existing grid connected wind and solar resources and the CEC (CED 2022 Hourly Forecast – CAISO – Planning Scenario) hourly IEPR load forecast. The ISO used the most recent year of one-minute actual load (2022) data to formulate a shaped and smoothed one-minute 2024-2026 load forecast. [5] This year, the ISO applied a load correction value to the one-minute 2024-2026 load forecast used in forming the three-hour ramp forecast. This load correction was not applied to the peak monthly load used in

[2] Reliability Requirements business practice manual Section 10. Available at http://bpmcm.caiso.com/Pages/BPMDetails.aspx?BPM=Reliability%20Requirements

[3] For the 2024 flex assessment, the ISO assumed its MSSC is the loss of one Diablo Unit, which is consistent with what was done in past assessments. Also, for this analysis the ISO continues to use 3.5% of its peak monthly load forecast to estimate the spinning reserve requirement of its contingency reserve obligation.

[4] Expected wind and solar resources also included monthly incremental renewable resources that are dynamically scheduled into the ISO.

[5] See the Draft 2024 Flexible Capacity Needs Assessment at https://stakeholdercenter.caiso.com/RecurringStakeholderProcesses/Local-capacity-requirements-process-2024 for more information on the shifting and smoothing methodology

calculating the monthly flexible capacity, MOO or AAH. More details are provided in Section 5.

2) Calculated the forecast monthly system-level three-hour upward net load ramp plus either the greater of the most severe single contingency or approximately 50% of the contingency reserves requirement of the system. Further, classify the monthly three-hour upward net load ramp into three categories and then calculate the percentages of each category relative to the three-hour upward net load ramp in each month. For the definition of each of the three categories and the relevant percentage, please refer to Section 6 below.

3) Applied the calculated percentages in Step 2 to the contingency reserve requirements for each month, so that each category has the appropriate amount of contingency reserve as well the three-hour net load ramp component. For each category, the ISO uses the sum of these two quantities as the monthly flexible capacity need.

4) Analyzed the distributions of both the largest three-hour net load ramps for the primary and secondary net load ramps to determine the appropriate seasonal demarcations[6].

5) Calculated a simple average of the percent of base flexibility needs for all months within a season; and

6) Determined each LRA's contribution to the flexible capacity need.

4. Forecasting One-Minute Net load

The first step in developing the flexible capacity needs assessment was to forecast the net load. To produce this forecast, the ISO collected through surveys the requisite information regarding the existing build-out in 2022 and the expected build-out in 2024 through 2026 of the grid-connected wind and solar resources. After obtaining this data from all LSEs, the ISO constructed the forecast one-minute load, grid connected solar and wind resources before calculating the net load curves for 2024 through 2026.

4.1 Building the Forecasted Variable Energy Resource Portfolio

To collect the necessary data, the ISO sent a data request in December 2022 to the scheduling coordinators for all LSEs representing load within the ISO balancing area[7]. To assist with common questions regarding the survey, this year the ISO published an FAQ document,

[6] The three-hour primary ramp in each day is the largest three-hour ramp in that day, while the secondary three-hour ramp is the largest three-hour ramp outside the range of the primary three-hour ramp.

[7] A reminder notice was also sent out in early January 2023

which is available on the stakeholder page.[8] The deadline for submitting the data request was January 15, 2023. At the time of the stakeholder call in February, the ISO had received data from all LSEs but was still performing outreach to ensure all expected resources and fuel types are included in the analysis. The data request asked for information on each grid connected wind and solar resource that is connected within the ISO's footprint, in whole or in part, in addition to external wind/solar resources that are under contractual commitment to the LSE for all or a portion of its capacity. Since the CEC's load forecast accounted for the expected behind-the-meter production, there was no need for the ISO to include the behind-the-meter production in the net load calculation.

The ISO also requested LSEs to provide data on existing and expected hybrid and co-located resources in order to quantify the contribution of the renewable component. The new co-located resource type went live in December 2021 as part of Phase 1 of the hybrid resources initiative[9], and phase 2 went live February 1, 2023 and included the addition of the new hybrid fuel type and ability to identify hybrid components by fuel type within the Master File. The submittals showed a total of about 4,551 MW of existing and expected co-located renewable resources (excluding storage) in the 2023 timeframe, which were factored into the flexible needs assessment. The survey submittals of hybrid resources showed a total of 336 MW of expected renewable hybrid components in 2023. For the 2023 and 2024 Flexible RA study, Co-located renewables and renewable components of Hybrid resources were also included in calculating the flexible capacity needs.

The ISO expects there to be a large increase in Co-located and Hybrid resources with renewable components on the system throughout 2023 and 2024. Co-located resources have the ability to produce as capable and with their treatment in the market being nearly identical to those of a traditional VER, co-located resources were included in the 2023 and 2024 three-hour ramp forecast and flexible capacity study. In regards to hybrid resources, although the hybrid resource as a whole will need to follow their dispatch operating targets (DOTs), the individual renewable components will contribute to the three-hour net load ramp. Renewable components of hybrid resources must be considered in the flexible needs assessment because all variable resources contribute to the three-hour ramp. Variable resources, whether it be a standalone or the variable component of a hybrid, contribute to the flexibility requirement of the system, thus the ISO incorporates forecasts to estimate the flexible needs associated with these resources. The ISO allows the storage component for co-located and hybrid resources to count for flexible capacity. The ISO will continue to monitor the operations of hybrid resources and their inclusion the Flex RA study in future years.

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[8] http://www.caiso.com/InitiativeDocuments/Flexible-Capacity-Requirement-Assessment-Survey-FAQ.pdf
[9] https://stakeholdercenter.caiso.com/StakeholderInitiatives/Hybrid-resources

As part of the data request, the ISO also asked for behind-the-meter existing and expected capacity within each LSEs portfolio. For resources that are external to the ISO, the ISO requested additional information as to whether the resource would be either fixed or dynamically scheduled into the ISO. The ISO only included incremental external resources in the flexible capacity requirements assessment if they were identified to be dynamically scheduled to the ISO.

Using the LSEs' submitted renewable resources data and the CEC's hourly load forecast, the ISO simulated the net load[10] output for 2024, 2025 and 2026 using actual one-minute load, wind and solar data for 2022. A breakdown of the LSEs submittal is shown in Table 1.

Table 1: Total ISO System Variable Energy Resource Capacity for Year End Based on LSE Survey Data (Net Dependable Capacity-MW)[11]

Resource Type	Existing 2022	Expected 2023	Expected 2024
ISO Solar PV	14,389	16,534	17,879
ISO Solar Thermal	860	858	858
ISO Wind	4,492	4,641	4,912
Co-Located Resources (Wind)	0	0	0
Co-Located Resources (Solar)	2,850	4,551	5,755
Hybrid Resources (Wind)	0	0	0
Hybrid Resources (Solar)	221	336	534
Total Variable Energy Resource Capacity within the ISO	***22,812***	***26,920***	***29,937***
Cumulative Non ISO Wind/Solar Resources that's Dynamically Scheduled into the ISO	1,884	1,986	1,991
Total Internal and Dynamically Scheduled VERs in Flexible Capacity Needs Assessment	***24,696***	***28,906***	***31,928***
Incremental New VERs Additions Each Year (Included in Flexible Capacity Needs Assessment)		***4,210***	***3,022***
Maximum behind-the-meter Solar PV Production in the CEC's Forecast		12,429	13,395
Cumulative behind-the-meter Solar PV Capacity reported by LSEs	13,249	14,312	15,565

[10] Net load is defined as load minus wind production minus solar production.

[11] Data shown is for December of the corresponding year. The ISO aggregated variable energy resources across the ISO system to avoid concerns regarding the release of confidential information.

*Note: The incremental behind-the-meter Solar PV production was imbedded in the CEC's hourly load forecast and therefore the LSE survey data was not explicitly factored into the flexible needs assessment.

Table 1 aggregates the system-wide variable energy resources output by year. Additionally, for existing solar and wind resources, the ISO used the most recent full year of actual solar output data available, which was 2022.

Figure 1a and 1b below show the expected buildout by month and year for hybrid and co-located resources with renewable components, broken down by fuel type. For this study, both co-located renewables and the renewable components of hybrid resources were considered.

Figure 1a: Expected buildout of Hybrid Resources for 2022 through 2026

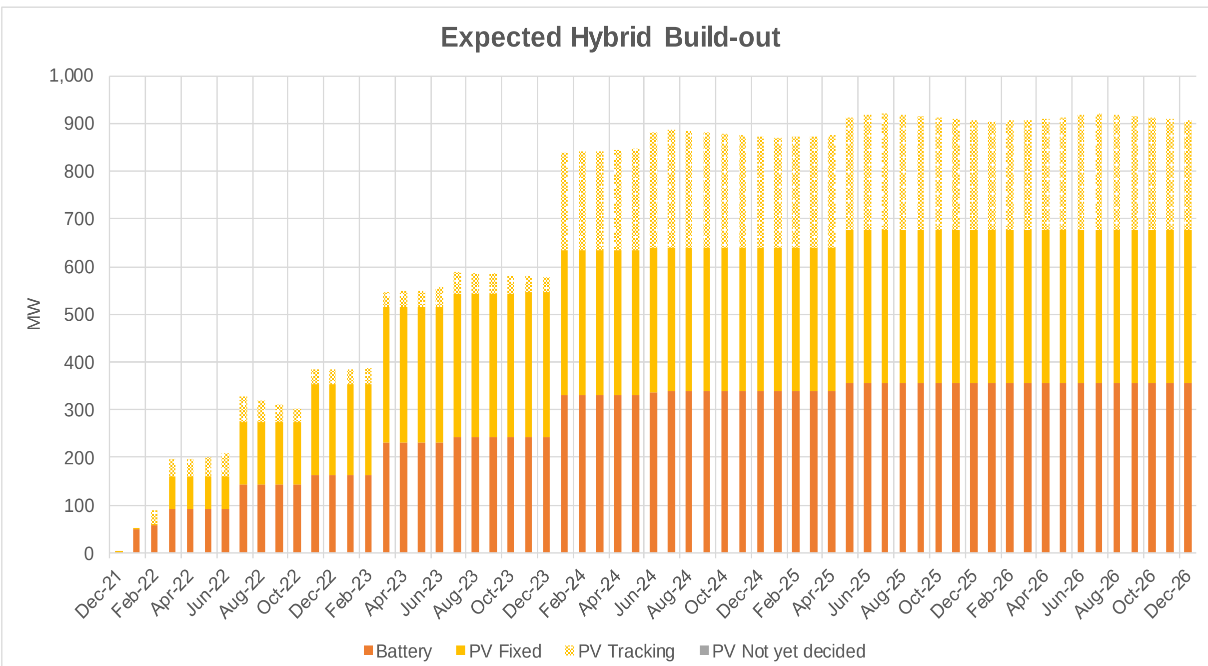
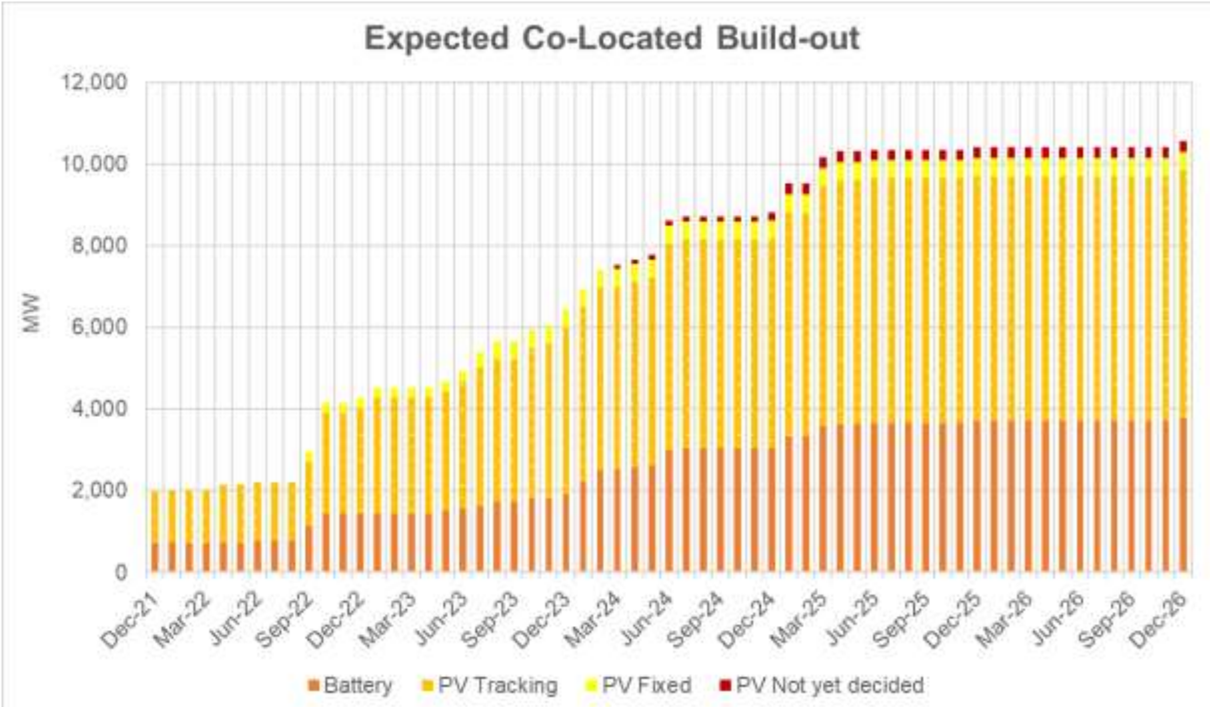


