



Final Flexible Capacity Needs Assessment for 2018

April 28, 2017

Table of Contents

1. Introduction	3
2. Summary	3
3. Defining the ISO System-Wide Flexible Capacity Need	5
4. Forecasting Minute-by-Minute Net load	6
4.1 Building the Forecasted Variable Energy Resource Portfolio	6
4.2 Building Minute-by-Minute Net Load Curves	8
5. Calculating the Monthly Maximum Three-Hour Net load Ramps Plus 3.5 Percent Expected Peak-Load	8
6. Calculating the Seasonal Percentages Needed in Each Category	10
6.1 Calculating the Forecast Percentages Needed in Each Category in Each Month	11
6.2 Analyzing Ramp Distributions to Determine Appropriate Seasonal Demarcations	13
6.3 Calculate a Simple Average of the Percent of Base Flexibility Needs	15
7. Allocating the Flexible Capacity Needs to Local Regulatory Authorities	16
8. Determining the Seasonal Must-Offer Obligation Period	22
9. Next Steps	24
10. Appendix	25

1. Introduction

The ISO conducts an annual flexible capacity technical study to determine the flexible capacity needed to help ensure ISO system reliability as provided in ISO tariff section 40.10.1. The ISO developed 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 final flexible capacity needs assessment specifying the ISO's forecast flexible capacity needs in 2018.

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 attributable to individual local regulatory authorities (LRAs) other than the CPUC.

The ISO will use the results from the final study to allocate shares of the system flexible capacity¹ need 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 need.

2. Summary

The ISO determines the quantity of flexible capacity needed 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 developed in the FRAC-MOO stakeholder initiative and 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 2018 are --

- 1) The ISO made two enhancements to the 2018 study methodology.
 - a. The ISO did not receive an Additional Achievable Energy Efficiency (AAEE) profile from the CEC. Therefore, the ISO has removed of the shaped profile for AAEE from the study process.

- b.** The ISO modified the method used to calculate the delta load component of the flexible capacity requirements allocation after identifying instability in the flexible capacity allocations based on the contribution of Δ Load, particularly during summer months. The issue with the prior mathematical equation was that divisor in the allocation can become small and cause unstable, and anomalous results. The new methodology resolves the issue and produces more stable flexible capacity requirements allocations.

Item (b) is discussed in greater detail in Section 7, below.

- 2) System-wide flexible capacity needs are greatest in the non-summer months and range from 10,908 MW in July to 15,743 MW in December.
- 3) The minimum amount of flexible capacity needed from the “base flexibility” category is 54 percent of the total amount of installed or available flexible capacity in the summer months (May – September) and 38 percent of the total amount of flexible capacity for the non-summer months (October – April).
- 4) The ISO will establish 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 3:00 p.m. to 8:00 p.m. for May through September, and 2:00 p.m. to 7:00 p.m. for January through April and October through December. These hours are different from those in Final Flexible Capacity Needs Assessment for 2017.
- 5) In previous years, the ISO has published advisory requirements the two years following the upcoming RA year. At the time of publication, the ISO is processing results for 2019 and 2020. Once this data is processed, the ISO will issue advisory results for those years.

The ISO received data from all LSEs.

Only PG&E and the Center for Energy Efficiency and Renewable Technology (CEERT) submitted comments on the Draft Flexible Capacity Needs Assessment. The ISO’s response to these comments are contained in the appendix of this report.

3. Defining the ISO System-Wide Flexible Capacity Need

Based on the methodology described in the ISO tariff and the business practice manual,² the ISO calculated the ISO system-wide flexible capacity needs as follows:

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

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

ε = Annually adjustable error term to account for load forecast errors and variability methodology

For the 2018 RA compliance year, the ISO will continue to set 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) Forecast minute-by-minute net load using all expected and existing wind and solar resources and the most recent year of actual load, as adjusted for load growth;
- 2) Calculate the monthly system-level 3-hour net load ramps needs using forecast minute-to-minute net load forecast;
- 3) Calculate the percentages needed in each category in each month and add the contingency requirements into the categories proportionally to the percentages established calculated in step 2;
- 4) Analyze the distributions of both largest three-hour net load ramps for the primary and secondary net load ramps to determine appropriate seasonal demarcations;
- 5) Calculate a simple average of the percent of base flexibility needs from all months within a season; and
- 6) Determine each LRA's contribution to the flexible capacity need.

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

This methodology allows the ISO to make enhancements and assumptions based on its experience and new information becoming available. Based on its experience in the previous iteration of this study process, the ISO as noted above, the ISO has only made two minor modifications to the methodology used for the 2018 Flexible Capacity Needs Assessment: AAEE profiles are not included in the study and modified the method used to calculate the delta load component of the flexible capacity requirements allocation.

4. Forecasting Minute-by-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 the requisite information regarding the expected build-out of the fleet of variable energy resources. After obtaining this data from all LSEs, the ISO constructed the forecast minute-by-minute net load curves for 2017.

4.1 Building the Forecasted Variable Energy Resource Portfolio

To collect the necessary data, the ISO sent a data request on December 8, 2016 to the scheduling coordinators for all LSEs representing load in the ISO balancing area.³ The deadline for submitting the data was January 15, 2017. The ISO sent follow-up data requests to LSEs that did not submit data by the January 15 deadline. At the time of this report, the ISO has received data from all LSEs. The data request asked for information on each wind, solar, and distributed wind and solar resource that the LSE owns, in whole or in part, or is under contractual commitment to the LSE for all or a portion of its capacity. As part of the data request, the ISO asked for information on resources internal and external to the ISO. For resources that are external or pseudo-tie to the ISO, the ISO requested additional information as to whether the resource is or will be a dynamically scheduled or pseudo-tie resource. The ISO only included external or pseudo-tie resources in the flexible capacity requirements assessment if they were dynamic system dynamically or pseudo-tied into the ISO.

Based on ISO review of the responses to the data request, it appears that the information submitted represents all wind, solar, and distributed wind and solar resources that the LSE owns, in whole or in part, or is contractual committed to the LSE for all or a portion of its capacity within the ISO balancing area.

Using the LSEs' data, the ISO simulated the variable energy resources' output to produce forecast minute-by-minute net load curves⁴ for 2018. The forecasted aggregated variable energy resource fleet capacity is provided in Table 1.

³ A reminder notice was also sent out on January 4, 2017.

⁴ Net-load load is defined as load minus wind minus solar.

