California ISO

Draft Flexible Capacity Needs Assessment for 2017

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1. Introduction

The ISO conducts an annual flexible capacity technical study to determine the flexible capacity needed to help ensure the 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, in conjunction with the CPUC annual Resource Adequacy proceeding (R.11-10-023). In this filing, the ISO presents this final flexible capacity needs assessment outlining the ISO's forecast flexible capacity needs in 2017.

The ISO calculates the overall flexible capacity need of the ISO system and the relative contributions to this flexible capacity need attributable to the load serving entities (LSEs) under each local regulatory authority (LRA). This report details the system-level flexible capacity needs as well as 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 LRAs other than the CPUC.

The ISO will use the results from the draft study to allocate shares of the system flexible capacity[1] need to each of the LRAs responsible for load in the ISO balancing authority area consistent with the allocation methodology detailed in the ISO's tariff section 40.10.2. Based on that allocation, the ISO will advise each Local Regulatory Authority of the MW amount of its share of the ISO's flexible capacity need.

2. Summary

The ISO determines the quantity of flexible capacity needed to reliably address the various flexibility and ramping needs for the upcoming resource adequacy year and publishes this finding through this flexible capacity needs assessment. To calculate the flexible capacity needs, the ISO uses the calculation method developed in the FRAC-MOO stakeholder initiative and codified in the ISO tariff. This methodology includes the ISO's calculation of the seasonal amounts of three flexible capacity categories as well as seasonal must-offer obligations for two of these flexible capacity categories.

The key results of the ISO's flexible capacity needs assessment for 2017 are --

1) The only significant enhancement made to 2017 study methodology is the use of a shaped profile for additional achievable energy efficiency that was provided by the CEC.

2) System-wide flexible capacity needs are greatest in the non-summer months and range from 9,918 MW in August to 14,977 MW in November.

3) The minimum amount of flexible capacity needed from the "base flexibility" category is 71 percent of the total amount of flexible capacity in the summer months (May – September) and 50 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 12:00 p.m. to 5:00 p.m. during May through September, and 3:00 p.m. to 8:00 p.m. during January through April and October through December.

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 2018 and 2019. As this data is processed, the ISO will issue advisory results for those years.

In calculating the allocations of flexible capacity needs, the ISO has identified one non-CPUC LSE's data was accidentally omitted. The ISO has contacted this LSE and will provide a draft of its flexible capacity requirements for that LSE by calculating the percentage contributions to the delta wind and solar components using the wind and solar portfolios identified in table 1 plus the LSE's additional input, below. As an example, if the solar portfolio identified in table one is 4,500 MW and the omitted LSE has 500 MW of wind, the ISO will estimate this LSEs contribution as 500/(4,500+500). If the ISO is unable to rerun the new wind and solar profiles prior to final report, the ISO will scale all LSEs' wind and solar contributions down using the MW quantities in Table 1 to reflect this error. Because this scaling factor will be less than one, it will not increase any LRA's contribution to the flexible capacity requirement.[2] It should be noted that the ISO does not expect a large change to the system need or the overall allocation to other LRAs once this correction is made.

3. Defining the ISO System-Wide Flexible Capacity Need

Based on the methodology described in the ISO tariff and the business practice manual,[3] 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

2 An LRA may have an increase in its contribution due to other factors or corrections.
3 Reliability Requirements business practice manual Section 10. Available at http://bpmcm.caiso.com/Pages/BPMDetails.aspx?BPM=Reliability%20Requirements

MTHy = Month y
MSSC = Most Severe Single Contingency

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

For the 2017 RA compliance year, the ISO will continue to set ε equal to zero. The ISO is conferring with the Department of Market Monitoring to determine if there is a need for future revisions based on the overlap between flexible capacity resources and the resources utilized for contingency reserves. At this time, there not sufficient data to warrant a non-zero ε term.

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.

This methodology allows the ISO make enhancements and assumptions as new information becomes available and experience allows. Based on experience gained through the previous iteration of this study process, the ISO has made minor enhancements to the methodology used for the 2017 Flexible Capacity Needs Assessment. Further, the CEC has provided the ISO this shaped profiles for AAEE that have been applied to the load profiles used by the ISO. The following section details the methodology employed by the ISO as well as the assumptions used and their implication on the results.

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 about the expected build-out of the fleet of variable energy resources. Once this data was collected from all LSE's the ISO constructed the forecast minute-by-minute net load curves for 2017.[4]

4.1 Building the Forecasted Variable Energy Resource Portfolio

To collect this data, the ISO sent a data request on December 18, 2015 to the scheduling coordinators for all LSEs representing load in the ISO balancing area. The deadline for submission of the data was January 15, 2016. The ISO sent follow-up data requests to all LSEs that did not submit data by the January 15 deadline. At the time of this report, the ISO received data from all but two LSEs. This data request asked for information on each wind, solar, and distributed wind and solar resource that is owned, in whole or in part, by the Load Serving Entity or under contractual commitment to the Load Serving Entity 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 to the ISO, additional information was requested as to whether the resource is or will be a dynamic system resource or pseudo-tie resource. The ISO only included external resources in the flexible capacity requirements assessment if they were dynamic system resources or pseudo-tie resources.

Based on ISO review of the responses to the data request, it appears that the information submitted in response to the data request represents all wind, solar, and distributed wind and solar resources that are owned, in whole or in part, by the Load Serving Entity or under contractual commitment to the Load Serving Entity for all or a portion of its capacity within the ISO balancing area.[5]

Using the LSEs' data, the ISO simulated the variable energy resources' output to produce forecast minute-by-minute net load curves[6] for 2017. The forecasted aggregated variable energy resource fleet capacity is provided in Table 1.