Figure 1b: Expected buildout of Co-Located Resources for 2022 through 2026



For future wind resources, the ISO scaled the overall one-minute wind production for each month of the most recent year by the expected future capacity divided by the installed wind capacity for the same month of the most recent year. Specifically, to develop the one-minute wind profiles for 2024, the ISO used the following formula:

$$2024W_{Mth\_Sim\_1min} = 2022W_{Act\_1min} * \frac{2024W_{Mth\,Capacity}}{2022W_{Mth\,Capacity}}$$

Similarly, to develop one-minute transmission connected solar profiles for 2024, the ISO used the actual one-minute profiles for 2022 using the following formula:

$$2024S_{Mth\_Sim\_1min} = 2022S_{Act\_1min} * \frac{2024S_{Mth\,Capacity}}{2022S_{Mth\,Capacity}}$$

Given the amount of incremental wind and solar resources expected to come on line, this approach simply scales the one-minute production with respect to capacity.

4.2 Building One-Minute Net Load Profiles

The ISO used the CEC 2022 Integrated Energy Policy Report (IEPR) 1-in-2 hourly managed net load forecast (CED 2022 Hourly Forecast – CAISO – Planning Scenario) to develop one-minute load forecasts for each month[12]. The ISO first scaled the actual load for each minute of each hour of 2022 using an expected CEC's load growth factor for the corresponding hour.

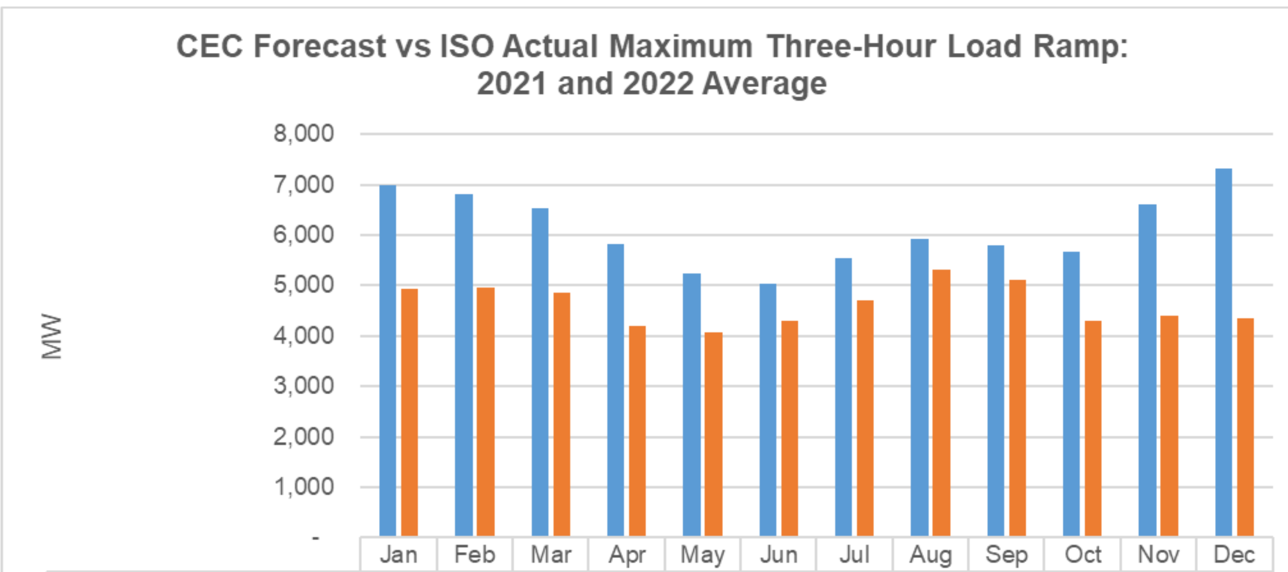
$$2024L_{Mth,Day,Hour\_Sim\_1min} = 2022L_{Mth,Day,Hour\_Act\_1min} * \frac{2024L_{Mth,Day,Hour\_Forecast}}{2022L_{Mth,Day,Hour\_Actual}}$$

Using this load forecast and the expected wind and solar profiles developed in Section 4.1, the ISO then developed the one-minute net load profiles for subsequent years by aligning weekdays and weekends within each month.

5. Calculating the Monthly Maximum Three-Hour Net load Ramps plus Reserve

Based on the LSEs submittal, the scaled solar and wind output and the CEC's load forecast, the forecast maximum upward three-hour monthly load ramps for 2024 using the previously described methodology were significantly higher than what was historically observed in 2021-2022. This is shown in Figure 3.

Figure 2: The three-hour load ramp forecast error for 2021 and 2022



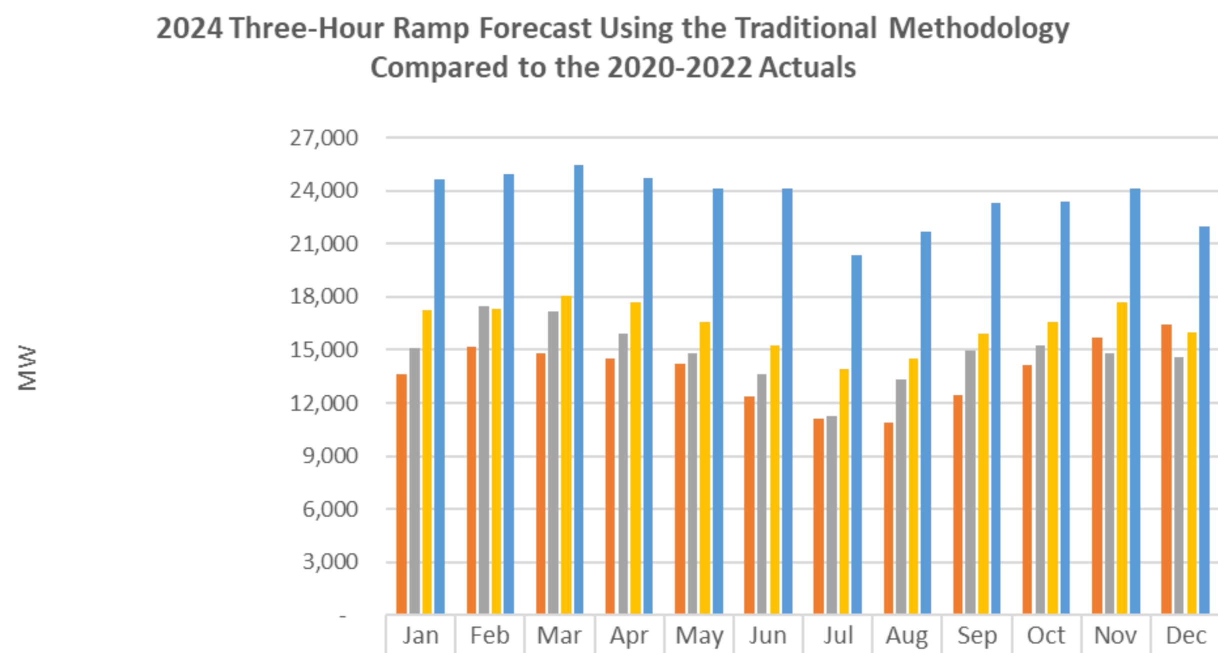
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CEC Load Ramp Forecast	6,994	6,818	6,533	5,830	5,236	5,039	5,546	5,935	5,797	5,666	6,613	7,308
CAISO Load Ramp Actual	4,922	4,957	4,870	4,203	4,064	4,287	4,705	5,314	5,109	4,308	4,406	4,346

After analysis of the CEC's load forecast, increase in renewable buildout submitted by the LSE's (standalone, co-located and hybrid components) and other potential impacts to the three-hour ramp, it was found that the IEPR forecast has a high difference compared to the CAISO actuals which was largely impacting the three-hour ramp forecast for 2024. This is shown in

[12] https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2022-integrated-energy-policy-report-update-2

Figure 3 below, showing the most recent three years of actuals as well as the 2024 three-hour ramp forecast using the IEPR forecast for 2024.

Figure 3: Orignal 2024 three-hour ramp forecast using traditional method compared to 2020-2022 actuals



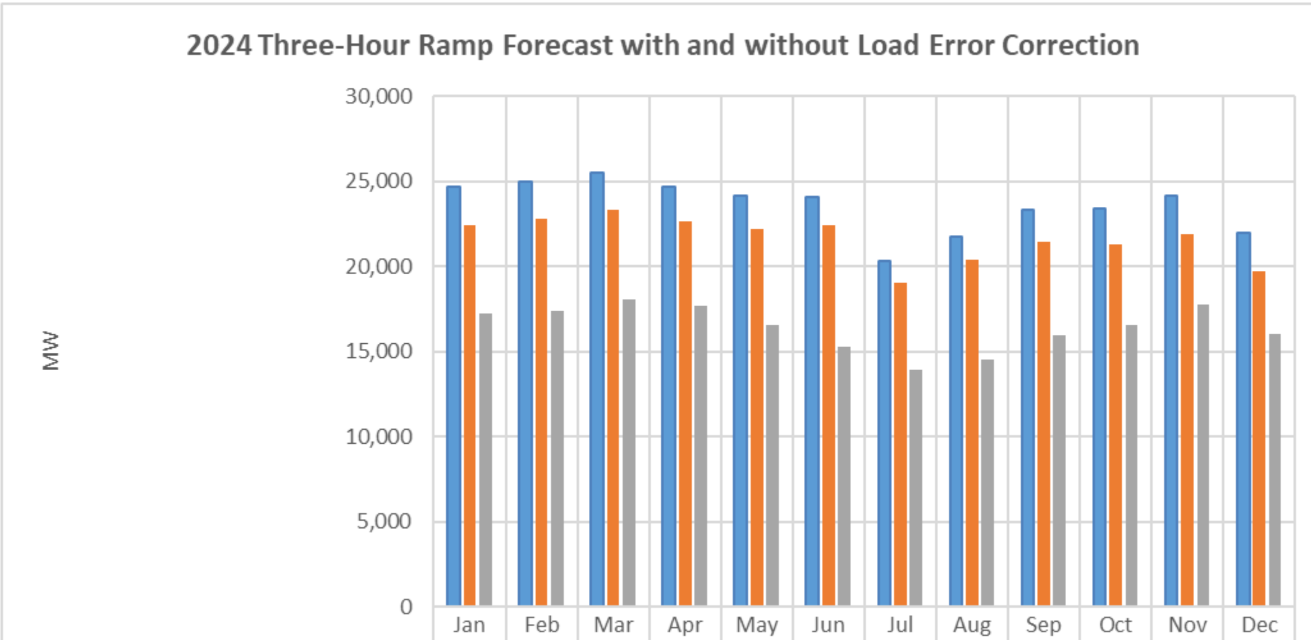
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020 Act 3-Hr Ramp	13,61	15,15	14,83	14,49	14,25	12,36	11,14	10,89	12,47	14,13	15,72	16,45
2021 Act 3-Hr Ramp	15,11	17,44	17,14	15,92	14,79	13,60	11,26	13,36	14,92	15,24	14,80	14,58
2022 Act 3-Hr Ramp	17,25	17,34	18,03	17,71	16,55	15,26	13,93	14,52	15,93	16,57	17,71	16,00
2024 Fcst Traditional Method	24,68	24,98	25,46	24,70	24,16	24,10	20,34	21,71	23,32	23,39	24,15	21,98

To determine the load error observed in the CEC forecast compared to the ISO actuals, the ISO looked at the average maximum three -hour load ramp error using the 2021 and 2022 actuals compared to the CEC IEPR forecast from 2019 for 2021 and the 2020 IEPR forecast for 2022 (as shown in Figure 2), as these were the forecasts used to calculate the final flexible capcity needs and three-hour ramp forecasts for those years. It was found that on average across the year, the IEPR forecast was higher for the three-hour load ramp by 24.3%.