Table 1: Total ISO System Variable Energy Resource Capacity (Net Dependable Capacity-MW)⁵

Resource Type	Existing MW (2016)	2017 MW	2018 MW
ISO Solar PV	8,127	8,505	9,082
ISO Solar Thermal	1,193	1,183	1,178
ISO Wind	4,900	4,871	4,866
Incremental behind-the-meter Solar PV		1,604	1,725
Total Variable Energy Resource Capacity in the 2017 Flexible Capacity Needs Assessment ⁶	14,220	16,163	16,851
Non ISO Resources			
All external VERS not-firmed by external BAA		1,182	1,202
<i>Total internal and non-firmed external VERS</i>	14,220	17,345	18,053
Incremental New Additions in Each Year		3,125	708

Although Table 1 aggregates the variable energy resources system wide, the ISO conducted the assessment using location-specific information. This ensured that the assessment captured the geographic diversity benefits. Additionally, for existing solar and wind resources, the ISO used the most recent full year of actual solar output data available, which was 2016. For future wind resources, the ISO scaled overall wind production for each minute of the most recent year by the expected future capacity divided by the installed wind capacity of the most recent year. Specifically, to develop the wind profiles for wind resources, the ISO used the following formula:

$$2017 W_{\text{Mth_Sim_1-min}} = 2016 W_{\text{Act_1-min}} * 2017 W_{\text{Mth Capacity}} / 2016 W_{\text{Mth Capacity}}$$

Given the small amount of incremental wind resources coming on line, this approach allows the ISO to maintain the load/wind correlation for over 94% of the forecasted wind capacity output.

The ISO's assumptions for solar resources' production portfolios for future years were primarily based on the overall capacity of the new resources.

The ISO has also included incremental behind-the-meter solar production for behind-the-meter solar PV that occurs after 2016. Although existing behind-the-meter solar PV is captured by changes in the 2016 historic load, additional incremental behind-the-meter solar PV that is installed after 2016 is not captured in load. If this capacity is not fully accounted for it would lead to an undercounting of the net load ramps for future years. Therefore, the ISO has created an additional element to account for the incremental behind the meter solar PV resources in

⁵ 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.

⁶ Includes all internal variable energy resources

the calculation of the three hour net load ramp. Including this incremental capacity allows the ISO to more accurately capture the forecasted three hour net load ramp. Because behind-the-meter solar is solar PV, the ISO included the contribution of the incremental behind-the-meter as a subset of the Δ Solar PV, but provides a breakout of the contribution for purposes of determining an LRA's allocable share of the flexible capacity needs. The ISO has not identified a material change from including the behind-the-meter resources in the summer months at this time, but will continue to work with the CEC to determine if additional modifications are needed as part of the next flexible capacity technical needs study.

4.2 Building Minute-by-Minute Net Load Curves

The ISO used the CEC 2016 Integrated Energy Policy Report (IEPR) 1-in-2 monthly peak load forecast (Mid Demand Scenario, with mid-additional achievable energy efficiency) to develop minute-by-minute load forecasts for each month.⁷ The ISO scaled the actual load for each minute of each month of 2016 using an expected load growth factor of the monthly peak forecast divided by the actual 2016 monthly peak. The ISO used this same methodology in the 2017 assessment.

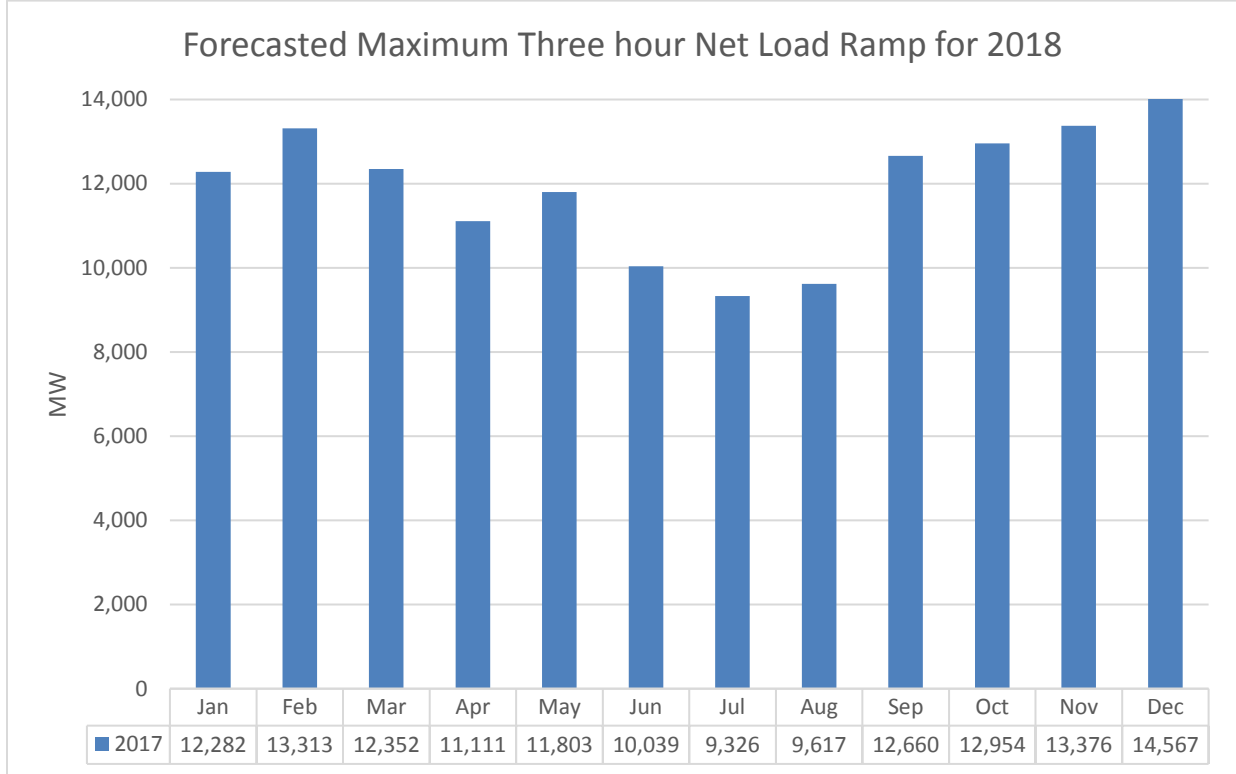
Using this forecasted load and expected wind and solar expansions, the ISO developed the minute-by-minute load, wind, and solar profiles. The ISO aligned these profiles and subtracted the output of the wind and solar resources from the load to generate the minute-by-minute net load curves necessary to conduct the flexible capacity needs assessment.

5. Calculating the Monthly Maximum Three-Hour Net load Ramps Plus 3.5 Percent Expected Peak-Load

The ISO, using the net load forecast developed in Section 4, calculated the maximum three-hour net load ramp for each month. The ISO system-wide, largest three-hour net load ramps for each month are detailed in Figure 1.