Table 1: Total ISO System Variable Energy Resource Capacity (Net Dependable Capacity-MW)[7]

Resource Type	Existing MW (2015)	2016 MW	2017 MW
ISO Solar PV	5,754	7,583	8,686

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[4] 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 2018 and 2019. As this data is processed, the ISO will issue advisory results for those years.

[5] The ISO received responses from 17 LSEs. The study assumes that the LSEs that did not respond have zero wind or solar resources.

[6] Net-load load is defined as load minus wind minus solar.

[7] Data shown is for December of the corresponding year. Variable energy resources have been aggregated across the ISO system to avoid concerns regarding the release of confidential information.

ISO Solar Thermal	1,219	1,204	1,183
ISO Wind	4,991	4,643	4,519
Incremental distributed PV		1,208	1,072
Total Variable Energy Resource Capacity in the 2016 Flexible Capacity Needs Assessment[8]	11,964	14,638	15,460
Non ISO Resources All external VERS not-firmed by external BAA		552	850
Total internal and non-firmed external VERs	11,964	15,190	16,310
Incremental New Additions in Each Year		3,226	1,120

While 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 2015. 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:

$$2016\ W_{Mth\_Sim\_1\text{-}min} = 2015W_{Act\_1\text{-}min} * 2016W_{Mth\ Capacity} / 2015W_{Mth\ Capacity}$$

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.

In the case of solar resources' production profiles, for future years, the ISO assumptions 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 2015. While existing behind-the-meter solar PV is captured by changes in load, new behind-the-meter solar PV would be missed and would lead to an undercounting of the net load ramps. Including this incremental capacity allows the ISO to more accurately capture the Δ Solar PV component of the net load calculation. Therefore, the ISO agrees with PG&E's recommendation and has calculated the impact of the incremental behind-the-meter solar PV. Because behind-the-meter solar is solar PV, the ISO included the contribution of the incremental behind-the-meter solar PV in the Δ Solar PV for purposes of determining an LRA's allocable share of the flexible capacity needs. During the stakeholder meeting on the draft results, the CEC and PG&E asked about the treatment or impact of the additional behind the meter solar resources and the CEC treatment of these resources in the

[8] Includes all internal variable energy resources

Integrated Energy Policy Report (IEPR). The ISO has reviewed these concerns and has not identified any change in non-summer months. The ISO has not identified a material change from the inclusion of 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 2014 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.[9] The ISO scaled the actual load for each minute of each month of 2015 using an expected load growth factor of the monthly peak forecast divided by the actual 2015 monthly peak. This is the same methodology used in the 2016 assessment.

As noted above, the ISO used the mid-additional achievable energy efficiency forecast. Specifically, the ISO included additional achievable energy efficiency profile for 2017 provided by the CEC. This profile is shaped to reflect both hourly and seasonal additional achievable energy efficiency. This differs from the 2016 assessment which applied additional achievable energy efficiency uniformly to all load. The impact of this change likely contributes to some portion of the increased flexible capacity needs identified in this year's study, though no specific assessment of the two additional achievable energy efficiency approaches has been done.

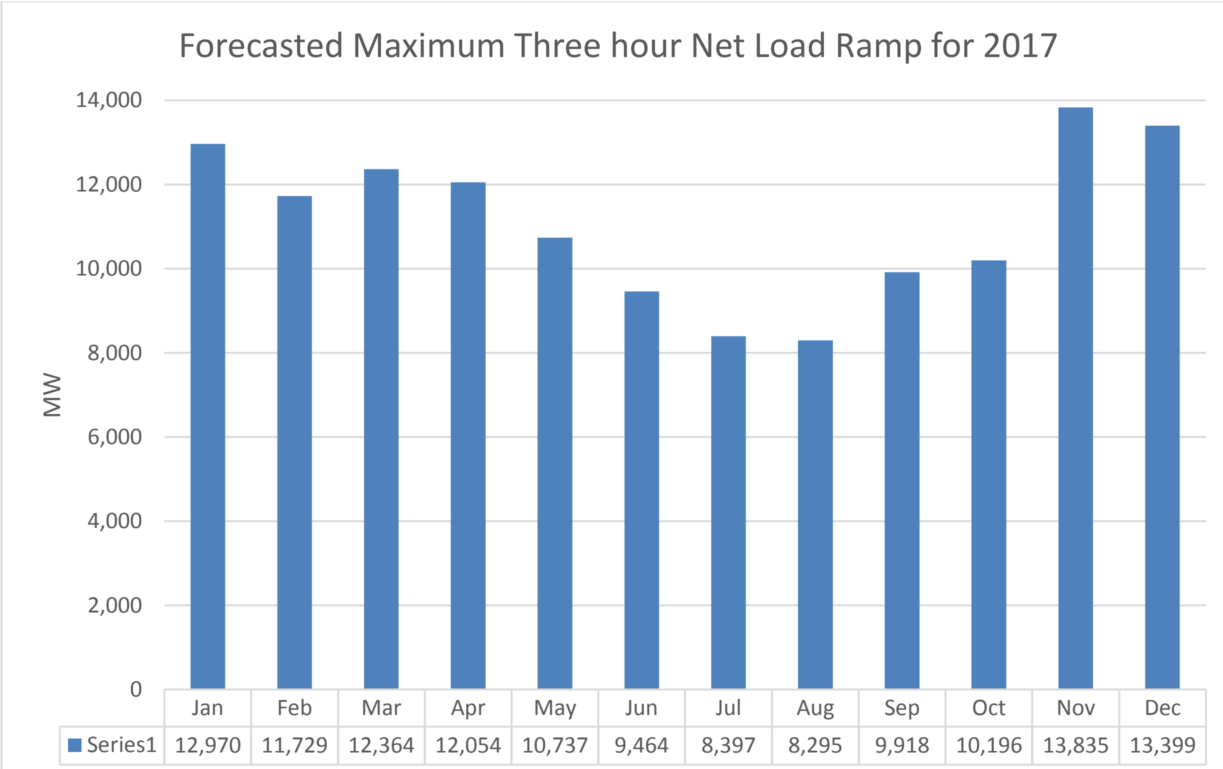
With this forecasted load, and expected wind and solar expansions, the ISO developed the minute-by-minute load, wind, and solar profiles. The ISO aligned these profiles and subtracted the output of the wind and solar resources from the load to generate the minute-by-minute net load curves necessary to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