To mitigate this average error observed on the load ramp, the ISO multiplied the smoothed one-minute CEC IEPR forecast by .757=(1-0.243) for all minutes of the year. The three-hour load ramp was then calculated, followed by the three-hour net load ramp by subtracting the expected solar and wind generation for years 2024-2026 using the scaled one-minute solar and wind data for each respective year for the forecast.

The three-hour net load forecasts using the error adjusted CEC forecast are shown in Figure 4 and are compared to the traditional three-hour ramp methodology that would have been published without changes to the IEPR forecast.

Figure 4: The updated 2024 three-hour ramp forecast with the load error correction compared to the 2024 three-hour ramp forecast without the error correction and 2022 actual three-hour ramps



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3-Hr Ramp Traditional Methodology	24,680	24,981	25,465	24,701	24,161	24,102	20,347	21,716	23,324	23,395	24,151	21,988
3-Hr Ramp Error Correction	22,432	22,775	23,296	22,632	22,163	22,390	19,031	20,384	21,467	21,272	21,924	19,699
Actual 2022 3-Hr Ramp	17,255	17,342	18,030	17,710	16,559	15,265	13,938	14,520	15,935	16,578	17,717	16,001

It is important to note that only the one-minute load data that was used to calculated the three-hour ramp was adjusted by the error correction. The expected peak monthly load used within the flexible capacity calculation shown in Section 3 above, load data used to calculate the must-offer obligation (MOO) and availability assessment hours (AAH) were **not** multiplied by the error correction. This was done because the difference calculated was based on the three-hour load ramp, not all periods of the day, and the monthly peak and maximum load values within the forecast are in better alignment with historical CAISO actuals and did not see a similar trend.

The ISO publishes the one-minute data used to calculate the net load ramp along side this paper on the stakeholder page.[13] This year's assesment, in addition to the one-minute data typically published, the ISO is also providing the one-minute data multiplied by the load error correction for the hours that set the three-hour net load ramp for each month. Table 2 below

[13] https://stakeholdercenter.caiso.com/RecurringStakeholderProcesses/Flexible-capacity-needs-assessment-2024

provides the start and end time of the 'Three-Hour Ramp Error Correction' available in the file and are shown in Figure 4.

Table 2: The start and end time of the three-hour net load ramp used in determing the flexible capacity

Month	Ramp Start Time	Ramp End Time	Net Load Ramp
January	1/31/2024 14:38	1/31/2024 17:38	22,432
February	2/26/2024 14:54	2/26/2024 17:54	22,775
March	3/8/2024 14:59	3/8/2024 17:59	23,296
April	4/21/2024 16:13	4/21/2024 19:13	22,632
May	5/25/2024 16:41	5/25/2024 19:41	22,163
June	6/9/2024 16:43	6/9/2024 19:43	22,390
July	7/4/2024 16:46	7/4/2024 19:46	19,031
August	8/24/2024 16:04	8/24/2024 19:04	20,384
September	9/14/2024 15:48	9/14/2024 18:48	21,467
October	10/27/2024 14:58	10/27/2024 17:58	21,272
November	11/7/2024 14:13	11/7/2024 17:13	21,924
December	12/10/2024 14:08	12/10/2024 17:08	19,699

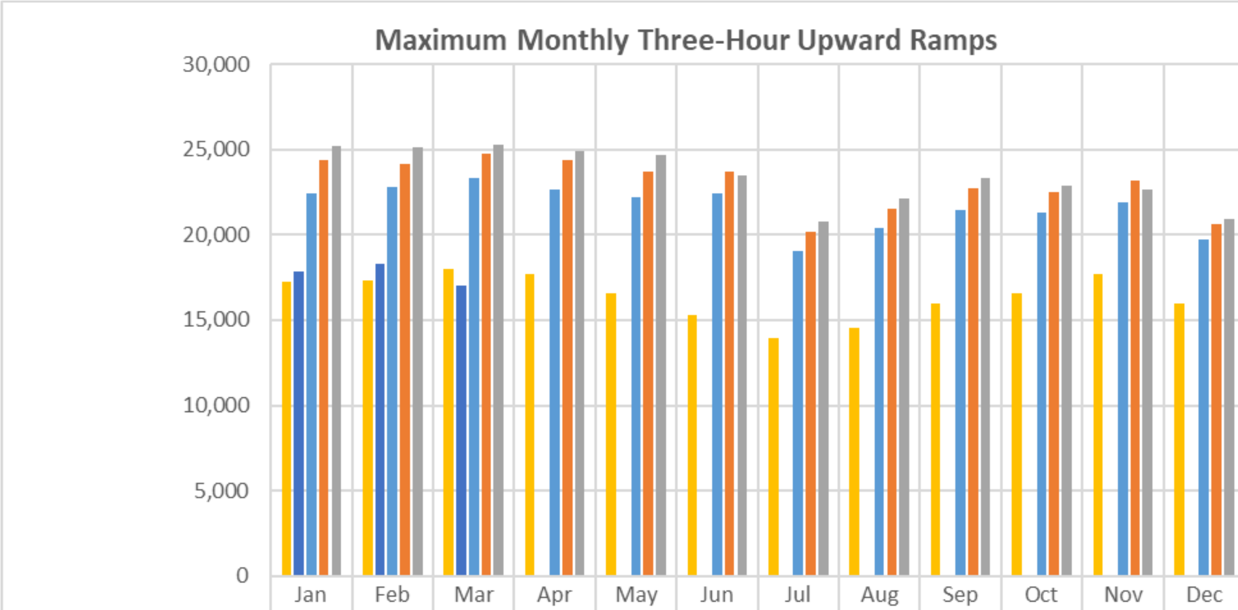
Using the data provided in the one-minute net load spreadsheets, the three-hour ramps can be replicated using the 2024 load forecast (with the error correction multiplier) and scaled 2024 wind and solar outputs. An example is shown below in Table 3.

Table 3: Example of how to calculate the three-hour net load ramp for 2024

	Datetime	Load	Load w/ Error Correct	Wind	Solar	Net Load w/ Error Correct	Net load	3-Hr Net Load Ramp w/ Error Correct	3-Hr Net Load Ramp
Ramp start	2024/03/08 14:59	21,406	16,204	359	17,479	-1,634	3,568	23,296	25,194
Ramp end	2024/03/08 17:59	29,218	22,119	141	315	21,663	28,762	--	--

The 0.757 multiplier was applied to the one-minute load forecast for 2024, 2025 and 2026 used in calculating the three-hour net load ramp for each year. Figure 5 shows the expected ISO system-wide largest three-hour net load ramp for each month of 2024 through 2026 compared with each month of the actual three-hour net load ramp for 2022 and 2023 through March.

Figure 5: Expected ISO System Maximum Monthly Three-Hour Net Load Ramps



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2022 Actuals	17,255	17,342	18,030	17,710	16,559	15,265	13,938	14,520	15,935	16,578	17,717	16,001
2023 Actuals	17,821	18,261	17,003									
2024 3-Hr Ramp Fcst	22,432	22,775	23,296	22,632	22,163	22,390	19,031	20,384	21,467	21,272	21,924	19,699
2025 3-Hr Ramp Fcst	24,352	24,171	24,767	24,340	23,714	23,670	20,163	21,502	22,719	22,515	23,156	20,638
2026 3-Hr Ramp Fcst	25,197	25,101	25,255	24,909	24,648	23,506	20,747	22,096	23,292	22,889	22,648	20,940

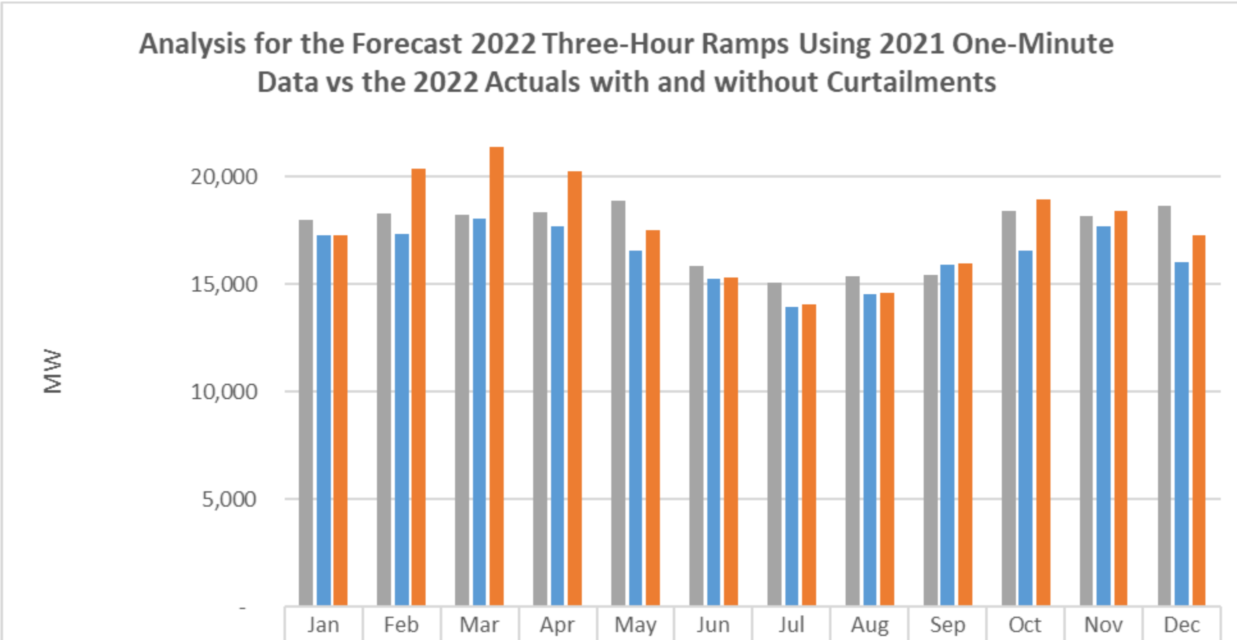
For 2024, the maximum three-hour upward ramp of approximately 23,296MW is expected to occur in March and the minimum three-hour upward ramp of approximately 19,031MW is expected to occur in July.

Incremental resources dynamically scheduled into the ISO for 2024, 2025 and 2026 are included in the calculation of the three-hour ramp forecast because the ISO must provide balancing services for these resources. Also, dynamically scheduled resources in the actual 2022 data were already factored into the ISO's load.

Depending on the time of day the curtailments occur, they can have an effect on reducing the three-hour ramp by raising the "belly of the duck". The impact of curtailments on the three-hour ramp is shown in Figure 6. It is important to note that the actual three-hour net load ramps include real-time curtailments as the actual one-minute wind and solar data used to determine the forecast three-hour monthly ramps include curtailments[14]. As shown in Figure 6, curtailments can reduce the observed three-hour ramp compared to the actuals where curtailments are not included.

[14] Curtailments would be reflected in the actual three-hour ramps if the ISO curtailed renewables in real time.