⁷ <http://www.energy.ca.gov/2014publications/CEC-200-2014-009/CEC-200-2014-009-SD.pdf>

Figure 1: ISO System Maximum 3-hour Net load Ramps

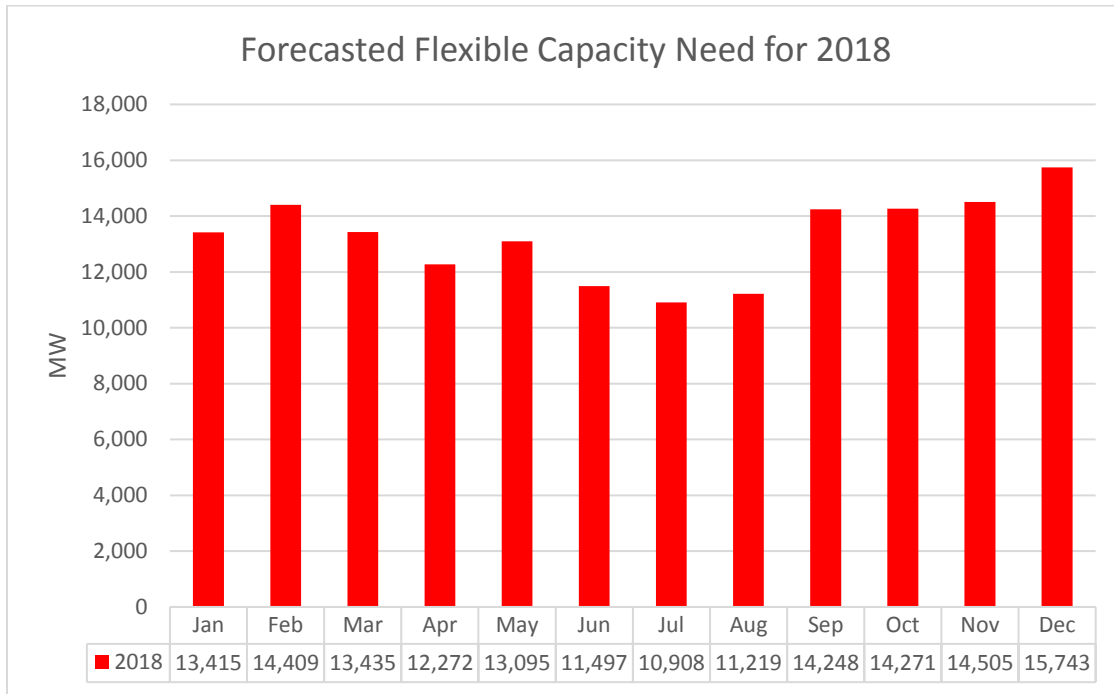


The results for the non-summer months of 2018 are higher than those predicted in the summer months. This is consistent with historical trends. Further, although the three hour net load ramps are forecasted to increase in each month, the differential between the summer maximums and the non-summer maximums remained fairly stable (approximately 5,000 MW difference between July and December).

As part of the 2018 Flexible Capacity Needs Assessment, the ISO assessed the weather patterns to identify anomalous results. As shown in Figure 1, flexible capacity needs follow a predictable pattern, whereby the flexible capacity needs for all summer months remain low relative to the flexible capacity needs for non-summer months. Finally, the ISO summed the monthly largest three-hour contiguous ramps and 3.5 percent of the forecast peak-load for each month.⁸ This sum yields the ISO system-wide flexible capacity needs for 2018. These totals are shown in Figure 2 below.

⁸ The most severe single contingency was consistently less than 3.5 expected peak-load.

Figure 2: ISO System Maximum 3-Hour Net load Ramps Plus 3.5 Percent of Forecast Peak Load



6. Calculating the Seasonal Percentages Needed in Each Category

As described in 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 define 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 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 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 3-hour secondary net load⁹ ramp

⁹ The largest daily secondary 3-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 3-hour net-load ramp

Peak Flexibility: Operational need determined by the difference between 95 percent of the maximum 3-hour net load ramp and the largest 3-hour secondary net load ramp

Super-Peak Flexibility: Operational need determined by five percent of the maximum 3-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:

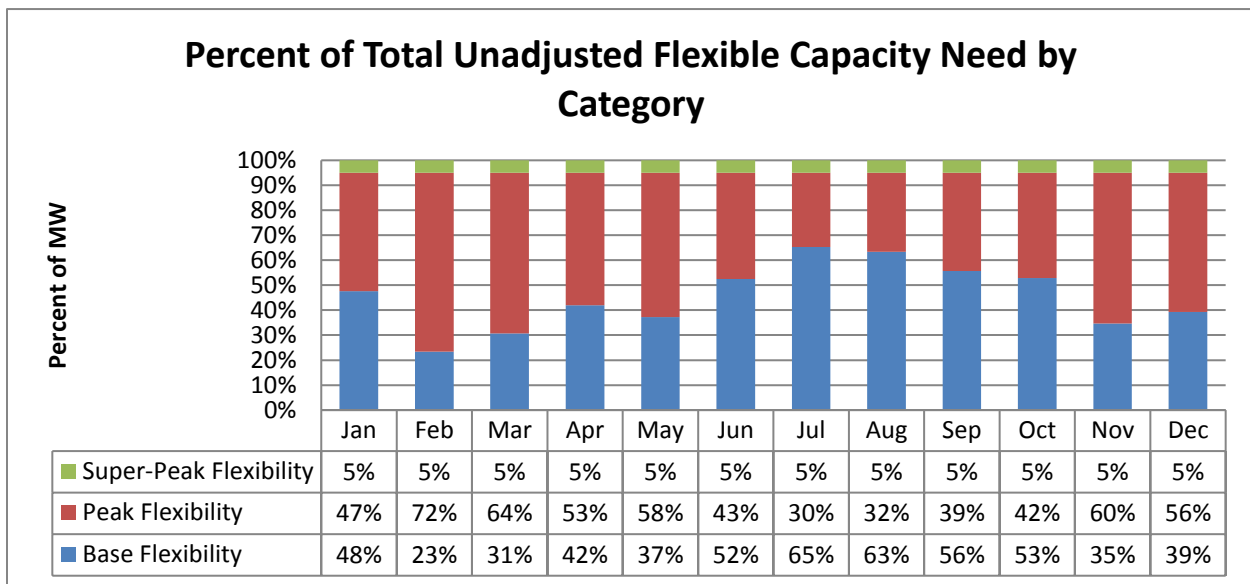
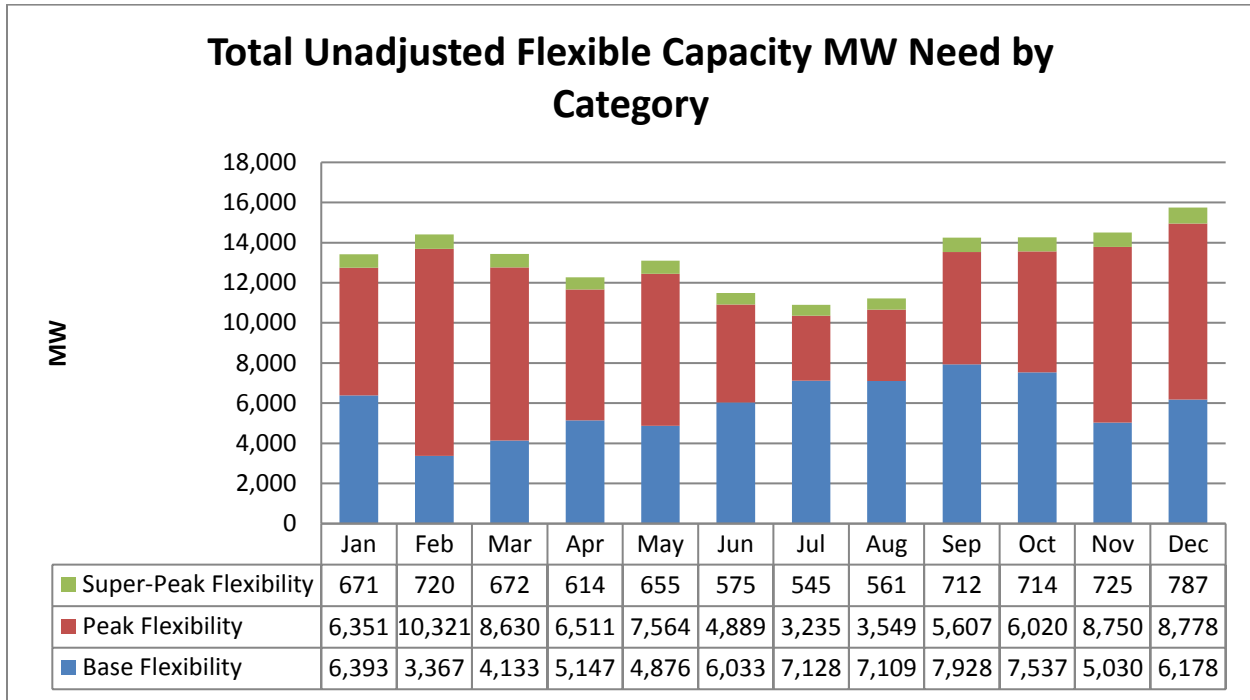
- 1) Calculate the forecast percentages needed in each category in each month;
- 2) Analyze the distributions of both largest three-hour net load ramps for the primary and secondary net load ramps to determine appropriate seasonal demarcations; and
- 3) Calculate a simple average of the percent of base 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 ISO calculated the system level needs for 2018 based only on the maximum monthly 3-hour net load calculation. Then the ISO calculated the quantity needed in each category in each month based on the above descriptions. The ISO calculated the secondary net load ramps to eliminate the possibility of over-lapping time intervals between the primary and secondary net load ramps. The ISO then added the contingency requirements into the categories proportionally to the percentages established by the maximum 3-hour net load ramp. For example, for the month of January, the ISO added 90 percent of the contingency reserves portion into the base flexibility category 1, 5 percent into the peak flexibility category 2, and the final 5 percent into the super-peak flexibility category 3. The calculation of flexible capacity needs for each category for 2018 is shown in Figure 3.