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

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

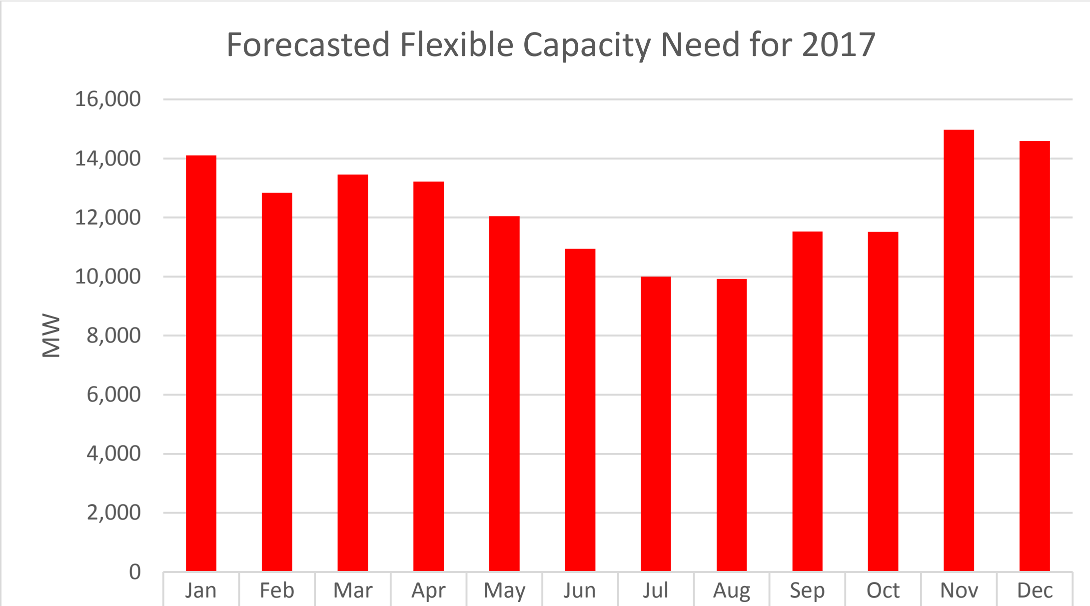


The results for the non-summer months of 2017 are higher than those predicted in the previous flexible capacity needs assessment. This is due to the inclusion of a much higher base of behind-the-meter solar. Specifically, the base of existing behind-the-meter solar in thee 2016 assessment was 4,442 MW for 2017, while this year's assessment shows a base of 5,976 MW. This is important because the year-over-year incremental behind-the-meter solar is not dramatically different from the previous studies.

As part of the 2017 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.[10] This sum yields the ISO system-wide flexible capacity needs for 2017. These totals are shown in Figure 2 below.

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

[10] The most severe single contingency was consistently less than 3.5 expected peak-load.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017	14,110	12,840	13,456	13,220	12,044	10,939	9,994	9,918	11,525	11,514	14,977	14,588

6. Calculating the Seasonal Percentages Needed in Each Category

As described in the ISO's 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. While there is no limit to the amount of resources that meet the base flexibility criteria that can be used to meet the system's flexible capacity, 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 load[11] 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

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[11] 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 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.

<u>Super-Peak Flexibility</u>: Operational need determined by five percent of the maximum 3-hour net load ramp of the month

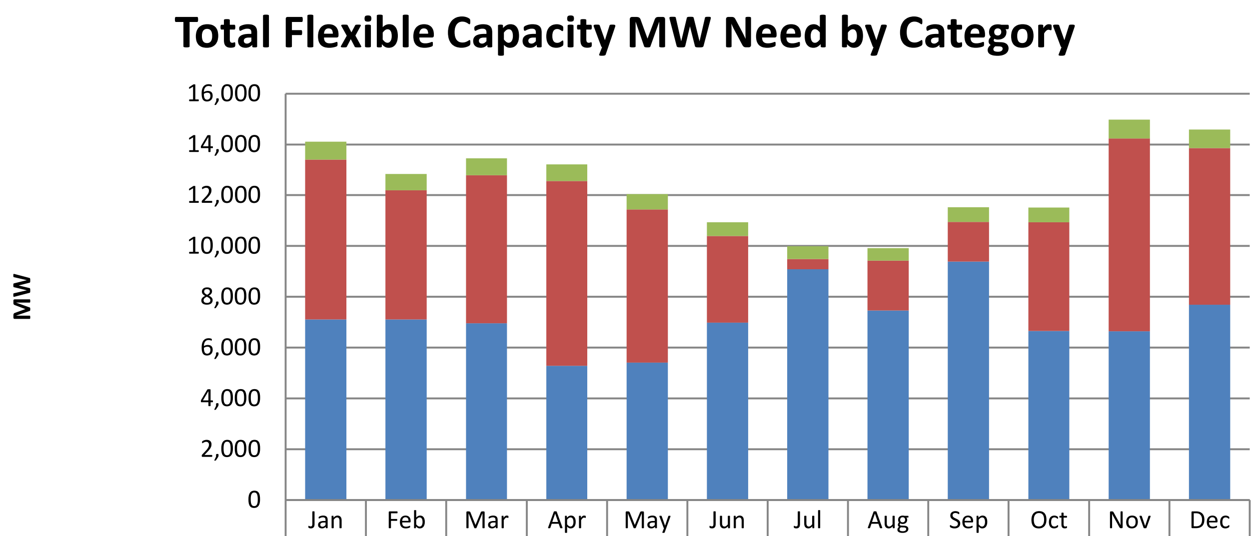
These categories include different minimum flexible capacity operating characteristics and different limits on the total quantity of flexible capacity within each category. In order to calculate the quantities needed in each flexible capacity category, the ISO conducted a three-step assessment process:

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.

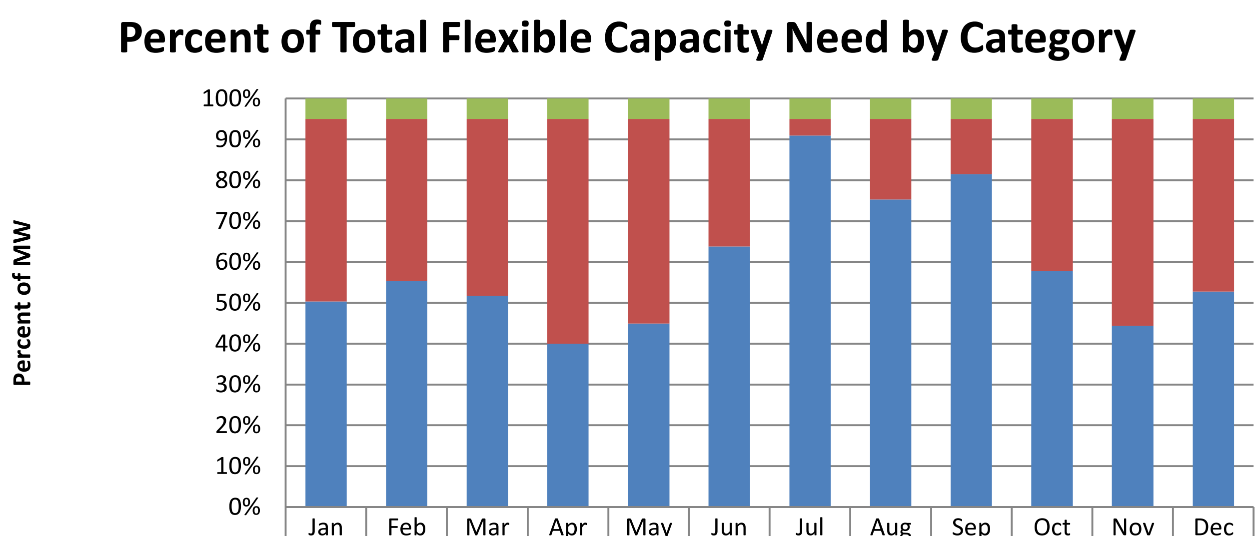
6.1 Calculating the Forecast Percentages Needed in Each Category in Each Month

Based on the categories defined above, the ISO calculated the system level needs for 2017 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 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 2017 is shown in Figure 3.

Figure 3: ISO System-Wide Flexible Capacity Monthly Calculation by Category for 2017



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Super-Peak Flexibility	706	642	673	661	602	547	500	496	576	576	749	729
Peak Flexibility	6,301	5,088	5,821	7,274	6,029	3,412	404	1,957	1,561	4,276	7,578	6,164
Base Flexibility	7,104	7,110	6,962	5,285	5,412	6,980	9,091	7,465	9,388	6,662	6,650	7,694



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Super-Peak Flexibility	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Peak Flexibility	45%	40%	43%	55%	50%	31%	4%	20%	14%	37%	51%	42%
Base Flexibility	50%	55%	52%	40%	45%	64%	91%	75%	81%	58%	44%	53%

Again, the large quantity of existing and incremental 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 relative to last year's study.

6.2 Analyzing Ramp Distributions to Determine Appropriate Seasonal Demarcations

To determine the seasonal percentages for each 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. While this year's assessment focused on the data produced in this study process, the ISO also referred back to last year's[12] 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 2016