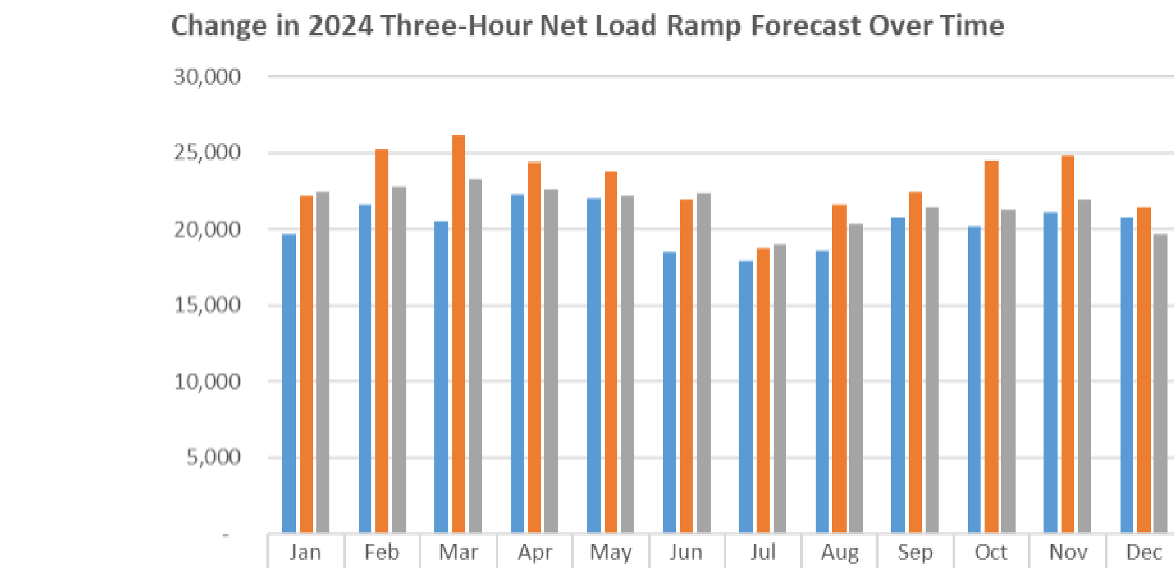
Figure 6: The ISO 2022 Expected Maximum Monthly three-Hour Ramp vs 2022 Actuals With and Without Curtailments



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2022 Forecast	17,990	18,294	18,212	18,377	18,911	15,863	15,085	15,382	15,429	18,400	18,150	18,669
2022 Actual	17,255	17,342	18,030	17,710	16,559	15,265	13,938	14,520	15,935	16,578	17,717	16,001
2022 Actual + Curtail	17,260	20,402	21,358	20,233	17,524	15,302	14,076	14,604	15,994	18,918	18,382	17,266

Other factors that can impact the three-hour ramp include tempertaures and cloud cover. January-March 2022 featured above normal temperatures across the state, as well as below normal precipitation, which led to higher mid-day loads and likely resulted in a lower three-hour ramp, which is shown above. The summer months of June through August across the state had above normal overnight temperatures. Warm overnights can keep morning loads elevated, which in turn can keep the midday loads elevated and reduce the three-hour ramp compared to the forecast. Finally, October through December 2022 had increased cloud cover and above normal precipitation for a large portion of the state. Due to the reduction in behind-the-meter solar generation, this resulted in lower observed three-hour ramps, and is likely the reason why the actuals are significantly lower than the forecast.

Figure 7: Comparing the Change in the 2024 three-hour Ramp Forecast From 2021-2023



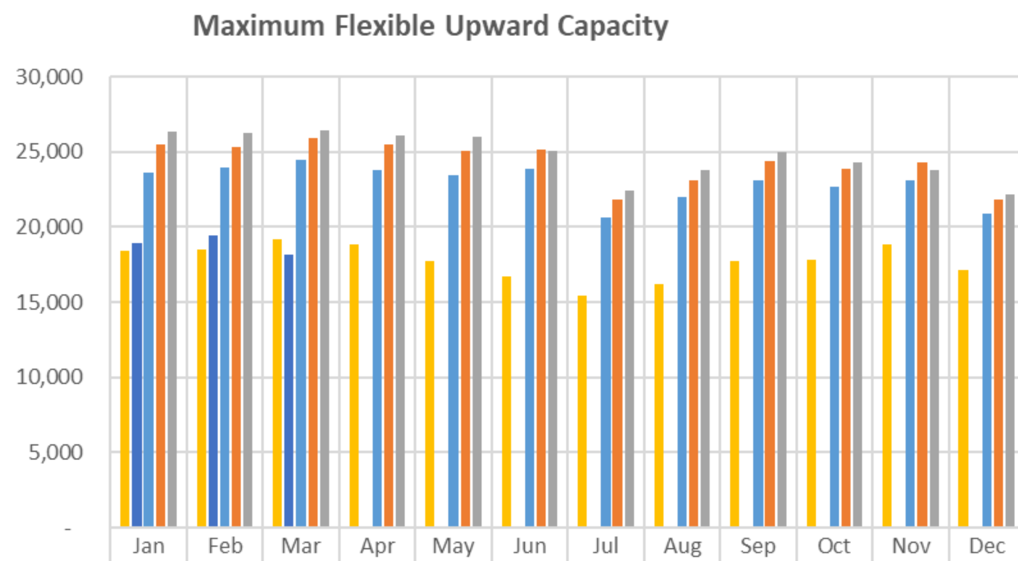
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2021 Forecast for 2024	19,687	21,573	20,511	22,309	22,029	18,536	17,882	18,565	20,815	20,206	21,092	20,808
2022 Forecast for 2024	22,163	25,224	26,179	24,396	23,786	21,990	18,777	21,633	22,439	24,450	24,825	21,460
2023 Forecast for 2024	22,432	22,775	23,296	22,632	22,163	22,390	19,031	20,384	21,467	21,272	21,924	19,699

Figure 7 above shows the change in the 2024 three-hour ramp forecast over time. For most months, the 2023 forecast for 2024 decreased compared to the 2022 forecast. This is due to the use of the load error correction value applied to the 2024 one-minute load forecast data used to calculate the three-hour ramp forecast.

To determine the monthly flexible capacity needs for 2024, the ISO summed the monthly largest three-hour contiguous ramps with the maximum of either the most severe single contingency or 3.5 percent of the forecast peak-load for each month. As mentioned above, the peak load for each month used in the flexible capacity calculation was not impacted by the error correction multiplier, only the three-hour contiguous ramp forecast was. This sum yields the ISO system-wide monthly flexible capacity needs for 2024 and advisory needs for 2025 and 2026.

As shown in Figure 8, the forecast flexible capacity for all months for years 2024-2026 are higher than the actual flexible capacity needs in 2022 and January through March of 2023.

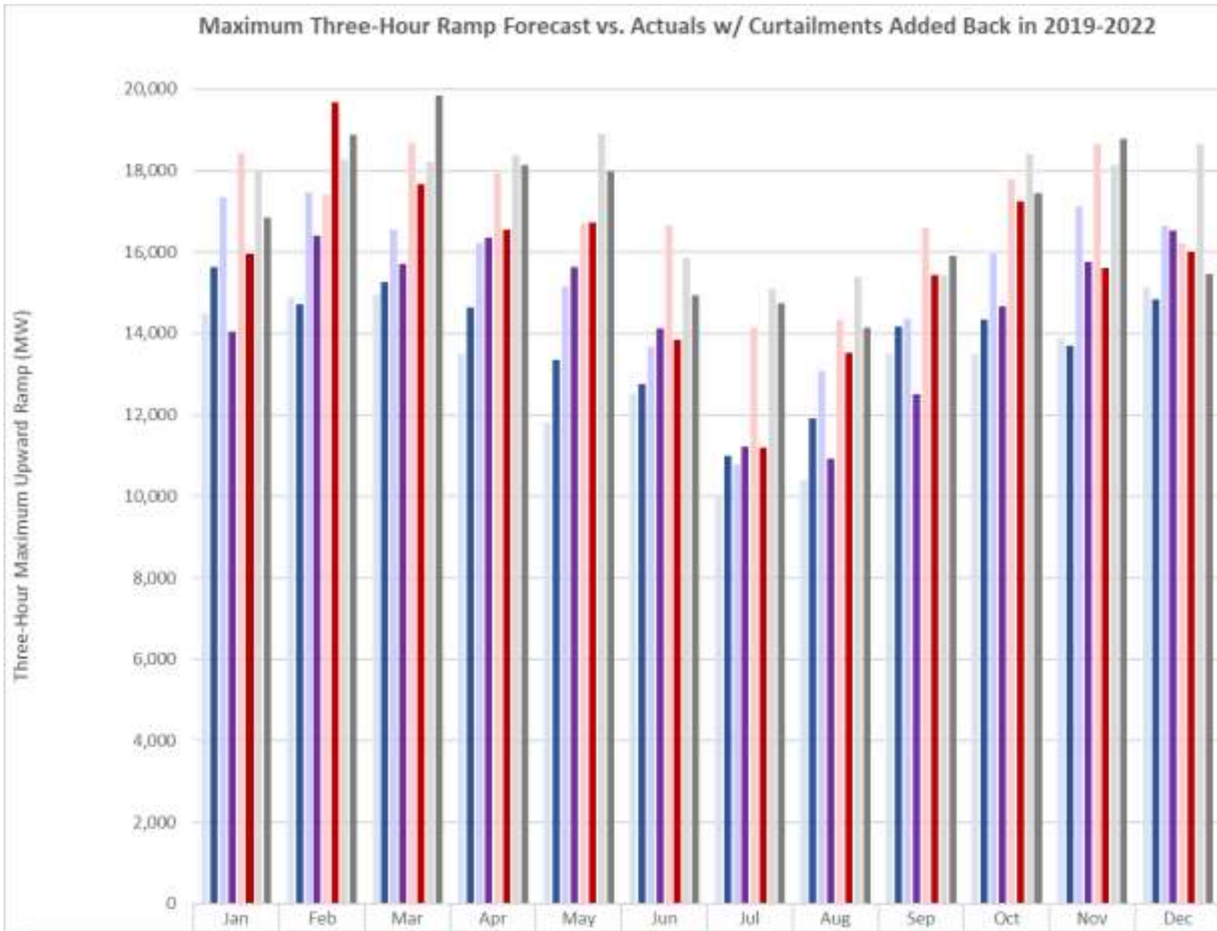
Figure 8: The ISO Monthly Maximum Three-Hour Flexible Capacity Requirements



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2022 Act Flex Capacity	18,405	18,492	19,180	18,882	17,762	16,724	15,420	16,178	17,757	17,795	18,867	17,151
2023 Act Flex Capacity	18,971	19,411	18,153									
2024 Fcst Flex Capacity	23,583	23,925	24,446	23,817	23,485	23,897	20,651	22,018	23,135	22,655	23,081	20,900
2025 Fcst Flex Capacity	25,519	25,321	25,917	25,539	25,052	25,194	21,794	23,150	24,405	23,918	24,329	21,855
2026 FcstFlex Capacity	26,383	26,251	26,405	26,126	26,002	25,044	22,394	23,763	24,995	24,308	23,833	22,170

In Figure 6 above, a comparison between the three-hour ramp actual with and without curtailments is shown for 2021, and for most months there is an impact of up to 10 percent on the three-hour ramp actuals when curtailments are included. A detailed accuracy analysis of the three-hour ramp forecast for years 2019-2022 is shown in Figure 9. The ramp forecast for each year was created from the previous year's one-minute actual load, wind, and solar data. For example, the 2022 monthly forecast bars were created in 2021 using actual 2020's one-minute load, wind and solar data. As shown, the monthly three-hour ramp appears to be higher than forecast when compared to the actuals for most months. It is important to note that the actual data in Figure 9 has curtailments added back in. While the 2022 actual data used to form the three-hour ramp forecast does include wind and solar curtailments, the forecast provided does not account for real-time wind or solar curtailments on a given day that would impact the three-hour ramp. The below actuals values show what the maximum three-hour ramp would have been had there not been any curtailments to wind or solar resources.

Figure 9: A comparison of the forecast three-hour ramp to the actual three-hour ramp (including curtailments) for years 2019-2022



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019 Forecast	14,506	14,889	14,971	13,509	11,808	12,524	9,967	10,393	13,511	13,510	13,898	15,129
2019 Act + Curtail	15,639	14,707	15,261	14,636	13,350	12,757	11,002	11,924	14,182	14,340	13,704	14,839
2020 Forecast	17,350	17,476	16,550	16,230	15,171	13,666	10,768	13,087	14,373	15,965	17,110	16,660
2020 Act + Curtail	14,051	16,393	15,716	16,347	15,645	14,132	11,213	10,924	12,522	14,666	15,749	16,522
2021 Forecast	18,446	17,424	18,682	17,936	16,695	16,652	14,156	14,335	16,589	17,779	18,666	16,207
2021 Act + Curtail	15,949	19,669	17,665	16,558	16,722	13,856	11,187	13,531	15,440	17,254	15,611	16,001
2022 Forecast	17,990	18,294	18,212	18,377	18,911	15,863	15,085	15,382	15,429	18,400	18,150	18,669
2022 Act + Curtail	16,840	18,871	19,850	18,136	17,990	14,942	14,737	14,149	15,908	17,438	18,794	15,452

6. Calculating the Seasonal Percentages Needed in Each Category

As described in the ISO Tariff sections 40.10.3.2 and 40.10.3.3, the ISO divided its flexible capacity needs into various categories based on the system's operational needs. These categories are based on the characteristics of the system's net load ramps and the mix of resources that can be used to meet the system's flexible capacity needs. Certain use-limited resources may not qualify to be counted towards the flexible capacity needs under the base flexibility category and may only be counted under the peak flexibility or super-peak flexibility categories, depending on their characteristics. Although there is no limit to the amount of flexible capacity that can come from resources meeting the base flexibility criteria, there is a maximum amount of flexible capacity that can come from resources that only meet the criteria to be counted under the peak flexibility or super-peak flexibility categories.

