Final Flexible Capacity Needs Assessment for 2016

May 1, 2015

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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 2016.

The ISO hosted a conference call to review the results with all stakeholders on April 13, 2015, and requested comments from stakeholders by April 20, 2015. The ISO addresses stakeholder comments in this final flexible capacity needs assessment.

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 final 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 2016 are --

1) System-wide flexible capacity needs are greatest in the non-summer months and range from 7,244 MW in June to 12,817 MW in December.

2) The minimum amount of flexible capacity needed from the "base flexibility" category is 87 percent of the total amount of flexible capacity in the summer months (May – September) and 64 percent of the total amount of flexible capacity for the non-summer months (October – April).

3) 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.

Additionally, given stakeholder comments, the ISO has made the following modifications or corrections to the draft study results.

- The original Figure 3 was calculated without including the 3.5 percent expected peak load portion of the calculation. This has been corrected.
- The seasonal contribution calculation for non-summer months was missing the reference to April. This increased the contribution to the base flexible capacity category from 54 percent to 64 percent.
- The cell reference used to calculate 3.5 percent expected peak load was misidentified by one month and has been corrected. For example, in "3 hour upward ramp" worksheet the calculation for 3.5 percent expected peak load for January referred to February's expected peak load.
- Table 2 has been modified to show the Δ wind, Δ solar PV, and Δ solar thermal as negative contributions. This modification makes the contributing factors consistent with the formula used to calculate the causes of each component.
- The ISO has added a worksheet to the 2016 and 2017 data files that details the calculations used to derive the relative contributions from load, wind, and solar.

The following additions or corrections have been made to the individual LRA draft results:

- Additional columns have been added to clarify that the relative contributions from load, wind, and solar (taken from the new worksheet added to the 2016 and 2017 data sets) sum to 100 percent.
- While additional achievable energy efficiency was included in the calculation of overall system need, it may not have been included in the calculation of individual LRAs contribution. This has been corrected.

Only three stakeholder submitted comments on the draft study results. The ISO's responses to these comments are as follows:

- CDWR identified several typographical errors. These have been corrected.
- CDWR recommended changing the must-offer hours for non-summer months from 3:00 p.m. to 8:00 p.m. to 2:00 p.m. to 7:00 p.m. The ISO addresses this proposal in section 8 of this report.
- The CPUC staff identified some calculation errors in the worksheets. These calculations have been corrected.
- The CPUC staff requested the ISO include the number of LSE SCs that responded to the ISO's data request. This information is included in section 4.
- The CPUC staff requested additional clarity regarding the treatment of LRAs that have negative contributions to the three-hour net load ramps. The ISO discusses this issue in section 7.
- PG&E requested additional detail regarding the treatment of behind-the-meter solar resources. This is discussed in section 4.
- PG&E suggested that base flexibility should take precedence over peak and super-peak flexibility should the base flexibility needs exceed 95 percent of the need. While this did not occur in this year's study, the ISO will continue to assess the possibility of this occurring in next year's study.
- PG&E requested a clarification that "merchant VERs" have not been allocated to LRAs. The ISO did not allocate the contribution to the flexible capacity needs from merchant VERs to LRAs.

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:

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

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

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

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

For the 2016 RA compliance year, the ISO will continue to set ε equal to zero because the data needed to establish this term is not yet available and the ISO stated that it would not apply a forecast adjustment in this study.

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 2016 Flexible Capacity Needs Assessment. 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 2016 – 2018.