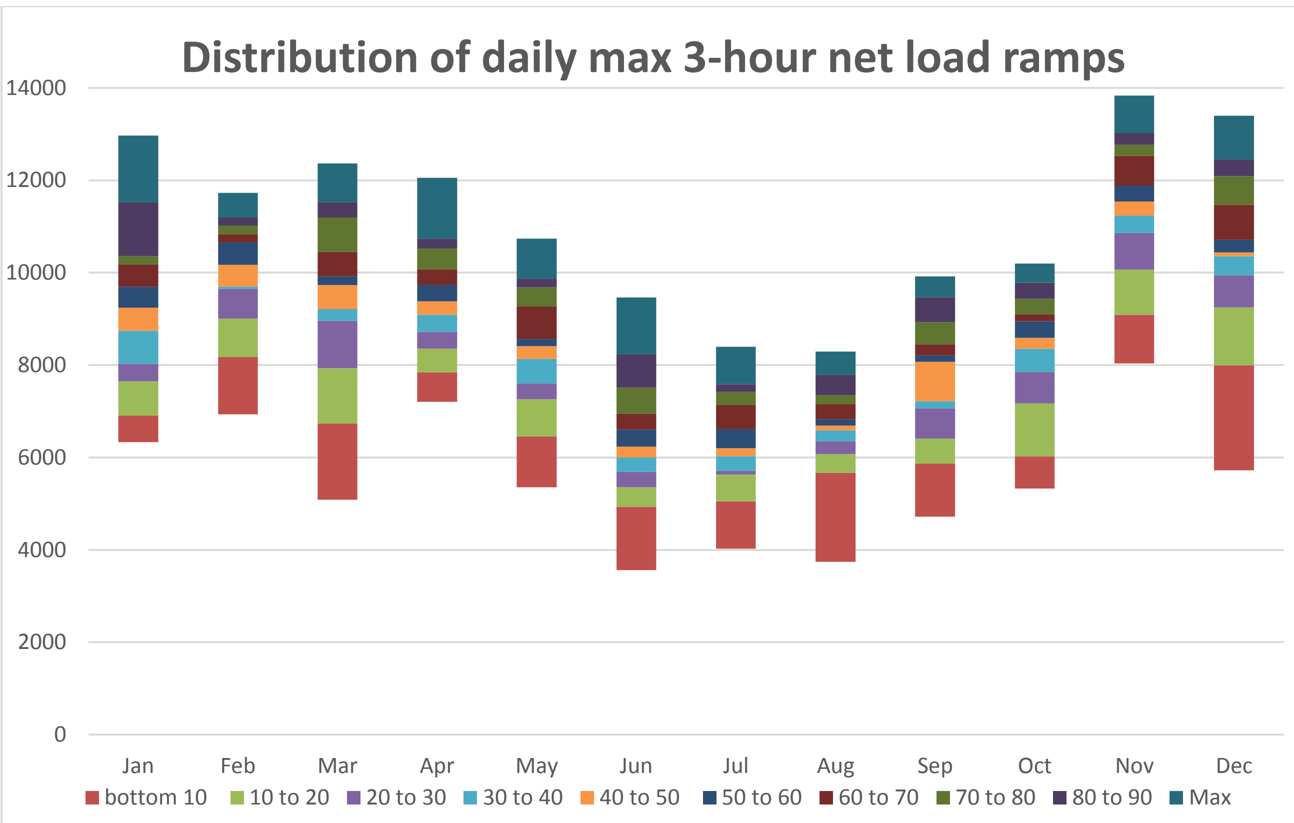
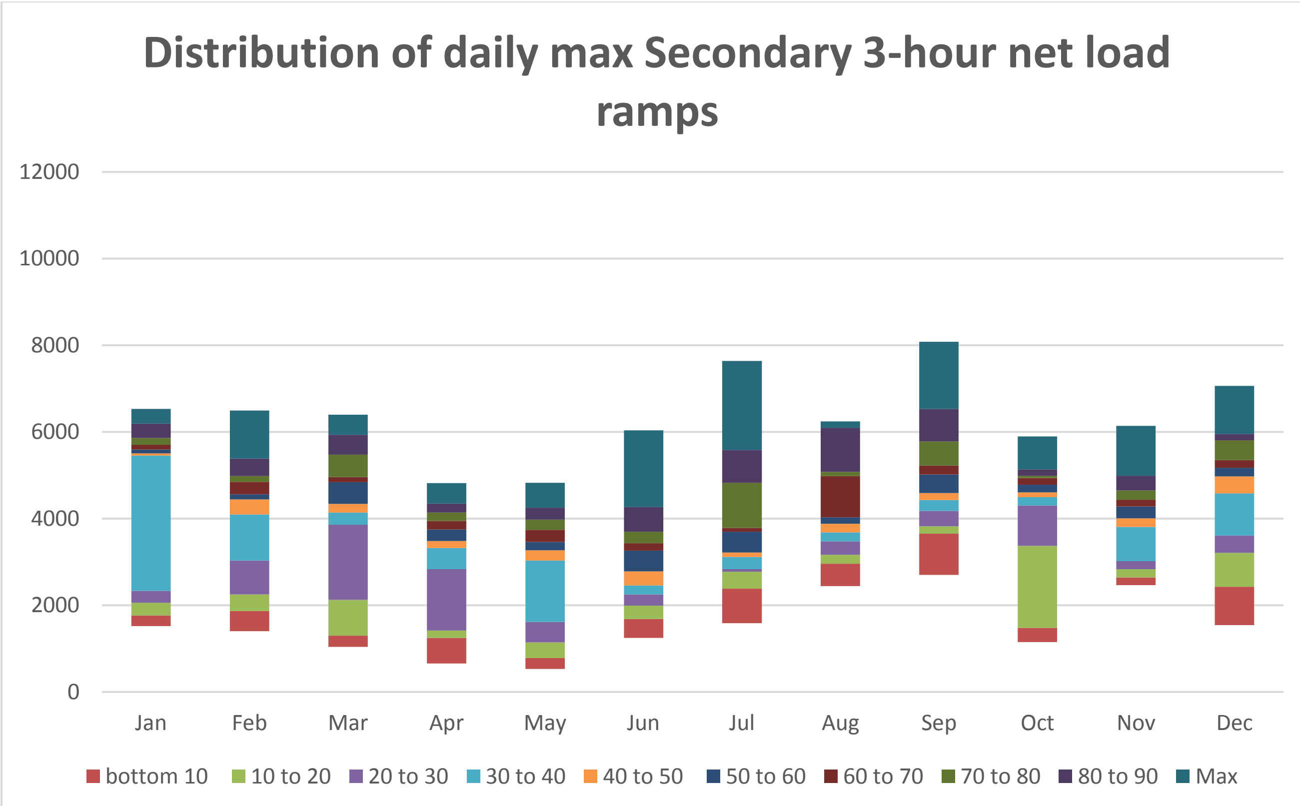


Figure 5: Distribution of Secondary 3-hour Net load Ramps for 2016

12 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.