The ISO structured the flexible capacity categories to meet the following needs:

Base Flexibility: Operational needs determined by the magnitude of the largest three-hour secondary net load[15] ramp

Peak Flexibility: Operational need determined by the difference between 95 percent of the maximum three-hour net load ramp and the largest three-hour secondary net load ramp

Super-Peak Flexibility: Operational need determined by five percent of the maximum three-hour net load ramp of the month

These categories include different minimum flexible capacity operating characteristics and different limits on the total quantity of flexible capacity within each category. In order to calculate the quantities needed in each flexible capacity category, the ISO conducted a three-step assessment process as follows:

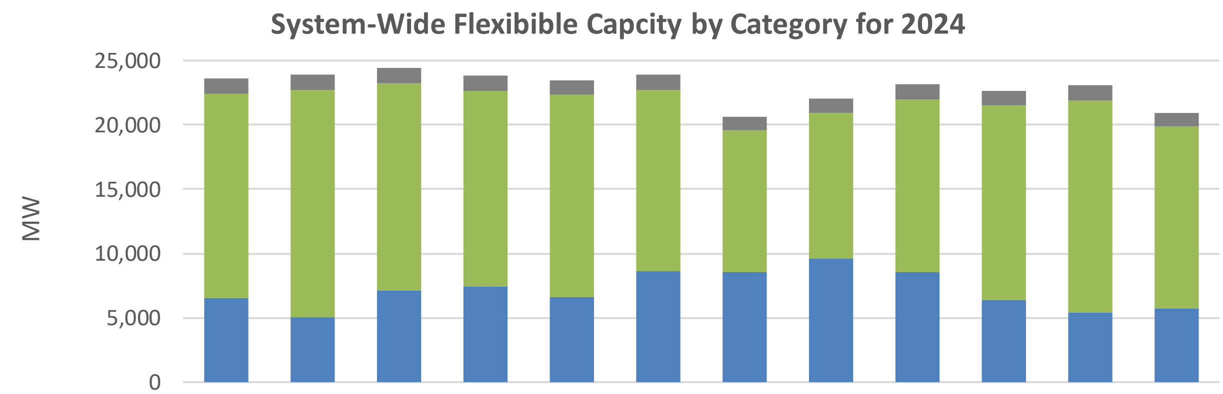
1) Calculated the forecast percentages needed in each category in each month;
2) Analyzed the distributions of both the largest three-hour net load ramps for the primary and secondary net load ramps to determine appropriate seasonal demarcations; and
3) Calculated a simple average of the percent of base flexibility needs from all months within a season.

6.1 Calculating the Forecast Percentages Needed in Each Category in Each Month

Based on the categories defined above, the system level needs for 2024 were calculated based only on the maximum monthly three-hour net load calculation. Then the quantity needed in each category in each month was calculated based on the above descriptions. The secondary net load ramps were then calculated to eliminate the possibility of over-lapping time intervals between the primary and secondary net load ramps. Finally, the contingency reserve requirements were added to the different categories proportional to the percentages established by the maximum three-hour net load ramp. The calculation of flexible capacity needs for each category for 2024 is shown in Figure 10.

[15] The largest daily secondary three-hour net load ramp is calculated as the largest net load ramp that does not correspond with the daily maximum net load ramp. For example, if the daily maximum three-hour net load ramp occurs between 5:00 p.m. and 8:00 p.m., then the largest secondary ramp would not overlap with the 5:00 p.m. - 8:00 p.m. period

Figure 10: ISO System-Wide Flexible Capacity Monthly Calculation by Category for 2024



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Super-Peak Flexibility	1,179	1,196	1,222	1,191	1,174	1,195	1,033	1,101	1,157	1,133	1,154	1,045
Peak Flexibility	15,857	17,706	16,070	15,189	15,673	14,084	11,089	11,319	13,415	15,142	16,531	14,118
Base Flexibility	6,546	5,023	7,153	7,436	6,638	8,618	8,529	9,597	8,563	6,379	5,396	5,737

6.2 Analyzing Ramp Distributions to Determine Appropriate Seasonal Demarcations

To determine the seasonal percentages for each flexible capacity category, the ISO analyzed the distributions of the largest three-hour net load ramps for the primary and secondary net load ramps to determine appropriate seasonal demarcations for the base flexibility category. The secondary net load ramps provide the ISO with the frequency and magnitude of secondary net load ramps. Assessing these distributions helps the ISO identify seasonal differences that are needed for the final determination of percent of each category of flexible capacity. The primary and secondary net load ramp distributions are shown for each month in Figure 11 and Figure 12, respectively.

Figure 11: Percentile Distribution of Daily Primary Three-hour Net Load Ramps for 2023

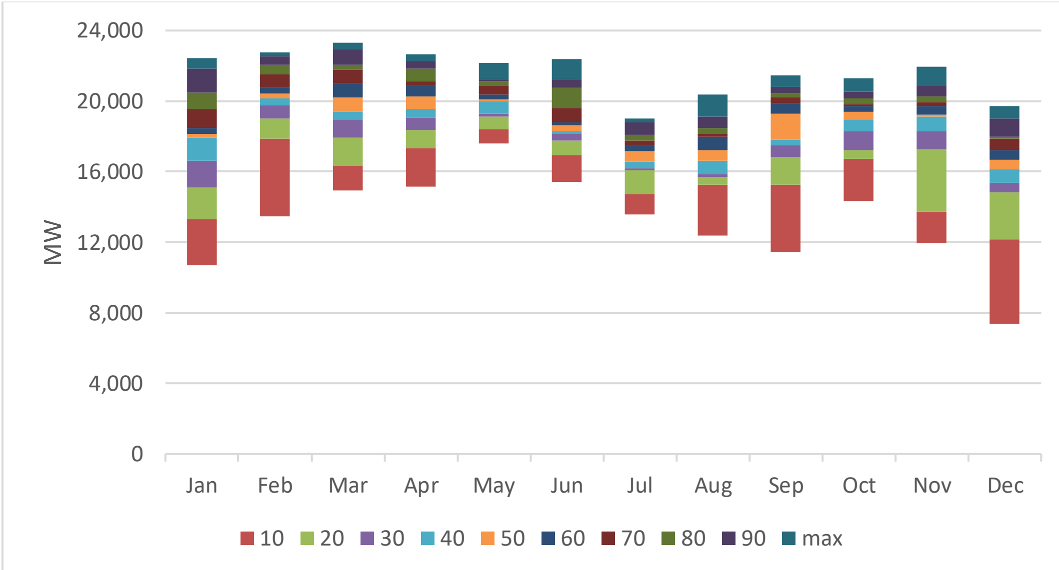
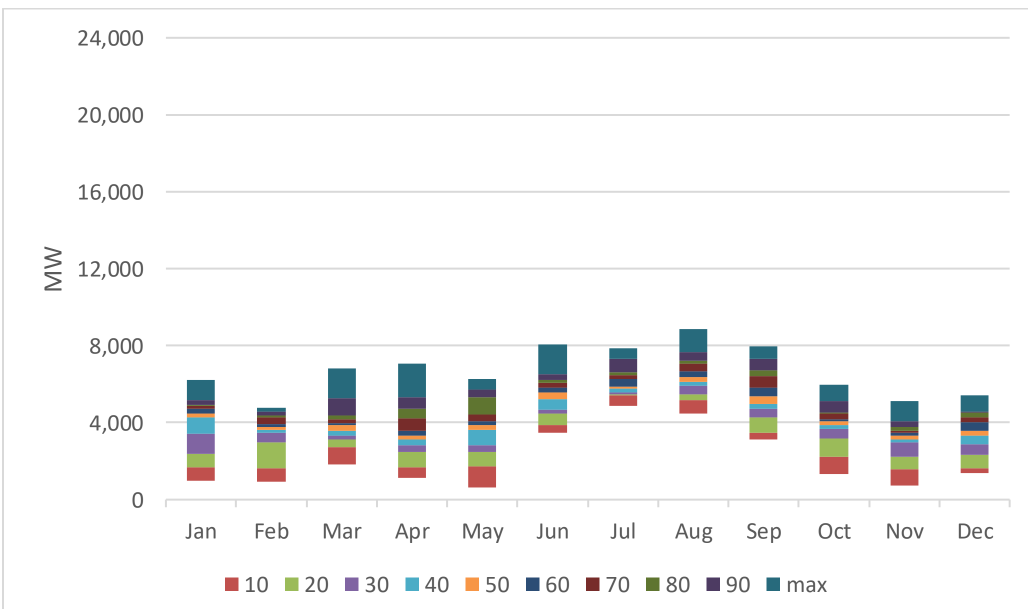


Figure 12: Percentile Distribution of Secondary Three-hour Net load Ramps for 2023



As shown in Figure 11 and Figure 12, there are certain variations for the primary and the secondary ramps over the months. These variations may have some impact on the ratios of maximum secondary ramp over maximum of primary ramp in each month. To reduce the potential impact of these ratios, which defines the values of base category in the flexible requirement, the ISO substitutes the seasonal averages of the ratios into the ratio in each months. Here, summer is May through September, and winter is October to February. Table 4 shows the unadjusted and adjusted percentages used in calculating the base category over the months.

Table 4: Unadjusted Monthly Ratio and Adjusted Seasonal Ratio

	Actual Contributions			Seasonal Contribution		
	Unadjusted			Adjusted		
Month	Base Flexibility	Peak Flexibility	Super-Peak Flexibility	Base Flexibility	Peak Flexibility	Super-Peak Flexibility
January	28%	67%	5%	27%	68%	5%
February	21%	74%	5%	27%	68%	5%
March	29%	66%	5%	27%	68%	5%
April	31%	64%	5%	27%	68%	5%
May	28%	67%	5%	37%	58%	5%
June	36%	59%	5%	37%	58%	5%
July	41%	54%	5%	37%	58%	5%
August	44%	51%	5%	37%	58%	5%
September	37%	58%	5%	37%	58%	5%
October	28%	67%	5%	27%	68%	5%
November	23%	72%	5%	27%	68%	5%
December	27%	68%	5%	27%	68%	5%

As shown in Figure 11, the distribution (i.e. the height of the distribution for each month) of the daily maximum three-hour net load ramps are smaller during the summer months. The base flexibility resources were designed to address days with two separate net load ramps. The distributions of these secondary net load ramps indicates that the ISO does not need to set seasonal percentages in the base flexibility category at the percentage of the higher month within that season. Accordingly, the ISO must ensure there is sufficient base ramping for all days of the month. Furthermore, particularly for summer months, the ISO did not identify two distinct ramps each day. Instead, the secondary net load ramp may be a part of single long net load ramp.

The distributions of the primary and secondary ramps provide additional support for the summer/non-summer split. Accordingly, the ISO proposes to maintain two flexible capacity needs seasons that mirror the existing summer season (May through September) and non-summer season (January through April and October through December) used for resource adequacy. This approach has two benefits.

First, it mitigates the impact that variations in the net load ramp in any given month can have on determining the amounts for the various flexible capacity categories for a given season. For example, a month may have either very high or low secondary ramps that are simply the result of the weather in the year. However, because differences in the characteristics of net load ramps are largely due to variations in the output of variable energy resources, and these variations are predominantly due to weather and seasonal conditions, it is reasonable to break out the flexibility categories by season. Because the main differences in weather in the ISO system are between summer and non-summer months, the ISO proposes to use this as the basis for the seasonal breakout of the needs for the flexible capacity categories.

Second, adding flexible capacity procurement to the RA program will increase the process and information requirements. Maintaining a seasonal demarcation that is consistent with the current RA program will reduce the potential for errors in resource adequacy showings.