4.1 Building the Forecasted Variable Energy Resource Portfolio

To collect this data, the ISO sent a data request on January 16, 2015 to the scheduling coordinators for all LSEs representing load in the ISO balancing area. 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.[3]

Using the LSEs' data, the ISO simulated the variable energy resources' output to produce forecast minute-by-minute net load curves[4] for 2016 – 2018. 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)[5]

Resource Type	Existing MW (2014)	2015 MW	2016 MW	2017 MW	2018 MW
ISO Solar PV	4,482	5,785	6,874	8,007	8,078
ISO Solar Thermal	1,214	1,214	1,200	1,130	1,095
ISO Wind	4,992	4,541	4,462	4,319	4,213
Incremental distributed PV		570	1,331	1,743	2,181
Total Variable Energy Resource Capacity in the 2014 Flexible Capacity Needs Assessment[6]	10,687	12,110	13,867	15,198	15,567
Non ISO Resources All external VERS firmed by external BAA	1,784	2,200	2,168	1,978	1,978
Total internal and external VERs	12,471	14,310	16,035	17,176	17,545
Incremental New Additions in Each Year		1,839	1,726	1,141	369

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

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

[5] 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.

[6] Includes all internal and dynamically scheduled variable energy resources

Final estimated Variable Energy Resource Capacity used in the 2014 Flexible Capacity Needs Assessment (for comparison purposes)	13,659	15,212	16,099		

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 2014. 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:

$$2015\ W_{1\text{-}min} = 2014W_{Actual\_1\text{-}min} * 2015W_{Installed\ Capacity}/2014W_{Installed\ Capacity}$$

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 technology of the new resources. If a resource was solar thermal, the ISO scaled the actual 2014 solar thermal 1-minute production data. Likewise, if the technology was solar PV, the ISO scaled the actual 2014 solar PV 1-minute production data. The ISO used this methodology to maximize the correlation between the load and solar production profiles for a particular year for the vast majority of variable energy resources.

The ISO has also included incremental behind-the-meter solar production for behind-the-meter solar PV that occurs after 2014. PG&E recommended that the ISO include this component in the determination of net load. 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 Integrated Energy Policy Report (IEPR). The ISO has reviewed these concerns and has not identified any change in non-summer months. The peak load during non-summer months typically occurs after the sun sets, meaning that the behind-the-meter solar resources would not affect peak load or the ramping requirements. 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.[7] The ISO scaled the actual load for each minute of each month of 2014 using an expected load growth factor of the monthly peak forecast divided by the actual 2014 monthly peak. This is the same methodology used in the 2014 assessment.

As noted above, the ISO used the mid-additional achievable energy efficiency forecast. Specifically, the ISO included additional achievable energy efficiency of 1,022 MW for 2016, 1,539 MW for 2017, and 2,035 MW for 2018. The ISO applied this additional achievable energy efficiency uniformly to all load. While this does not impact the three-hour net load portion of the flexible capacity need, it does reduce peak load, and thereby reduces the contribution to the 3.5 percent expected peak load portion of the flexible capacity need.[8] Integrating resources, such as energy efficiency, into the ISO flexible capacity needs assessment can be improved by developing profiles that show how additional achievable energy efficiency impacts net load on a minute-by-minute basis. For example, while energy efficiency may reduce system peak, further analysis is needed to determine the load shape impacts of any additional achievable energy efficiency or, stated differently, what effect energy efficiency has on the "belly of the duck."[9]

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.