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. Transitional months like May and October 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 July and September. These distribution indicates 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 need not 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 enough base ramping for all days of the month. Further, particularly for summer months, the ISO does not identify two distinct ramps each day. Instead, the secondary net-load ramp may be a part of single long net load ramp. The ISO is currently exploring the impact this may have for determining the quantity of based flexible capacity resources needed during summer months.

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. While not as distinct for May and September as was observed in the previous Flexible capacity needs assessment, the distributions of the secondary net load ramps from May through September remain more compact than the secondary net load ramps in the other months. This distribution change is a reflection of changes in the seasons and weather patterns. 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.[13] 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 breakout the flexibility categories by season. Because the main differences in weather in the ISO system are between the 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.

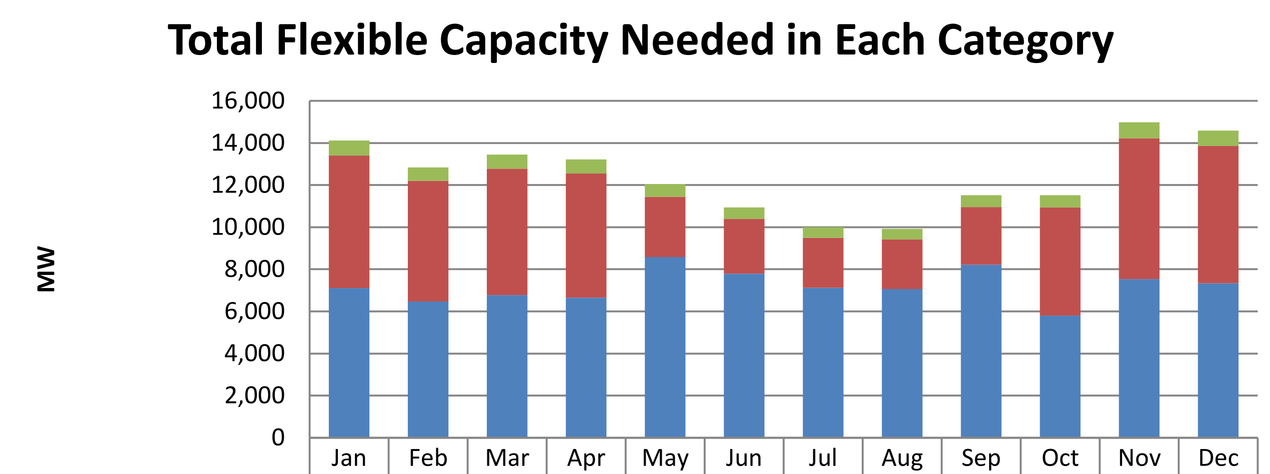
6.3 Calculate a Simple Average of the Percent of Base Flexibility Needs

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 50 percent of the ISO system flexible capacity need for the non-summer months and 71 percent for the summer months. Peak flexible capacity resources could be used to fulfill up to 50 percent of non-summer flexibility needs and 29 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 from those of in the 2016 Flexible Capacity Needs Assessment. As with the increase in the flexible capacity need, the change is largely attributable to the inclusion of the incremental behind-the-meter solar. The 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

[13] The ISO also reviewed the results of the initial calculations for categories used in the 2013 Flexible Capacity Needs Assessment to determine if the categories aligned with the previous assessment as well.

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 2017



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Super-Peak Flexibility	706	642	673	661	602	547	500	496	576	576	749	729
Peak Flexibility	6,300	5,733	6,008	5,903	2,856	2,594	2,370	2,352	2,733	5,141	6,687	6,514
Base Flexibility	7,104	6,465	6,775	6,656	8,585	7,798	7,124	7,070	8,216	5,797	7,541	7,345

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 Solar Thermal – 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 thermal 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.

Flexible Capacity Need = Δ Load – Δ Wind Output – Δ Solar PV – Δ Solar Thermal + (3.5% * Expected Peak * Peak Load Ratio Share)

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.[14] 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 may examine ways to address this issue as part of an upcoming stakeholder initiative. However, the ISO will assess the overall adequacy of flexible capacity using the system need.

The ISO has made available all non-confidential working papers and data that the ISO relied on for the Draft Flexible Capacity Needs Assessment for 2016. Specifically, the ISO 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.[15] This data is available at http://www.caiso.com/informed/Pages/StakeholderProcesses/FlexibleCapacityNeedsTechnicalStudyProcess.aspx

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.

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[14] 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.

[15] The data sets posted on the webpage reflect the corrected data. The draft data sets have been removed to avoid confusion.