occurs between 5:00 p.m. and 8:00 p.m., then the largest secondary ramp would be determined by the largest morning 3-hour net-load ramp.

Figure 3: ISO System-Wide Flexible Capacity Monthly Calculation by Category for 2018

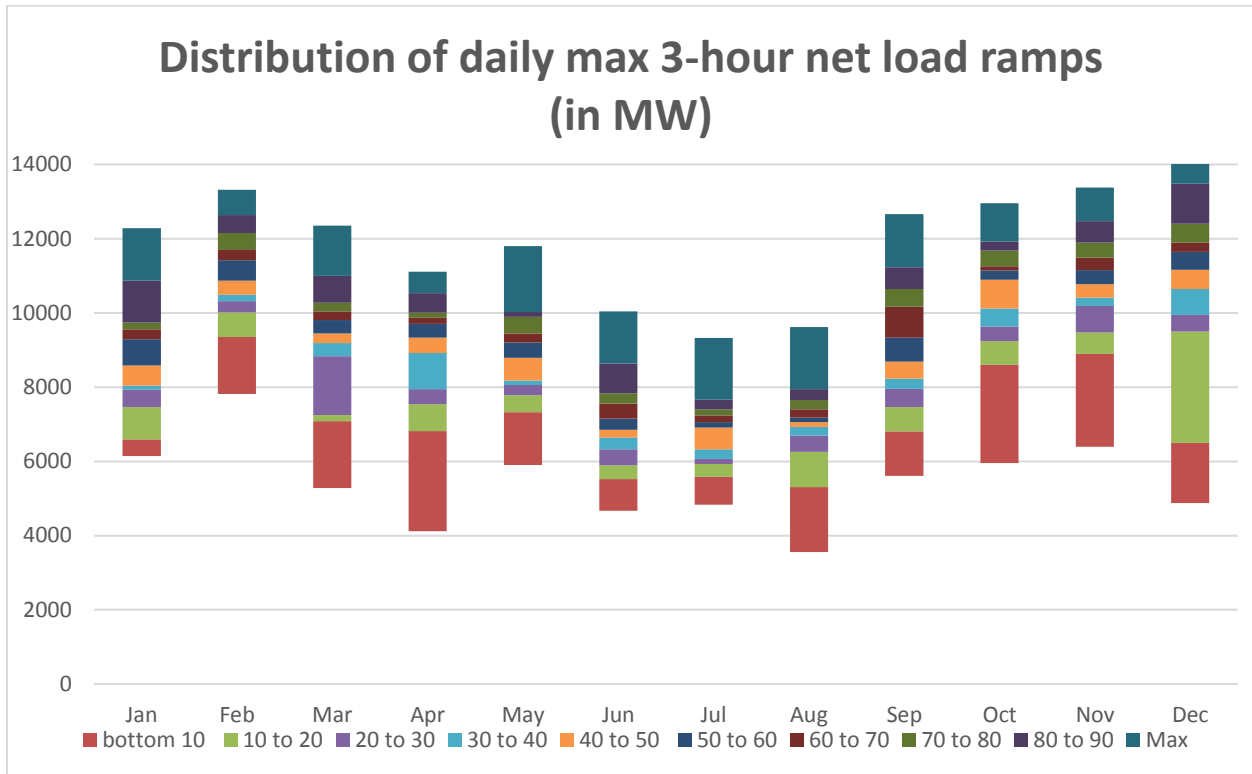


Again, the larger quantity of existing and incremental grid connected and behind-the-meter solar PV results in a greater difference between the primary and secondary net load ramps, particularly in the non-summer months. This results in a lower percent requirement for base flexible capacity resources compared to last year's study.