With more penetration of renewable energy in the ISO market, the daily net load shape shows gradual dominance of primary ramp over years, see Table 1. The ISO continues to show an increase in the need of peak category resources, due to the increasing growth of the secondary ramp during sunset.

Table 5: Change in peak category weighting over the past three years

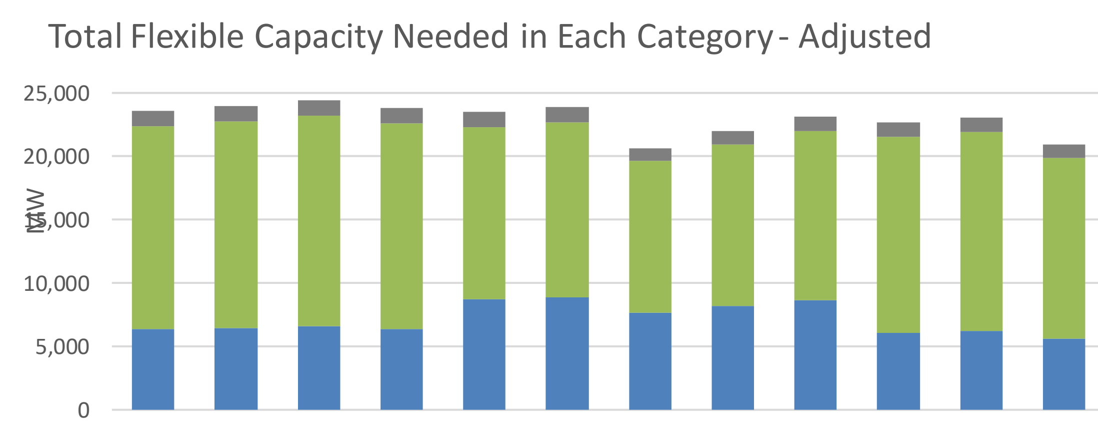
Month	2021	2022	2023	2024
January	57.30%	55.06%	62.74%	68.11%
February	57.30%	55.06%	62.74%	68.11%
March	57.30%	55.06%	62.74%	68.11%
April	57.30%	55.06%	62.74%	68.11%
May	45.62%	45.39%	49.28%	57.75%
June	45.62%	45.39%	49.28%	57.75%
July	45.62%	45.39%	49.28%	57.75%
August	45.62%	45.39%	49.28%	57.75%
September	45.62%	45.39%	49.28%	57.75%
October	57.30%	55.06%	62.74%	68.11%
November	57.30%	55.06%	62.74%	68.11%
December	57.30%	55.06%	62.74%	68.11%

6.3 Calculate a Simple Average of the Percent of Base Flexibility Needs

The ISO calculated the percentage of base flexibility needed using a simple average of the percent of base flexibility needs from all months within a season. Based on that calculation, the

ISO proposes that flexible capacity meeting the base-flexibility category criteria comprise 27 percent of the ISO system flexible capacity need for the non-summer months and 37 percent for the summer months. Peak flexible capacity resources could be used to fulfill 68 percent of non-summer flexibility needs and 58 percent of summer flexible capacity needs. The super-peak flexibility category is fixed at a maximum five percent across the year. We have observed over the years that the base flexibility category percentages continue to lower where the peak flexible capacity percentages continue to rise. As with the increase in the flexible capacity need, the change is largely attributable to the continued growth of both grid connected and behind-the-meter solar. As the gird connected solar and the incremental behind-the-meter solar continue to grow we are seeing an increase in the down-ramp associated with sunrise, especially during the shoulder months where there is minimal heating or cooling load. The ISO's proposed system-wide flexible capacity categories are provided in Figure 13.

Figure 13: System-wide Flexible Capacity Need in Each Category for 2024 -Adjusted



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Super-Peak Flexibility	1,179	1,196	1,222	1,191	1,174	1,195	1,033	1,101	1,157	1,133	1,154	1,045
Peak Flexibility	16,062	16,296	16,650	16,222	13,564	13,802	11,927	12,716	13,361	15,430	15,720	14,235
Base Flexibility	6,341	6,434	6,574	6,404	8,747	8,901	7,692	8,201	8,617	6,092	6,206	5,620

7. Allocating the Flexible Capacity Needs to Local Regulatory Authorities

The ISO's allocation methodology is based on the contribution of a local regulatory authority's LSEs to the maximum three-hour net load ramp.

Specifically, the ISO calculated the LSEs under each local regulatory authority's contribution to the flexible capacity needs using the following inputs:

1) The maximum of the most severe single contingency or 3.5 percent of forecasted peak load for each LRA based on its jurisdictional LSEs' peak load ratio share

2) Δ Load – LRA's average contribution to load change during the top five daily maximum three-hour net load ramps within a given month from the previous year times total change in ISO load

3) Δ Wind Output – LRA's average percent contribution to changes in wind output during the five greatest forecasted three-hour net load changes times ISO total change in wind output during the largest three-hour net load change

4) Δ Solar PV – LRA's average percent contribution to changes in solar PV output during the five greatest forecasted three-hour net load changes times total change in solar PV output during the largest three-hour net load change

These amounts are combined using the equation below to determine the contribution of each LRA, including the CPUC and its jurisdictional load serving entities, to the flexible capacity need.

Flexible Capacity Need = Δ Load – Δ Wind Output – Δ Solar PV +

*Max(MSSC, 3.5% * Expected Peak * Peak Load Ratio Share)*

The above equation can be simply expressed as

$$\textit{Flex Requirement} = \Delta NL_{2024} + R_{2024}$$

$$= \Delta L_{2024} - \Delta W_{2024} - \Delta S_{2024} + R_{2024}$$

The ISO uses the following symbols to illustrate the evolution of allocation formula:

*L (load), W (wind), S (solar), and NL(net load), R (reserve) = max(MSCC, 3.5*peak_load),*

NL = L – W – S,

ΔNL = ΔL – ΔW – ΔS,

Where

Δ is denoted as Ramp*,*

ΔNL_{2024} Net Load Ramp Req in 2023,

$\Delta NL_{sc,2024}$ Net Load Ramp Allocation for LSC in 2024,

pl_r_{lsc} CEC peak load ratio, and finally,

Σ the summation of all LSC.In 2022, the ISO has forecasts from CEC L_{2024}, where survey results from $W_{2024} = \Sigma W_{lsc, 2024}$, $S_{2024} = \Sigma S_{lsc, 2024}$, and all the estimated ramps are ΔL_{2024}, ΔW_{2024}, ΔS_{2024}, plus R_{2024}. Moreover, the ISO has the peak load ratio list from CEC which totals to 100 percent, $\Sigma pl\_r_{lsc} = 1$.

Based the above information, the allocation for wind, solar, and reserve portion of flexible need is straight forward as follows

$$Flex\ Need = \Delta NL_{2024} + \Sigma pl\_r_{lsc} * R_{2024}$$

$$= \Delta L_{2024} - \frac{\Sigma W_{lsc, 2024}}{W_{2024}} * \Delta W_{2023} - \frac{\Sigma S_{lsc,2024}}{S_{2024}} * \Delta S_{2024} + \Sigma pl\_r_{lsc} * R_{2024}$$

Since the ISO has no pre-knowledge of, $\Delta L_{lsc,y+2}$, the load ramp at LSE level in future year $y + 2$ at the current year $y = 2022$, the allocation of ΔL_{2024} to SC has been more challenging. Over the years, the ISO has used different approaches to meet the challenge.

In year 2014-2016, the ISO used an intuitive formula as

$$\frac{\Delta L_{lsc, y}}{\Delta L_y} \Delta L_{y+2},$$

where $\Delta L_y = \Sigma \Delta L_{lsc, y}$ is the summation of metered load ramp available at LSC level in year y. Later, the ISO realized this approach had a risk to unstable allocation, since the divider ΔL_y, the system load ramp can be zero or negative.

In year 2017-2018, the ISO employed the following formula

$$\Delta L_{lsc,y+2} = L^E_{lsc,y}\left(\frac{L^E_{y+2}}{L^E_y}\right) - L^S_{lsc,y}\left(\frac{L^S_{y+2}}{L^S_y}\right),$$

where $S =$ ramping start time, $E =$ramping end time.

The above seemingly a bit more complicated formula carefully avoided the potential zero divider ΔL_y, but later the ISO found out that it had a material drawback. Unlike the original formula used in 2014-2016, the revised formula carried little scalability for each SC, that is, the historical load ramp $\Delta L_{lsc, y}$ has no explicit impact on future $y + 2$ allocation $\Delta L_{lsc, y+2}$.

Starting from year 2019, the ISO proposed a new formula which best utilizes $\Delta L_{sc, y}$ while the system ΔL_y is not in the denominator,

$$\Delta L_{2024} = \Delta L_{2022} + (\Delta L_{2024} - \Delta L_{2022})$$

$$= \Sigma \Delta L_{lsc,\,2022} + \frac{\Sigma L^{M}_{lsc,\,2022}}{L^{M}_{2022}} * \left(\Delta L_{2024} - \Delta L_{2022}\right),$$

where ΔL_{2022} is the average load portion of top 5 maximum 2022 three-hour ramps and L^{M}_{2022} is the average load at beginning and the end of points during those top 5 ramps. In 2024, each LSC will receive:

$$\Delta L_{lsc,\,2022} + \frac{L^{M}_{lsc,\,2022}}{L^{M}_{2022}} * (\Delta L_{2024} - \Delta L_{2022})$$

Therefore each LSC's contribution $\Delta L_{lsc,\,2022}$ will be explicitly projected into future year 2024, and any additional increase of differences of average load portions $(\Delta L_{2024} - \Delta L_{2022})$ will be allocated by a load ratio share. The new calculation provides stable allocation for the load proportion.

Any LRA with a negative contribution to the flexible capacity need is limited to a zero megawatt allocation, not a negative contribution. As such, the total allocable share of all LRAs may sum to a number that is slightly larger than the flexible capacity need. The ISO does not currently have a process by which a negative contribution could be reallocated or used as a credit for another LRA or LSE.

The ISO will make all non-confidential working papers available and data that the ISO relied on for the Final Flexible Capacity Needs Assessment for 2024. Specifically, the ISO will post materials and data used to determine the monthly flexible capacity needs, the contribution of CPUC jurisdictional load serving entities to the change in load, and seasonal needs for each flexible capacity category. This data is available for download as a large Excel file named "2024 Flexible Capacity Needs Assessment – 2024 Net Load Data" here. The file above is the one-minute forecast from the CEC IEPR. The file titled "2024 Flexible Capacity Needs Assessment – 2024 Net Load Data Load Error Correction" has the one-minute data that was used during the three-hour ramp period that set the flexible capacity for each month, multitiplied by the load error correction value of 0.757 described above in Section 5. Table 6 shows the final calculations of the individual contributions, of each of the inputs to the calculation of the maximum three-hour continuous net load ramp at a system level.