Table 2: Contribution to Maximum 3-hour Continuous Net load Ramp for 2016[16]

Month	Average of Load contribution 2017	Average of solar PV contribution 2017	Average of BTM Solar contribution 2017	Average of Wind contribution 2017	Average of OOS Wind contribution 2017	Total percent 2017
January	49.09%	-47.68%	-2.66%	-0.52%	-0.05%	100%
February	31.99%	-63.00%	-3.77%	-0.77%	-0.47%	100%
March	27.28%	-63.69%	-8.15%	-1.28%	0.40%	100%
April	23.01%	-68.11%	-9.61%	0.71%	0.02%	100%
May	23.87%	-64.15%	-9.83%	-1.65%	-0.50%	100%
June	8.76%	-79.58%	-11.52%	-0.55%	0.41%	100%
July	11.66%	-78.87%	-11.11%	1.47%	0.17%	100%
August	-0.72%	-94.04%	-12.81%	5.93%	0.21%	100%
September	6.27%	-82.42%	-10.82%	-0.28%	-0.21%	100%
October	18.23%	-72.80%	-11.45%	1.61%	0.86%	100%
November	34.75%	-55.91%	-8.69%	-0.51%	-0.15%	100%
December	42.28%	-48.62%	-6.05%	-2.02%	-1.04%	100%

As Table 2 shows, Δ Load is not the largest contributor to the net load ramp during the summer months. This is 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 relative 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 occurs 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 2015 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 2015. Then, using the

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[16] The contribution of behind-the-meter solar is captured in the solar PV calculations. All contributions are captured on the "contributing factors" worksheet in the ISO's 2016 data set. As shown in the formula above, the flexible capacity requirement will be 100 percent.

same methodology as that for determining the maximum 3-hour continuous net load ramp described above, the ISO calculated the maximum three-hour net load ramps for 2015 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.[17] 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 Solar Thermal) included in the allocation methodology.

Table 3: CPUC Jurisdictional LSEs' Contribution to Flexible Capacity Needs[18]

	Δ Load	Δ PV Fixed	Δ BTM Solar	Δ Wind	Δ OOS Wind
Jan	95.02%	93.38%	99.35%	96.90%	100%
Feb	99.70%	93.38%	99.35%	96.90%	100%
Mar	102.52%	93.43%	99.35%	96.90%	100%
Apr	70.38%	93.56%	99.35%	96.87%	100%
May	104.90%	93.56%	99.35%	96.86%	100%
Jun	96.69%	93.56%	99.35%	96.85%	100%
Jul	93.67%	93.56%	99.35%	96.86%	100%
Aug	95.05%	93.62%	99.35%	96.86%	100%
Sep	42.62%	93.64%	99.35%	96.86%	100%
Oct	91.08%	93.64%	99.35%	96.86%	100%
Nov	101.01%	93.65%	99.35%	96.86%	100%
Dec	103.81%	93.68%	99.35%	96.86%	100%

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

[17] 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.

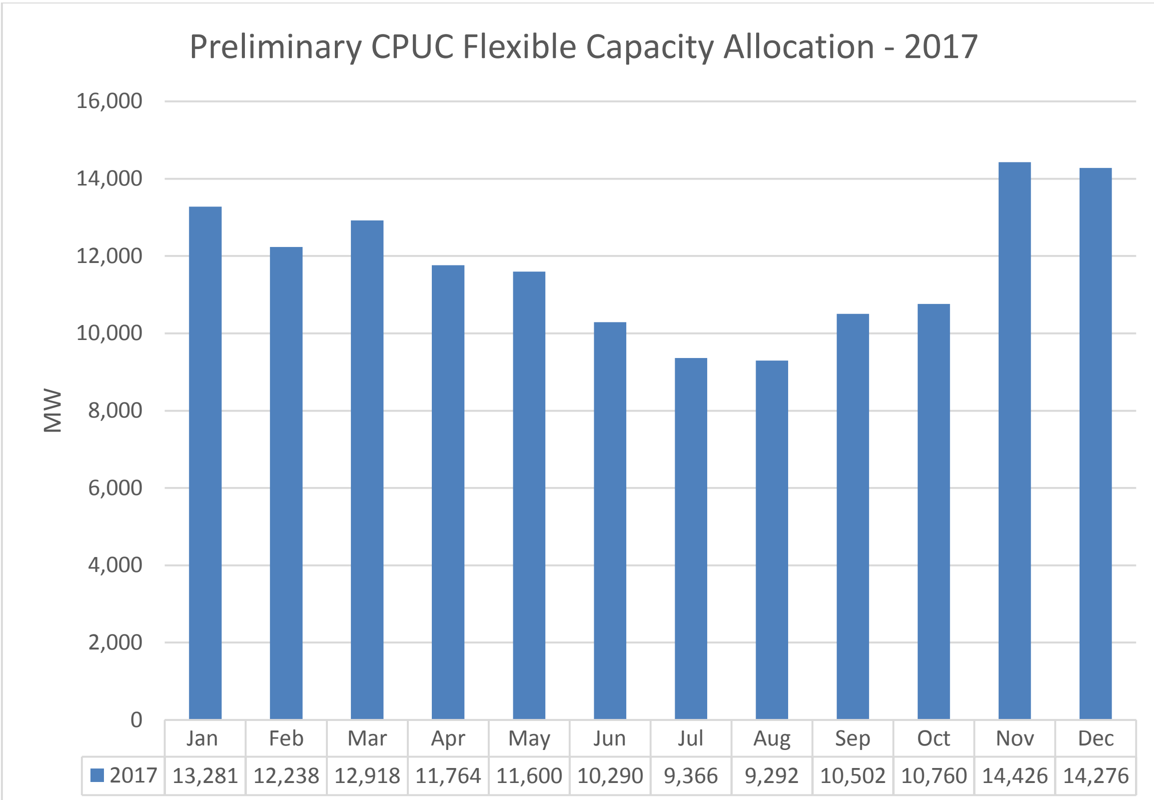
[18] Because of the geographic differences in the output, at some times one LRA's resources could be reducing the net-load ramp while another's could be increasing it.

Table 4 and Figure 7. The contributions of individual LSEs will only be provided to its jurisdictional LRA as per section 40.10.2.1 of the ISO tariff.