6.2 Analyzing Ramp Distributions to Determine Appropriate Seasonal Demarcations

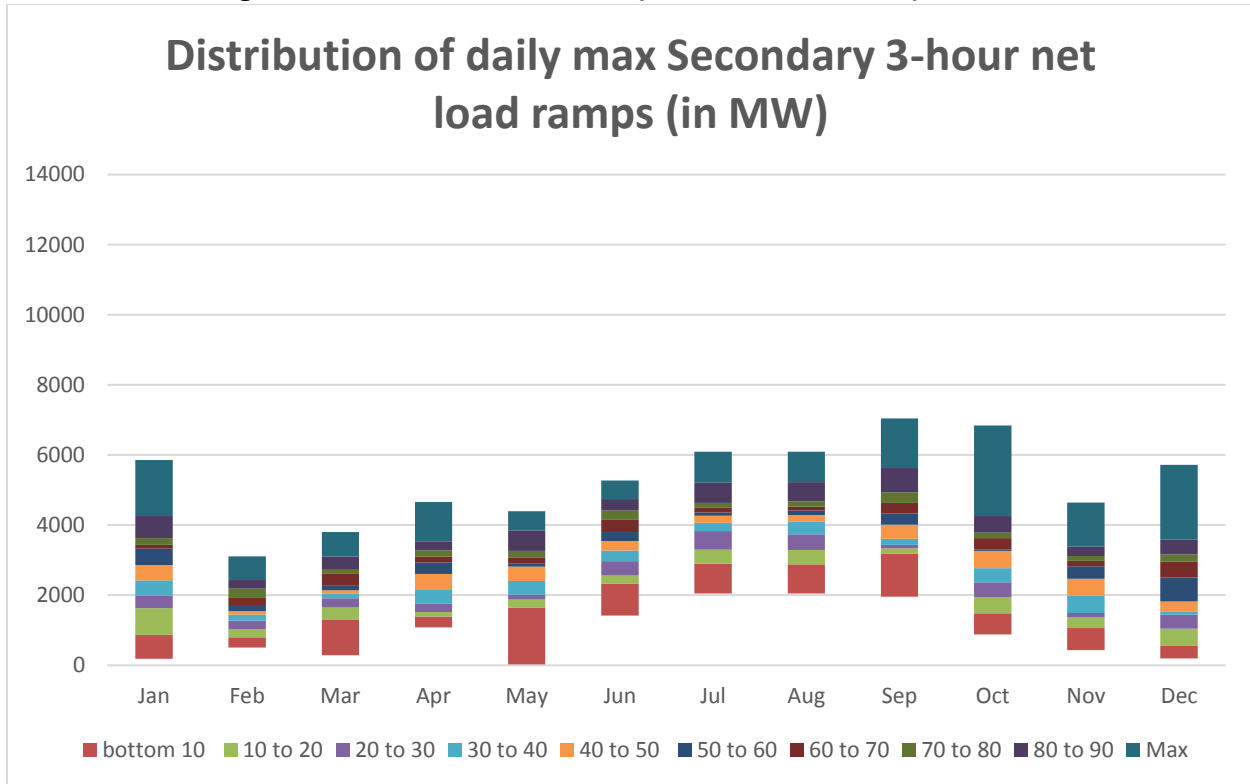
To determine the seasonal percentages for each flexible capacity category, the ISO analyzed the distributions of the largest three-hour net load ramps for the primary and secondary net load ramps to determine appropriate seasonal demarcations for the base flexibility category. The secondary net load 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 that is needed. Although this year’s assessment focused on the data produced in this study process, the ISO also referred back to last year’s¹⁰ assessment to confirm that the patterns persist. The primary and secondary net load ramp distributions are shown for each month in figures 4 and 5 respectively.

Figure 4: Distribution of Daily Primary 3-hour Net Load Ramps for 2018



¹⁰ Last year’s assessment refers to the 2014 Flexible Capacity Needs Assessment. The ISO has changed the naming convention to refer to the RA year, and not the year in which the study was conducted.

Figure 5: Distribution of Secondary 3-hour Net load Ramps for 2018



As Figure 4 shows, the distribution (*i.e.* the width of the distribution for each month) of the daily maximum three-hour net load ramps is slightly narrower during the summer months. The maximum three-hour net load ramps for May and September are slightly higher than seen in previous years. This is due in large part to these months being transitional months where some days resemble summer days, while other days resemble non-summer days. In other words, these months can exhibit a wide range of daily net-load profiles. Transitional months like May and September differ slightly from their seasonal counterparts, but not sufficiently to warrant changes to any seasonal treatment for those months. Further, the daily secondary three-hour net load ramps are also similar, except for May and September.¹¹ These distributions indicate two things. First, given the breadth of this distribution, it is unlikely that all base flexible capacity resources will be used for two ramps every day. The base flexibility resources were designed to address days with two separate significant 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. Second, because there are still numerous bimodal ramping days in the distribution, many of the base flexibility resources will still be needed to address bimodal ramping needs. Accordingly, the ISO must ensure there is sufficient base ramping for all days of the month.

¹¹ The secondary net load ramp for May 20 was deleted due to the fact that it was clear outlier, at 9,279 MW.

Further, 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.

Figures 3-5 shows that the seasonal divide established in last year's assessment remains reasonable. 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.

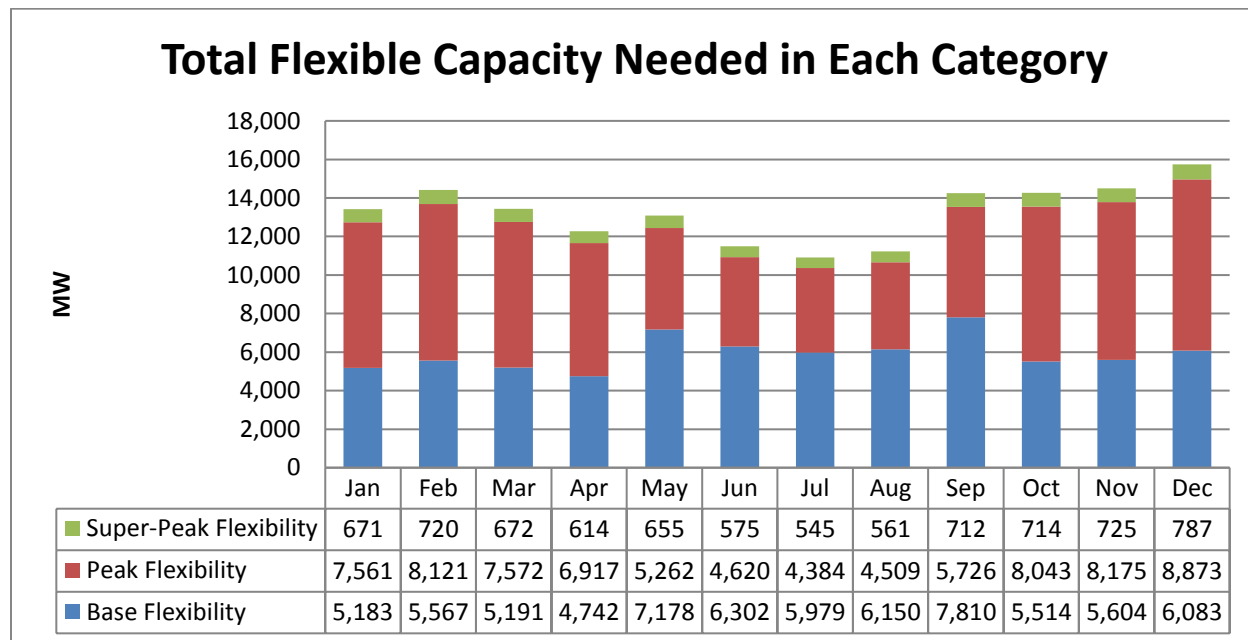
Second, adding flexible capacity procurement to the RA program will increase the process and information requirements. Maintaining a seasonal demarcation that is consistent with the current RA program will reduce the potential for errors in resource adequacy showings.

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 38 percent of the ISO system flexible capacity need for the non-summer months and 55 percent for the summer months. Peak flexible capacity resources could be used to fulfill up to 38 percent of non-summer flexibility needs and 55 percent of summer flexible capacity needs. The super-peak flexibility category is fixed at a maximum five percent across the year. These percentages are significantly different than those of in the 2017 Flexible Capacity Needs Assessment. 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. The increase in grid connected solar and incremental behind-the-meter solar will reduce the secondary net load ramp in the non-summer months, but will increase the primary net load ramp, which reduces the percentage of base-ramping capacity in the non-summer months.