Table 6: Individual Contributions of each Input into the Net Load

Month	Load contribution 2024	Wind contribution 2024	Solar contribution 2024	Total percent 2024
January	29.42%	-3.49%	-67.09%	100%
February	30.17%	0.78%	-70.61%	100%
March	25.39%	-0.94%	-73.68%	100%
April	28.49%	2.89%	-74.41%	100%
May	28.10%	-4.22%	-67.68%	100%
June	23.82%	-4.53%	-71.65%	100%
July	18.95%	4.58%	-85.64%	100%
August	20.35%	0.37%	-80.02%	100%
September	18.11%	-3.20%	-78.69%	100%
October	30.50%	-0.23%	-69.27%	100%
November	31.65%	-0.70%	-67.65%	100%
December	33.82%	-0.80%	-65.38%	100%

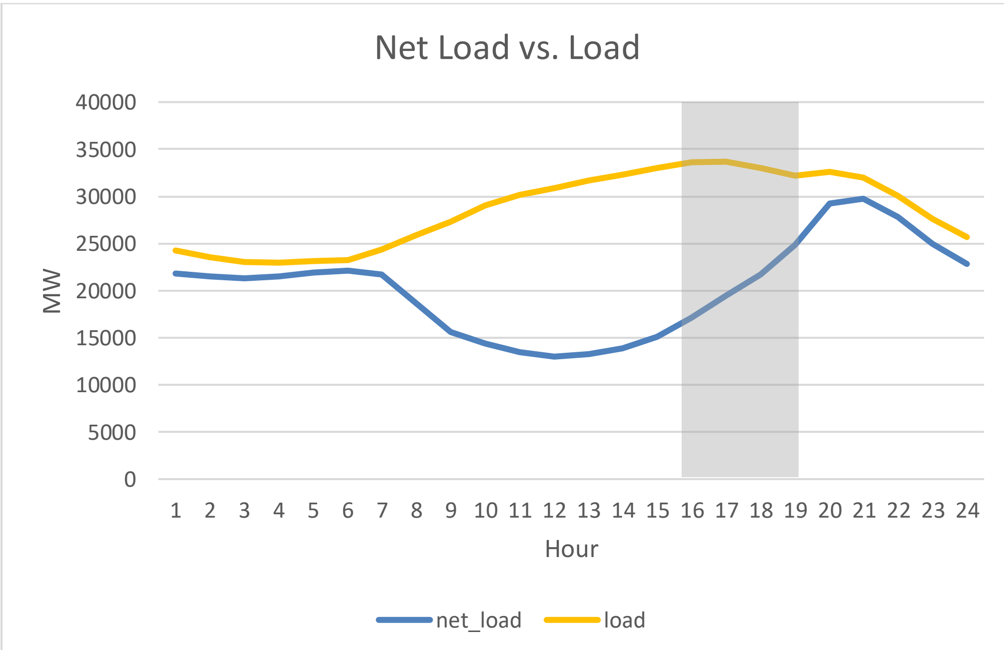
When looking at the contribution to the maximum three-hour continuous net load ramp shown in Table 6, the above total percentage is calculated as Load – Wind – Solar. For example, when looking at July 100 percent contribution is determined by:

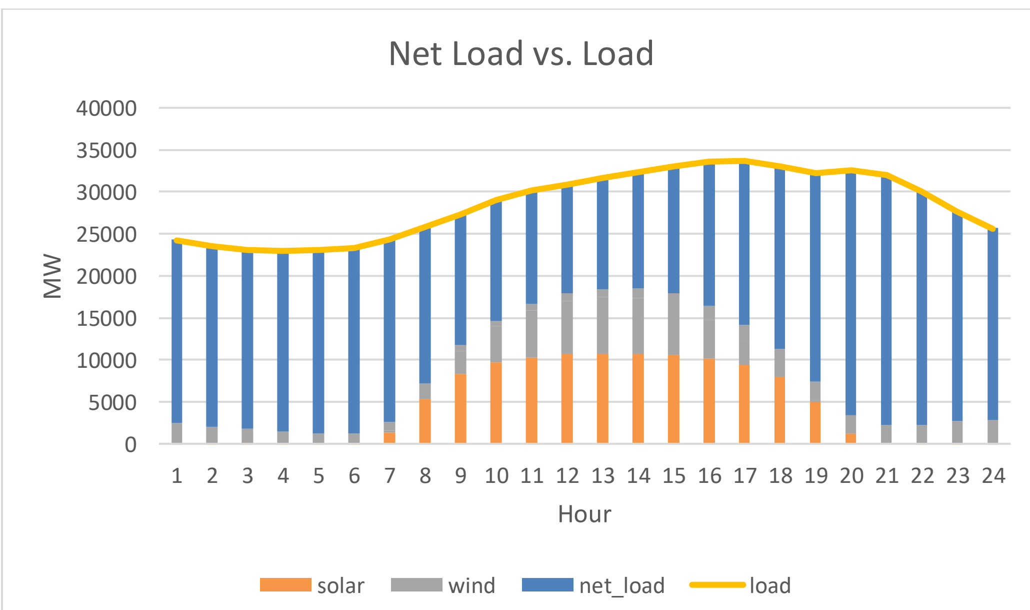
Total Contribution = 30.50%– 0.23% – (-69.27%) = 100%

As Table 6 shows, Δ Load is not the largest contributor to the net load ramp because the incremental solar PV mitigates morning net load ramps. The solar resources are leading to maximum three-hour net load ramps during summer months that occur in the afternoon. This is particularly evident during July and August. This implies that the maximum three-hour net load ramp typically occurs during sunset. The contribution of solar PV resources has increased relative to last year's study and remains a significant driver of the three-hour net load ramps. Since the CEC has behind meter solar imbedded in its 2023 hourly load forecast, the interplay between load and solar contributions will depend on the scales of future expansion of utility base solar PV and future installation of behind meter solar panels. The ISO anticipates more solar dominance in the ISO flexible needs in the coming years.

Figure **14** illustrates the behavior of load, wind, and solar when the net load reaches its maximum. In this example, the load ramp has a negative contribution to the net load ramp.

Figure 14: Examples of Load Contribution to Net Load Ramp





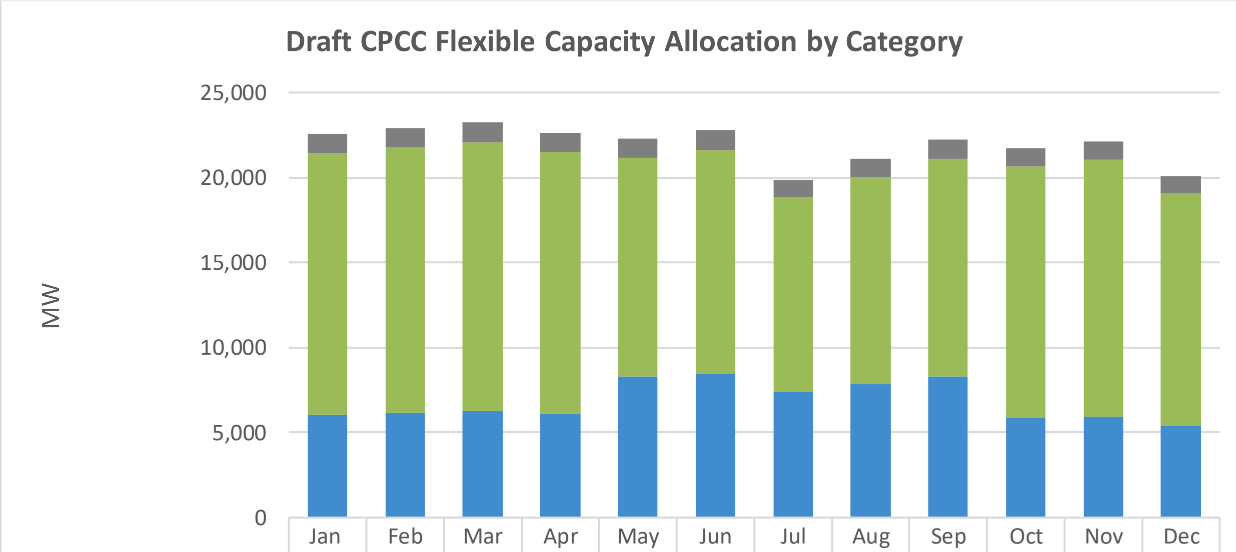
The CPUC allocations are shown in Table 7 and Figure 15. The contributions calculated for other LRAs will only be provided to show the contribution of its jurisdictional LRA as per section 40.10.2.1 of the ISO tariff.

Table 7: CPUC Jurisdictional LSEs' Contribution to Flexible Capacity Needs

Month	Load	Wind	Solar	reserve	Total Allocation
January	6,491	-736	-14,289	1,037	22,553
February	6,722	168	-15,320	1,036	22,910
March	5,722	-205	-16,284	1,036	23,247
April	6,210	617	-15,982	1,068	22,643
May	6,001	-881	-14,221	1,192	22,293
June	5,245	-953	-15,220	1,358	22,777
July	3,734	821	-15,463	1,459	19,836
August	4,208	71	-15,479	1,472	21,087
September	3,981	-647	-16,096	1,503	22,226
October	6,405	-46	-14,050	1,246	21,746
November	6,784	-145	-14,173	1,043	22,145
December	6,544	-148	-12,318	1,082	20,093

Finally, the ISO applied the seasonal percentage established in Section 6 to the contribution of CPUC jurisdictional load serving entities to determine the expected flexible capacity needed in each flexible capacity category. These results are detailed in Figure 15.

Figure 15: CPUC Flexible Capacity Need in Each Category for 2024



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Super-Peak Flexibility	1,128	1,145	1,162	1,132	1,115	1,139	992	1,054	1,111	1,087	1107	1005
Peak Flexibility	15,361	15,604	15,833	15,422	12,875	13,154	11,456	12,179	12,837	14,811	15083	13685
Base Flexiblity	6,065	6,160	6,251	6,089	8,303	8,483	7,388	7,854	8,278	5,847	5955	5403

8. Determining the Seasonal Must-Offer Obligation Period

Under ISO Tariff Sections 40.10.3.3 and 40.10.3.4, the ISO establishes the specific five-hour period during which flexible capacity counted in the peak and super-peak categories will be required to submit economic energy bids into the ISO's market (*i.e.*, have an economic bid must-offer obligation). The average net load curves for each month provide the most reliable assessment of whether a flexible capacity resource would provide the greatest benefit. The ISO analyzes the starting time of the calculated daily net load ramp to ensure the must-offer obligation hours line up with daily maximum three hour net load ramp and support the continuous net load need thereafter, which is typically correlated to the solar ramp down during sunset. Table 8 shows the frequency of forecasted starting hour for the three-hour net load ramp.

Table 8: Frequency of forecasted Starting Hour of the Maximum Three-Hour Net Load Ramp for 2024

	Three Hour Net Load Ramp Start Hour				
Month	HE14	HE15	HE16	HE17	HE18
January	4	27			
February		22	6		
March		2	15	14	
April				29	1
May				30	1
June				26	4
July			2	29	
August		1	7	23	
September		1	25	4	
October		10	21		
November	10	19	1		
December	4	27			

Table 9 below shows an early (HE15), start of the three-hour ramp pattern for November through February. For the months of March through August, the majority of days likely have a HE17 starting time of the three hour net load ramp. The fall shoulder months, September and October, have the starting time concentrated on HE16.

Table 9: Summary of MOO Hours Proposed by the ISO for 2024

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HE15-HE19	x	x									x	x
HE16-HE20									x	x		
HE17-HE21			x	x	x	x	x	x				

In summary, based on the data for all daily maximum three hour net load ramps, the ISO believes that the appropriate flexible capacity must-offer obligation for peak and super-peak flexible capacity categories is HE 15 through HE 19 for January and February, and November through December; HE 16 to HE 20 for September and October, HE 17 through HE 21 for March through August.

The ISO reviewed the timing of the top five net load ramps to confirm that the intervals captured the largest net load ramps. As shown above, the proposed intervals do, in fact, capture the intervals of the largest ramps. Both of these changes are consistent with continued solar growth and reflect the fact that the initial solar drop-off is a primary driver of the three-hour net load ramp. This is further supported by the contributing factors shown in Table 2, above.

9. Availability Assessment Hours

The availability assessment hours (AAH) were originally developed as part of the ISO standard capacity product and are maintained as part of the Reliability Service Initiative. This includes the RA Availability Incentive Mechanism (RAAIM). The goal of calculating the AAH is to determine the hours of greatest need to maximize the effectiveness of RAAIM by rewarding resources for being available during hours of greatest need.

To calculate the AAH, the ISO does the following:

1. Uses the CEC hourly IEPR forecast
2. Calculate the hourly average load by hour for each month for years 2022-2026
3. Calculate the top 5 percent of load hours within each month using the hourly load distribution in step 2

For this annual study, the draft recommendation for 2024 will be published and the estimated for years 2025 and 2026.