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

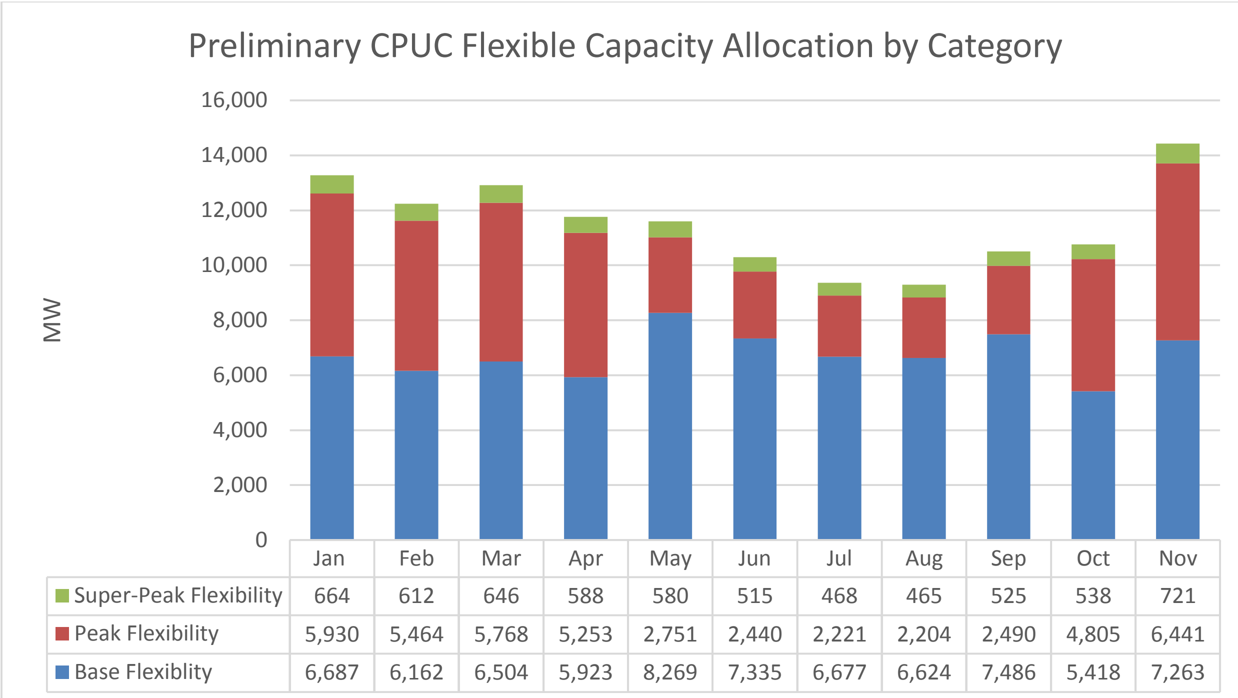
	Δ Load MW	Δ PV Fixed MW	Δ BTM Solar MW	Δ Wind MW	Δ OOS Wind MW	Net Load Allocation MW	3.5% expected peak load* Peak load ratio share 2017	Total Allocation
Jan	6049	-5774	-343	-65	-7	12239	1042	13281
Feb	3741	-6901	-439	-87	-55	11223	1015	12238
Mar	3457	-7358	-1001	-153	49	11920	998	12918
Apr	1952	-7681	-1151	83	2	10699	1065	11764
May	2689	-6444	-1048	-171	-54	10407	1194	11600
Jun	802	-7047	-1083	-51	39	8943	1347	10290
Jul	917	-6197	-927	120	14	7907	1459	9366
Aug	-56	-7304	-1055	476	17	7809	1483	9292
Sep	265	-7654	-1066	-27	-21	9033	1468	10502
Oct	1692	-6950	-1160	159	88	9556	1205	10760
Nov	4856	-7244	-1194	-68	-20	13383	1043	14426
Dec	5881	-6102	-805	-262	-139	13189	1086	14276

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 2016



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Super-Peak Flexibility	664	612	646	588	580	515	468	465	525	538	721
Peak Flexibility	5,930	5,464	5,768	5,253	2,751	2,440	2,221	2,204	2,490	4,805	6,441
Base Flexiblity	6,687	6,162	6,504	5,923	8,269	7,335	6,677	6,624	7,486	5,418	7,263

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: 2016 Forecasted Hour in Which Monthly Maximum 3-Hour Net load Ramp Began

Month	Starting Hour	Month	Starting Hour
Jan	14	Jul	12
Feb	15	Aug	12
Mar	16	Sep	14
Apr	16	Oct	15
May	16	Nov	14

Jun	15	Dec	14

Based on this data, the ISO has determined that the appropriate flexible capacity must-offer obligation period for peak and super-peak flexible capacity categories is the five-hour period of 12:00 p.m. to 5:00 p.m. for May through September, and 3:00 p.m. to 8:00 p.m. for January through April and October through December. The hours for January through April and October through December are unchanged from the previous year's study. In its comments, CDWR suggested the ISO adjust the time period to 2:00 p.m. to 7:00 p.m. The ISO considered making this adjustment as part of the draft results. At this time, the ISO believes that the appropriate must-offer obligation period is between 3:00 p.m. to 8:00 p.m. because the summer hour net load ramps are now later in the day. The later timing of net load ramps is attributable to the fact that increased solar PV continues to mitigate the morning ramps in the summer. This pushed the maximum net load ramps further into the day. However, the ISO will consider changing these hours if the trend of non-summer net load ramps starting at 2:00 p.m. continues in the next study process.

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 host a stakeholder call on April 18, 2016, with stakeholder comments due on April 26, 2016. The ISO will then submit final allocations to LRAs by May 1, 2016.