However, it would have the opposite effect in the summer months. The ISO’s proposed system-wide flexible capacity categories are provided in Figure 6.

Figure 6: System-wide Flexible Capacity Need in Each Category for 2018



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 3-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 top five daily maximum three-hour net load ramps within a given month from the previous year x total change in ISO load
- 3) Δ Wind Output – LRA’s average percent contribution to changes in wind output during the five greatest forecasted 3-hour net load changes x ISO total change in wind output during the largest 3-hour net load change

- 4) Δ Solar PV – LRA’s average percent contribution to changes in solar PV output during the five greatest forecasted 3-hour net load changes x total change in solar PV output during the largest 3-hour net load change
- 5) Δ BTM Solar – LRA’s average percent contribution to changes in BTM solar PV output during the five greatest forecasted 3-hour net load changes x total change in BTM solar output during the largest 3-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.

$$\text{Flexible Capacity Need} = \Delta \text{ Load} - \Delta \text{ Wind Output} - \Delta \text{ Solar PV} - \Delta \text{ BTM Solar} + (3.5\% * \text{Expected Peak} * \text{Peak Load Ratio Share})$$

In the Flexible Capacity Needs Assessment for 2017, the ISO started to identify instability in the flexible capacity allocations based on the contribution of Δ Load, particularly during summer months. The ISO, as part of its February 1, 2017 stakeholder call identified the need to modify the determination of Δ Load allocations as necessary for this year’s study process. As a primary assessment, the ISO calculated LRA’s allocation of Δ Load using last year’s methodology. The results demonstrated that the results were overly sensitive to small Δ Load on select days and could result in allocations in excess of flexible capacity needs for some LSE, while other LSEs would receive comparable negative allocations. As such, the ISO has calculated the average contribution of Δ Load using the change of the proportion of load at the end of the ramp minus the proportion of load at the start of the ramp. The resulting calculations provided stable results.

$$\Delta L_{sc,2018} = L_{sc,2016}^E \left(\frac{L_{2018}^E}{L_{2016}^E} \right) - L_{sc,2016}^S \left(\frac{L_{2018}^S}{L_{2016}^S} \right),$$

where $L = \text{Load}$,

2016 has metered load, 2018 has forecasted load

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

Subscript sc is for each RALSE scheduling coordinator.

Therefore, when sum (Σ) it over all sc , we have

$$\Sigma \Delta L_{sc,2018} = \Delta L_{2018}$$

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.¹² 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 is examining ways to address this issue as part of the Flexible Resource Adequacy Criteria and Must Offer Obligation – Phase 2 stakeholder initiative.

The ISO has made available all non-confidential working papers and data that the ISO relied on for the Final Flexible Capacity Needs Assessment for 2018.¹³ Specifically, the ISO has posted 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 at

http://www.caiso.com/Documents/2018DraftFlexibleCapacityNeedsAssessment_2018NetLoadData.xlsx.

Table 2 shows the final calculations of the individual contributions of each of the inputs to the calculation of the maximum 3-hour continuous net load ramp at a system level.

¹² Some small LRAs had negative contributions to the flexible capacity needs. The ISO is proposing to change this limitation as part of the Flexible Resource Adequacy Criteria and Offer Obligation – Phase 2 stakeholder initiative. However, this initiative is not yet complete, and thus the ISO cannot modify this rule.

¹³ There were no revisions to the data posted for the draft report.

Table 2: Contribution to Maximum 3-hour Continuous Net load Ramp for 2018

Month	Average of Load contribution 2018	Average of Solar PV contribution 2018	Average of BTM Solar contribution 2018	Average of Wind contribution 2018	Total percent 2018
January	39.99%	-55.68%	-4.85%	0.53%	100%
February	38.51%	-54.40%	-4.57%	-2.52%	100%
March	31.60%	-59.86%	-7.63%	-0.91%	100%
April	21.23%	-70.60%	-8.93%	0.76%	100%
May	14.80%	-71.96%	-7.28%	-5.95%	100%
June	8.87%	-80.17%	-9.57%	-1.38%	100%
July	5.76%	-83.32%	-11.55%	0.64%	100%
August	11.19%	-86.89%	-12.40%	10.48%	100%
September	16.45%	-73.16%	-10.35%	-0.03%	100%
October	21.34%	-64.77%	-10.30%	-3.59%	100%
November	28.04%	-60.41%	-9.98%	-1.56%	100%
December	42.44%	-48.38%	-5.90%	-3.28%	100%

As Table 2 shows, Δ Load is not the largest contributor to the net load ramp during the summer months because the incremental solar PV mitigates morning net load ramps. This changed the timing of the largest net load ramps and changed the Δ Load impact on the net load ramps. However, the percentage contribution of load to the net load ramp is down in all months compared to last year’s study. Again, this is attributable to the inclusion of the incremental behind-the-meter solar resources. The behind-the-meter solar resources are leading to maximum three-hour net load ramps during summer months that occur in the afternoon. This is particularly evident during August, when the contribution of delta load is negative. This implies that load is less at the end of the net load ramp than it was at the beginning. This is caused by the timing of the largest three net load ramp in August. It typically occurs midday and when both load and solar are decreasing. Further, 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.

Consistent with the ISO’s flexible capacity needs allocation methodology, the ISO used 2016 actual load data to determine each local regulatory authority’s contribution to the Δ Load component. The ISO calculated minute-by-minute net load curves for 2016. Then, using the same methodology it used for determining the maximum 3-hour continuous net load ramp described above, the ISO calculated the maximum three-hour net load ramps for 2016 and applied the Δ load calculation methodology described above. The ISO used settlements data to determine the LRA’s contribution the Δ load component. This data is generated in 10-minute

increments. This number may be the same for some LSEs over the entire hour. The ISO smoothed these observations by using a 60-minute rolling average of the load data. This allowed the ISO to simulate a continuous ramp using actual settled load data.

Based on this methodology, the ISO determined the flexible capacity need attributable to the CPUC jurisdictional LSEs.¹⁴ Table 3 shows the CPUC jurisdictional LSEs’ combined relative contribution to each of the each of the factors (Δ Load, Δ Wind, Δ Solar PV, and Δ BTM Solar) included in the allocation methodology.

Table 3: CPUC Jurisdictional LSEs’ Contribution to Flexible Capacity Needs¹⁵

	Δ Load	Δ PV Fixed	Δ BTM Solar	Δ Wind
Jan	93.34%	92.01%	99.01%	87.43%
Feb	89.64%	92.06%	99.01%	87.31%
Mar	101.99%	92.07%	99.01%	87.32%
Apr	114.01%	92.12%	99.01%	87.23%
May	105.85%	92.12%	99.01%	87.16%
Jun	98.70%	92.12%	99.01%	87.11%
Jul	102.03%	92.12%	99.01%	87.01%
Aug	124.09%	92.12%	99.01%	87.02%
Sep	104.70%	92.28%	99.01%	87.08%
Oct	95.07%	92.28%	99.01%	87.22%
Nov	95.58%	92.28%	99.01%	87.23%
Dec	93.28%	92.39%	99.01%	87.15%

Finally, the ISO multiplied the flexible capacity needs from Figure 2 and the contribution to each factor to determine the relative contribution of each component at a system level. The ISO then multiplied the resultant numbers by the Local Regulatory Authority’s calculated contribution to each individual component. Finally, the ISO added the 3.5 percent expected peak load times the LRA’s peak load ratio share. The resulting CPUC allocations are shown in Table 4 and Figure 7. The contributions are calculated by LRA and LRA will only be provided the contribution of its jurisdictional LRA as per section 40.10.2.1 of the ISO tariff.