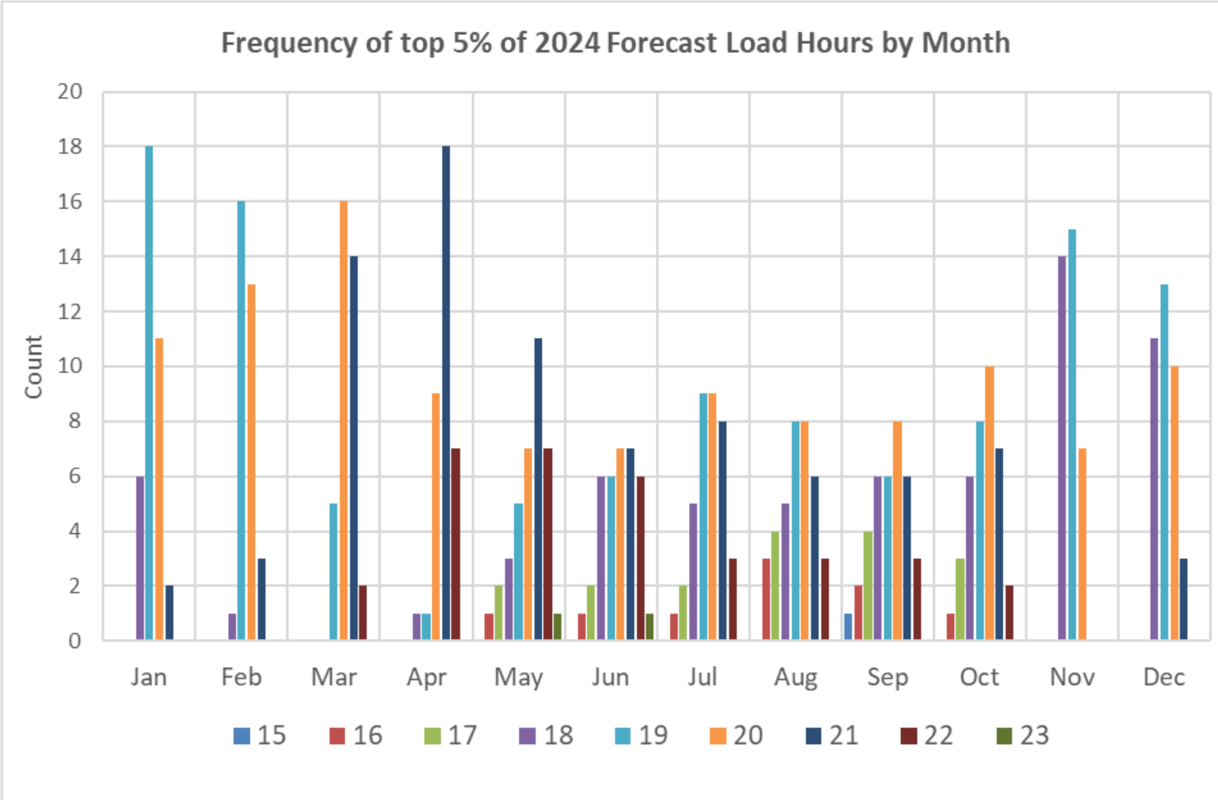
Historically, the AAH has had two seasons: winter (November-December, January – February), and summer (March – October) both with AAH of hour-ending 17-21 (4 p.m. – 9 p.m.). In the 2023 Flexible Capacity Study published in 2022, the ISO included the addition of a spring season for the months of March and April which had shown a shift to a later AAH to hour-ending 18-22 (5 p.m. – 10 p.m.). The addition of a spring season with later AAH was based on both the recent historical trends and the IEPR forecast for future years. For this year's study, the ISO is proposing another change to the spring season: the addition of May to the spring months based on recent historical actuals and trends in the IEPR forecast. Table 10 below shows the number of times each hour is within the top 5% of load hours for each month using the 2022 observed ISO load.

Table 10: Count of the number of times each hour is in the top 5% of load hours for each month of the 2022 load actuals

	Hour	7	8	9	10	11	13	14	15	16	17	18	19	20	21	22	23
MONTH	Jan											10	18	7	2		
	Feb	2	2									2	17	6	3	1	
	Mar											2	12	16	5	2	
	Apr							1	2	2	2	3	4	8	8	4	2
	May							1	1	2	3	4	6	8	8	3	1
	Jun									4	7	8	7	7	3		
	Jul								1	3	5	9	10	6	3		
	Aug									3	6	13	10	3	2		
	Sep						1	2	3	6	6	6	5	4	3		
	Oct									4	6	9	9	8	1		
	Nov				1	1						13	13	8			
	Dec		1	1								11	11	7	5	1	
	Grand Total	**2**	**3**	**1**	**1**	**1**	**1**	**4**	**7**	**24**	**35**	**90**	**122**	**88**	**43**	**11**	**3**

Looking at the distribution of the top 5% of load hours by month for the 2024 forecast in Figure 16, which is used to form the draft AAH, it shows a similar trend to 2022 actuals in Table 10. The 2024 forecast data also supports that HE17-21 has the highest frequency in the top 5% of load hours for the winter and summer months. This includes January- February and November – December for winter and June – October for summer. The spring months now include March – May for 2024 and the data in both Table 10 and Figure 16 show that for these months HE18-HE22 have the highest frequency of the top 5 percent of load hours.

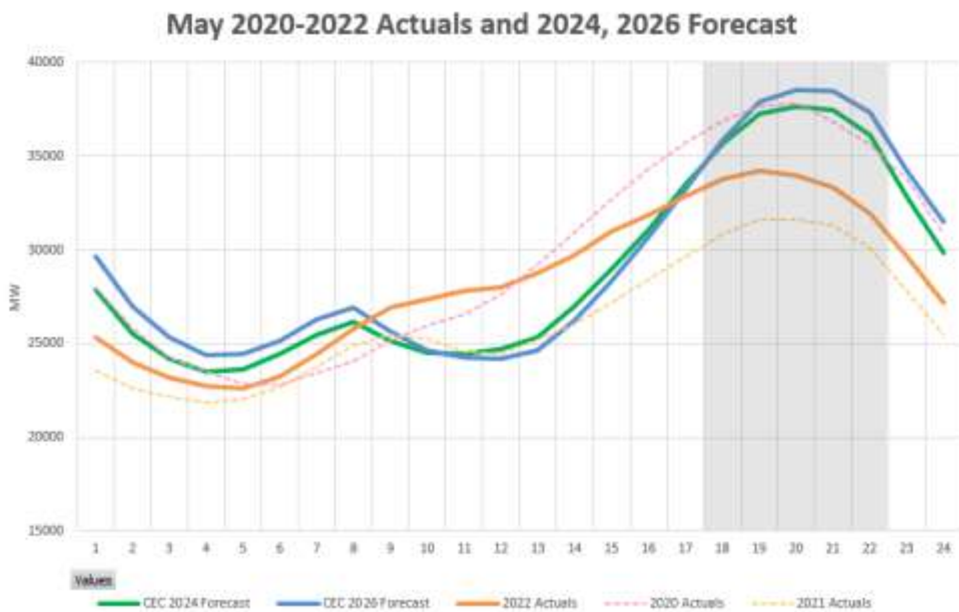
Figure 16: The frequency of the top 5% of load hours for the 2024 forecast

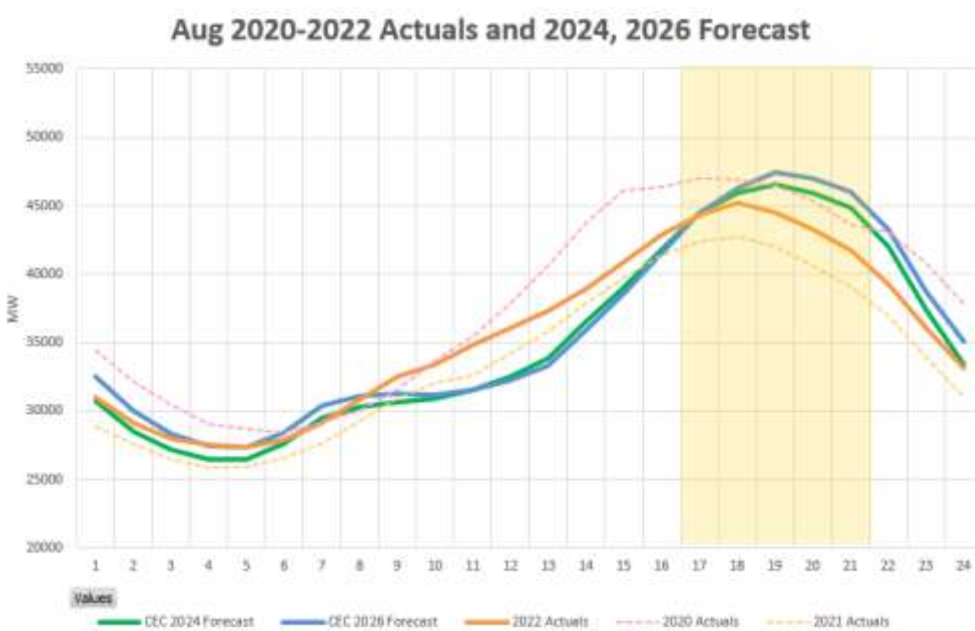


When analyzing the AAH, it is also beneficial to view the maximum observed and forecasted load for each month to visualize the forecasted load shape compared to recent actuals. The timing and shape of the load peak, as well as the magnitude and timing of the ramps into and out of load peak can all be impacted by weather events such as extreme heat for the given month or heavy rainfall. The most recent three years of actuals along with the CEC forecast for 2024 and 2026 are shown in Figure 17 and show how much the load actuals can vary by year for each month. In May for example, the 2020 actuals were about 5,000 MW higher than the 2021 actuals due to hot temperatures in May 2020. In November, 2022 had increased cloud cover and cooler temperatures, which led to higher mid-day loads in the actual data, that may not have been represented in the forecast. The rest of the months are included in the draft allocation presentation on the 2024 flex RA stakeholder page.[16]

[16] https://stakeholdercenter.caiso.com/RecurringStakeholderProcesses/Flexible-capacity-needs-assessment-2024

Figure 17: The May (top), August (middle) and November (bottom) maximum load actuals from 2020-2022 and maximum CEC forecast for 2024 and 2026





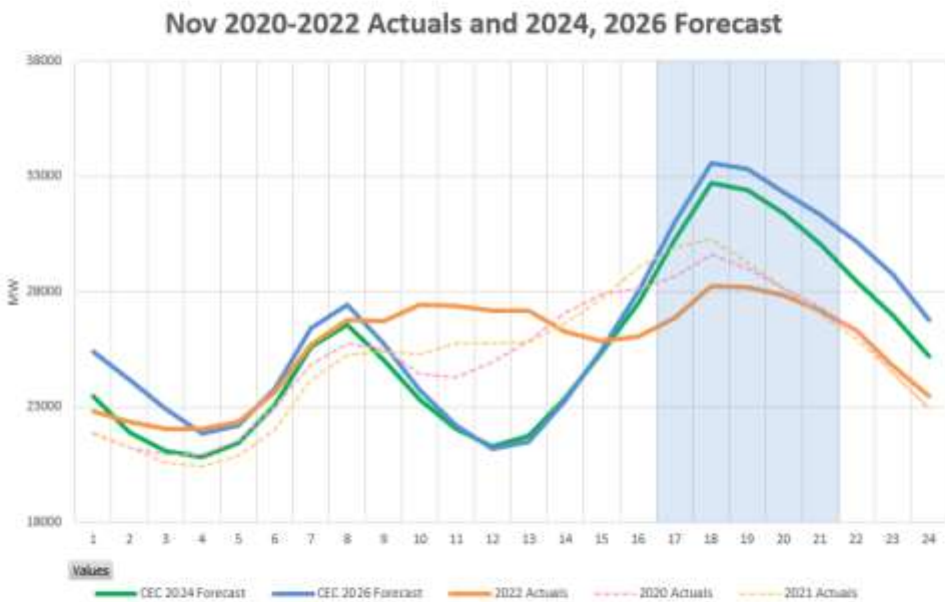


Table 11 below shows the draft recommendation for the winter, summer and spring seasons. For the 2023 final, May was a part of the summer season, but for the 2024-2026 draft and estimates, May is a part of the spring season.

Table 11: The AAH draft hour recommendation

Winter and Summer Season Draft Recommendation

Jan-Feb, Nov-Dec, Jun-Oct (also includes May for 2023)

Year	Start	End
2023 (Final)	HE 17	HE 21
2024 (Draft)	HE 17	HE 21
2025 (Estimate)	HE 17	HE 21
2026 (Estimate)	HE 17	HE 21

Spring Season Draft Recommendation

Mar-Apr for 2023; Mar-May for 2024-2026

Year	Start	End
2023 (Final)	HE 18	HE 22
2024 (Draft)	HE 18	HE 22
2025 (Estimate)	HE 18	HE 22
2026 (Estimate)	HE 18	HE 22

10. Next Steps

Comments on the 2024 Draft Flexible Capacity Needs Assessment and AAH are due on Wednesday, May 10, 2023. The ISO plans to publish the final Flexible Capacity Needs Assessment paper and final AAH for 2024 by May 17, 2023. The 2024 Flexible Capacity Needs Assessment to establish the ISO system flexible capacity needs for 2025 will begin in early 2024.