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

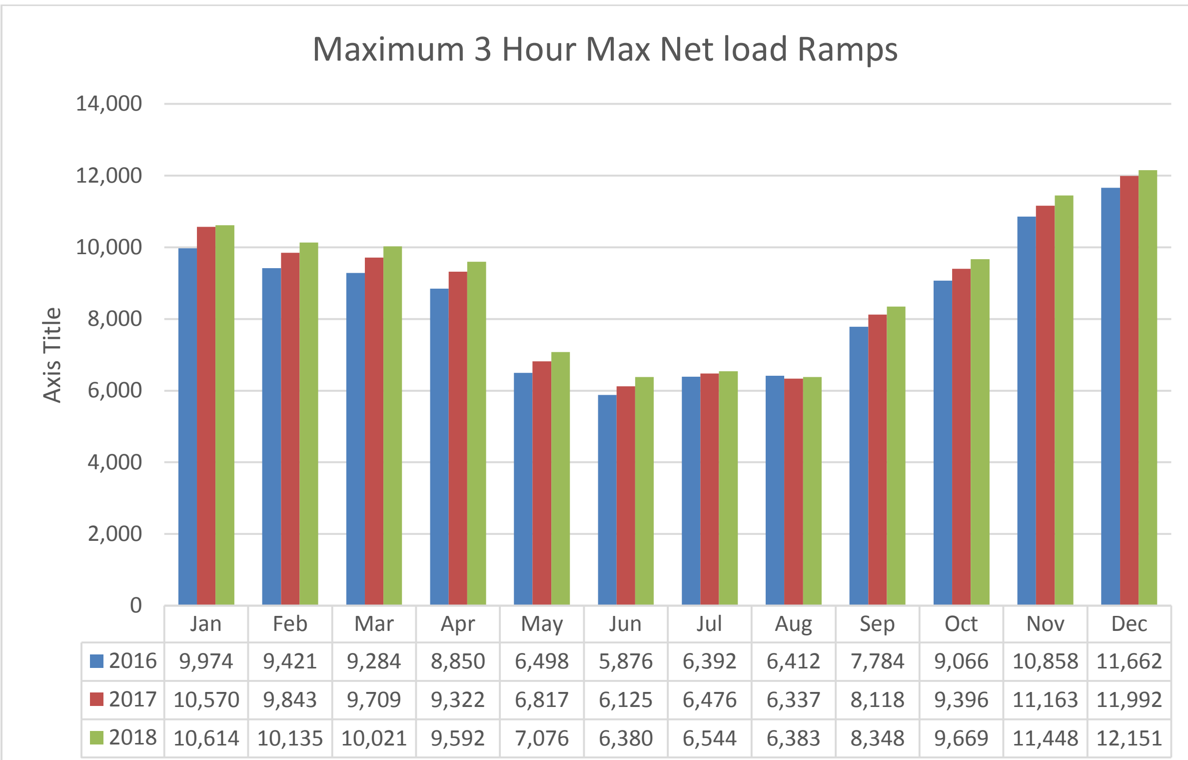
8 The ISO did not subtract the additional achievable energy efficiency from the load data provided by in the forecasted load calculations. It was only subtracted in the calculation of 3.5% expected peak load. This approach reduces the complexity and size of an already large data set without impacting the flexible capacity needs.

9 For example, it is likely that a reduction in the net load at the head of the duck will be matched by a comparable drop in the belly. This would result in no reduction of the three-hour maximum net-load ramps.

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



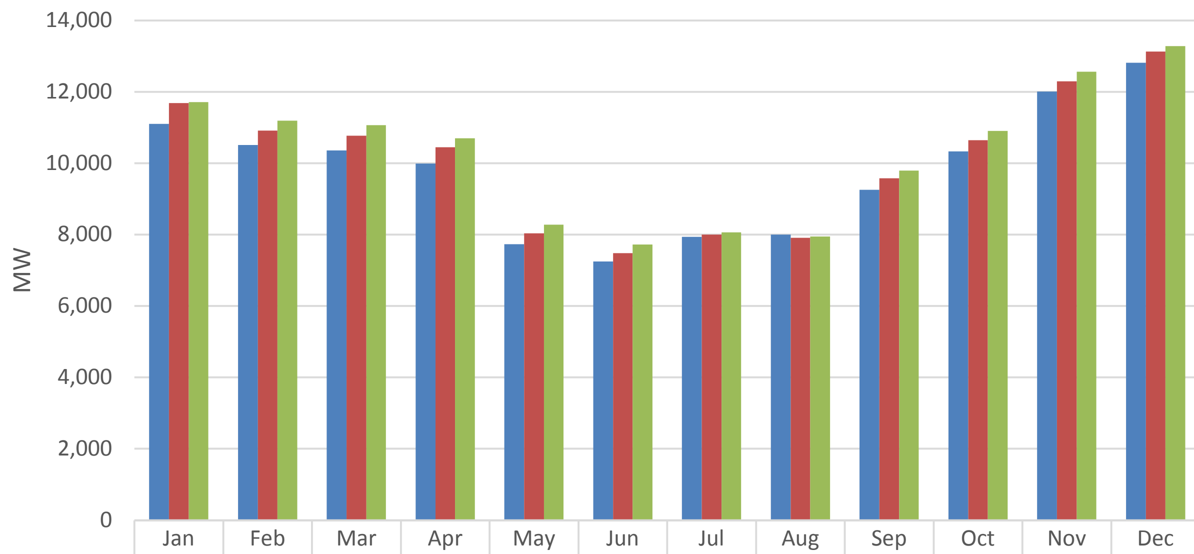
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	9,974	9,421	9,284	8,850	6,498	5,876	6,392	6,412	7,784	9,066	10,858	11,662
2017	10,570	9,843	9,709	9,322	6,817	6,125	6,476	6,337	8,118	9,396	11,163	11,992
2018	10,614	10,135	10,021	9,592	7,076	6,380	6,544	6,383	8,348	9,669	11,448	12,151