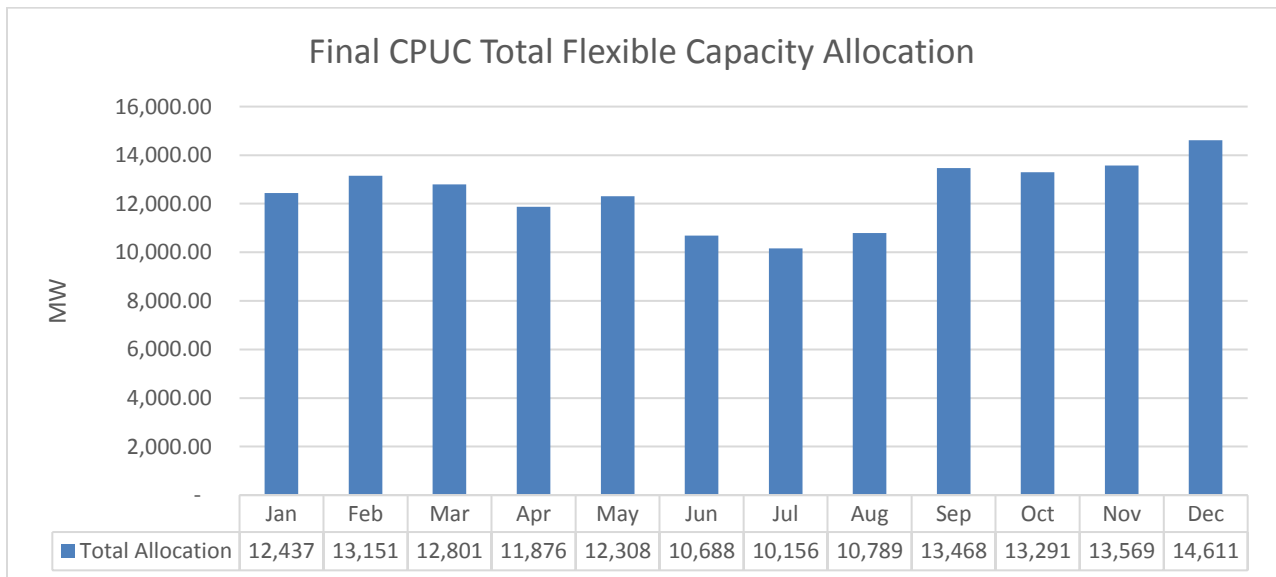
¹⁴ Because the Energy Division proposal states that the CPUC will allocate flexible capacity requirements to its jurisdictional LSEs based on peak load ratio share, the ISO has not calculated the individual contribution of each LSE.

¹⁵ Because of the geographic differences in the output, at some times one LRA’s resources could be reducing the net-load ramp while another’s could be increasing it.

Table 4: CPUC Jurisdictional LSEs' Contribution to Flexible Capacity Needs

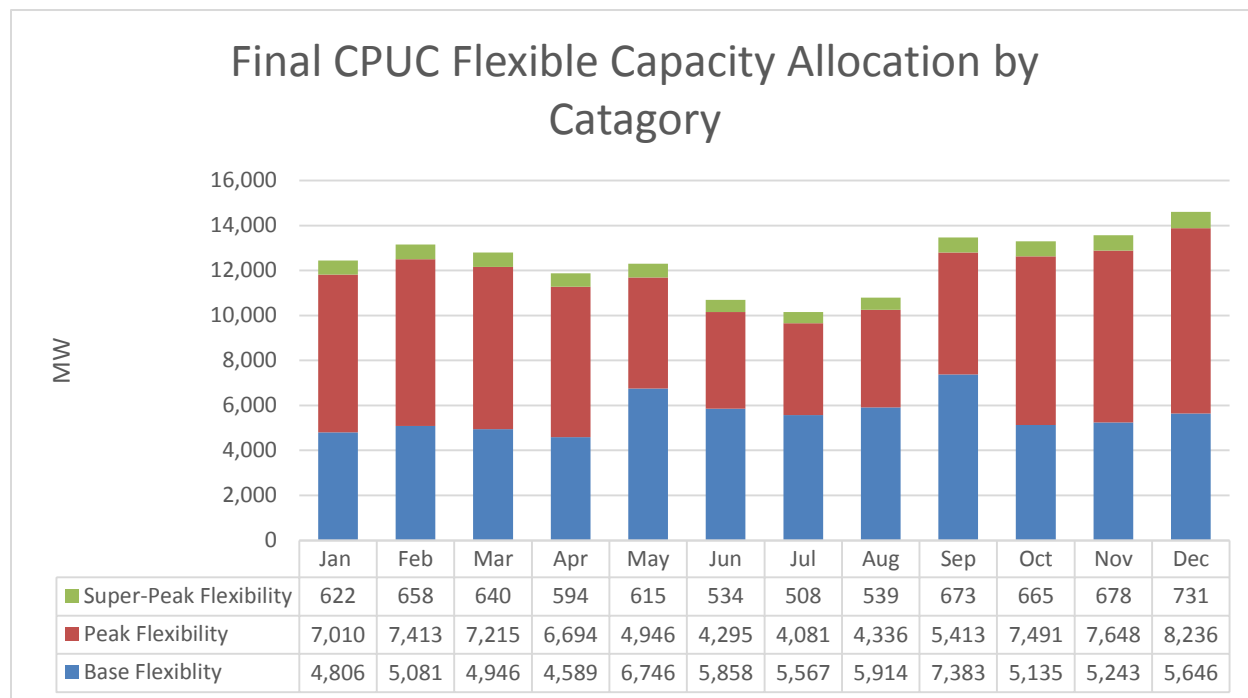
	Δ Load MW	Δ PV Fixed MW	Δ BTM Solar MW	Δ Wind MW	Net Load Allocation MW	3.5% expected peak load* Peak load ration share 2018	Total Allocation
Jan	4,584	-6,292	-590	56	11,410	1,027	12,438
Feb	4,595	-6,666	-602	-293	12,158	993	13,151
Mar	3,981	-6,808	-933	-97	11,820	981	12,801
Apr	2,689	-7,226	-982	73	10,824	1,052	11,876
May	1,849	-7,824	-851	-612	11,137	1,171	12,308
Jun	879	-7,414	-951	-120	9,366	1,322	10,688
Jul	548	-7,159	-1,066	51	8,722	1,433	10,156
Aug	1,335	-7,697	-1,181	877	9,337	1,452	10,790
Sep	2,180	-8,547	-1,297	-3	12,029	1,439	13,469
Oct	2,627	-7,742	-1,321	-405	12,097	1,193	13,291
Nov	3,585	-7,457	-1,321	-182	12,546	1,023	13,570
Dec	5,766	-6,510	-851	-416	13,545	1,066	14,612

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



Finally, the ISO applied the seasonal percentage established in section 6 to the contribution of CPUC jurisdictional load serving entities to determine the quantity of flexible capacity needed in each flexible capacity category. These results are detailed in figure 8.

Figure 8: CPUC Flexible Capacity Need in Each Category for 2018



8. Determining the Seasonal Must-Offer Obligation Period

Under ISO tariff sections 40.10.3.3 and 40.10.3.4, the ISO establishes, by season, 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 market (*i.e.* have an economic bid must-offer obligation). Whether the ISO needs peak and super-peak category resources more in the morning or afternoon depends on when the larger of the two ramps occurs. The average net load curves for each month provide the most reliable assessment of whether a flexible capacity resource would be greatest benefit in the morning or evening net load ramps. The ISO looked at the average ramp over the day to see if the bigger ramp was in the morning or afternoon and then set the hours for the must-offer obligation accordingly. The ISO calculated the maximum three-hour net load for all months. Table 5 shows the hours in which the maximum monthly average net load ramp began.

**Table 5: 2018 Forecasted Hour in Which Monthly Maximum
3-Hour Net load Ramp Began**

Frequency of All Three Hour Net Load Ramp Start Hour ramp Start

Month	11:00	12:00	13:00	14:00	15:00	16:00	17:00
January				28	3		
February				15	14		
March					12	19	
April					2	16	12
May			1		2	13	15
June			1		1	22	6
July	1	2			5	23	
August			1	1	21	7	
September	1		1	4	17	7	
October				6	23	2	
November				25	5		
December			1	29	1		

Frequency of Top Five Three Hour Net Load Ramp Start Hour ramp Start

	13:00	14:00	15:00	16:00	17:00
January		5			
February		5			
March			3	2	
April				4	1
May	1			3	1
June				2	3
July				5	
August			4	1	
September			3	2	
October		1	4		
November		5			
December		5			

Based on the data for all daily maximum three hour net load ramps, the ISO believes that the appropriate flexible capacity must-offer obligation period for peak and super-peak flexible capacity categories is the five-hour period of 3:00 p.m. to 8:00 p.m. for May through September, and 2:00 p.m. to 7:00 p.m. for January through April and October through December. The hours for January through April and October through December are one hour early than the hours established in the 2017 assessment. However, the summer hours are much later than the 2017 hours. Given that the ISO is proposing a change to both must-offer

obligation seasons, the ISO also reviewed the timing of the top five net load ramps to confirm that the intervals also capture the largest net load ramps. As shown above, the newly proposed intervals do, in fact capture the intervals of the largest ramps, too. 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.

The ISO continues to believe it is appropriate to align the must-offer obligations with the summer/non-summer demarcation used for the RA program and contributions to the categories described above. Because these months align with the with the summer/non-summer demarcation in the RA program and aforementioned contributions to the categories, the ISO expects that this will also make the procurement process less complicated.

9. Next Steps

The ISO will commence the flexible capacity needs assessment to establish the ISO system flexible capacity needs for 2019 in late 2017. At that time, the ISO will host a stakeholder meeting to discuss potential enhancements needs assessment methodology as identified in stakeholder comments and in this final paper. Specifically, the ISO will continue to assess the modeling approach used for distributed solar resources, further review methods to address year-to-year volatility, and account for potential controllability of some variable energy resources.

10. Appendix

Summary of PG&E comments and replies

1. CAISO should include the shaped AAEE profile, if possible, in its final study.

The ISO relies on the CEC for this data, at this time we still do not have the CEC AAEE profiles. Due to the tariff deadlines and analysis needed we are unable to incorporate the data this year.

2. CAISO should reconcile and provide an explanation for data discrepancies in the net load data worksheet. Specifically, CAISO should provide an explanation for how solar thermal has been treated in the study and indicate if there has been an error in the data. In addition, there is missing data for solar PV beginning on August 5 at 9:29 and continuing through August 6 at 3:41; this missing data should be explained.

This is a misunderstanding. The overall wind capacity modeled this year included approximately 1,200 MW of additional dynamically scheduled out-of-state wind. The Solar thermal output was included in the overall solar profiles. The missing data on August 5 was due to the lack of telemetry and did not impact the 3-hour flexible capacity needs.

3. The methodology to calculate flexible capacity needs should take into account the bidding behavior of those resources. Solar and wind resources that offer economic bids should not be modeled as must-take resources.

The intent of the analysis is to show the monthly flexible capacity needs. Since historical bidding behavior is not a guaranteed of future behavior the CAISO believes that individual BAs would be in a better position to determine whether to use curtailable wind/solar to meet its flexible capacity needs.

4. PG&E suggests CAISO use other data sources at its disposal (such as the Master File and/or data reported on its own website) to check for accuracy and coverage of data reported by LSEs.

We appreciate the feedback above, and will continue to work towards providing more clarity to assist with the value differences. For the purposes of this study, the 14,220 MW value came from the survey responses from the LSEs.

5. Suggestions for future metrics.

a. CAISO could create a new metric that provides a simple metric that correlates installed capacity of a resource with its contribution to the flexible capacity requirement.

We appreciate the feedback and will take it into consideration in future iterations of the process.

- b. CAISO clearly indicates the forecasted flexible capacity need; another useful data point to include would be the existing flexible supply for comparison purposes.**

While not perfect measure, the previous year's Effective Flexible Capacity List is available at <http://www.caiso.com/planning/Pages/ReliabilityRequirements/Default.aspx>

- c. Shift Must Offer Obligation hours in March and April an hour later to better match the pattern of net load ramps.**

The CAISO understands that such a change could be justified. The ISO does not believe sufficient evidence exists to make this change for the 2018 assessment. However, if this trend continues, the ISO will consider the change in future assessment

6. Additional clarifications are also requested.

- a. Clarify whether the resource capacity in Table 1 is dependable capacity or installed capacity.**

It is installed capacity.

- b. CAISO should clarify if this data included any curtailment due to market signals or if the data was 2016 non-curtailed generation.**

The minute-by-minute wind and solar analysis include curtailments. The ISO excluded curtailments because curtailments typically occur before the hours of maximum ramping needs.

Summary of CEERT comments and replies

CEERT seeks additional clarity regarding an assessment of what resources have been used to meet flexible RA requirements. Specifically, CEERT sites to the use of imports dispatched through the ISO's day-ahead and real-time markets to address even ramps. By contrast, import resources are not currently eligible to provide flexible resource adequacy capacity. Based on this assessment, CEERT requests that the ISO reexamine the criteria used to determine flexible capacity eligibility criteria.

The ISO acknowledges the comments made by CEERT. However, these suggestion appear to be more appropriately addressed in the Flexible Resource Adequacy Criteria and Must Offer Obligation – Phase 2. The ISO looks forward to CEERT's participation in that initiative.