The results for the non-summer months of 2016 are higher than those predicted in the previous flexible capacity needs assessment. This is due to the inclusion of 2,181 MW of incremental behind-the-meter solar capacity noted above. Including this incremental capacity provides a more accurate depiction of three-hour net load ramp.

In the 2014 Flexible Capacity Needs Assessment, the study included the extreme temperatures the ISO system experienced in late June 2013 that lasted almost an entire week. As such, the three-hour flexible capacity needs for June were set based on extreme morning ramping needs to address steep increases in load during this heat wave. The weather for 2014 was much more consistent with historic patterns. As can be seen from Figure 1, flexible capacity needs follow a more predictable pattern. This means that 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 2016 – 2018. 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



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	11,103	10,507	10,362	9,989	7,731	7,244	7,935	7,998	9,259	10,331	12,005	12,817
2017	11,684	10,913	10,772	10,446	8,034	7,478	8,004	7,909	9,577	10,645	12,295	13,132
2018	11,714	11,192	11,070	10,702	8,282	7,721	8,061	7,944	9,796	10,906	12,567	13,277

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.

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

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

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 2016 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 2016 is shown in Figure 3.

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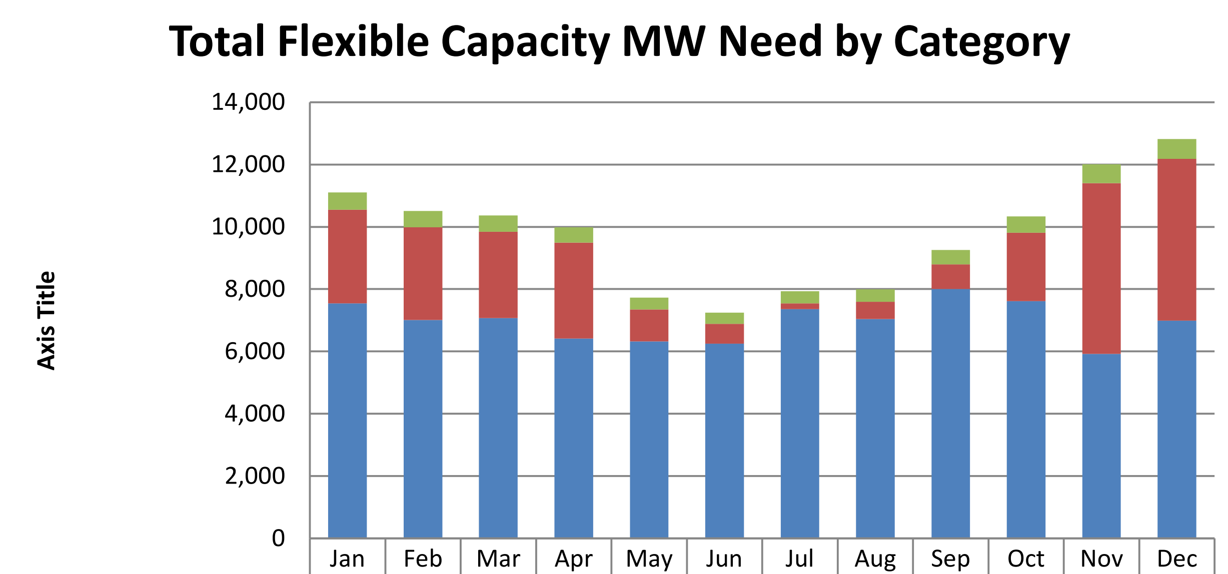
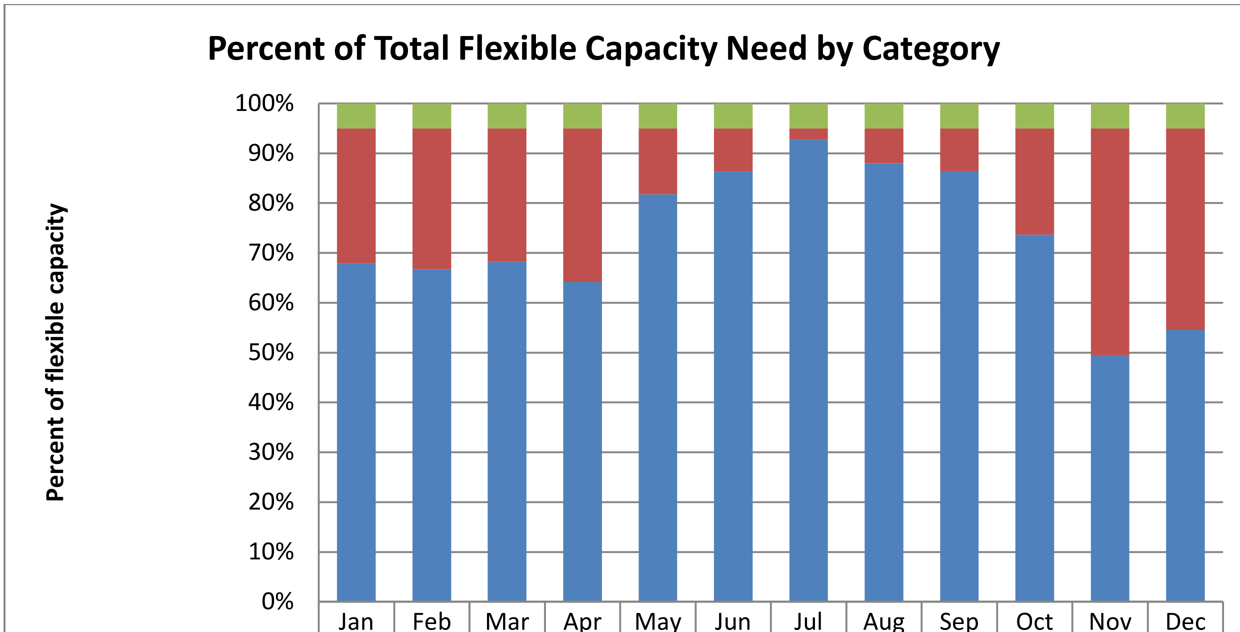
[11] The largest daily secondary 3-hour net-load ramp is calculated as the largest net load ramp that does not correspond with the daily maximum net-load ramp. For example, if the daily maximum 3-hour net-load ramp occurs between 5:00 p.m. and 8:00 p.m., then the largest secondary ramp would be determined by the largest morning 3-hour net-load ramp.

Figure 3: ISO System-Wide Flexible Capacity Monthly Calculation by Category for 2016



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Super-Peak Flexibility	555	525	518	499	387	362	397	400	463	517	600	641
Peak Flexibility	3,001	2,967	2,774	3,078	1,023	629	178	560	790	2,203	5,486	5,187
Base Flexibility	7,547	7,015	7,070	6,412	6,321	6,253	7,360	7,039	8,006	7,612	5,919	6,989



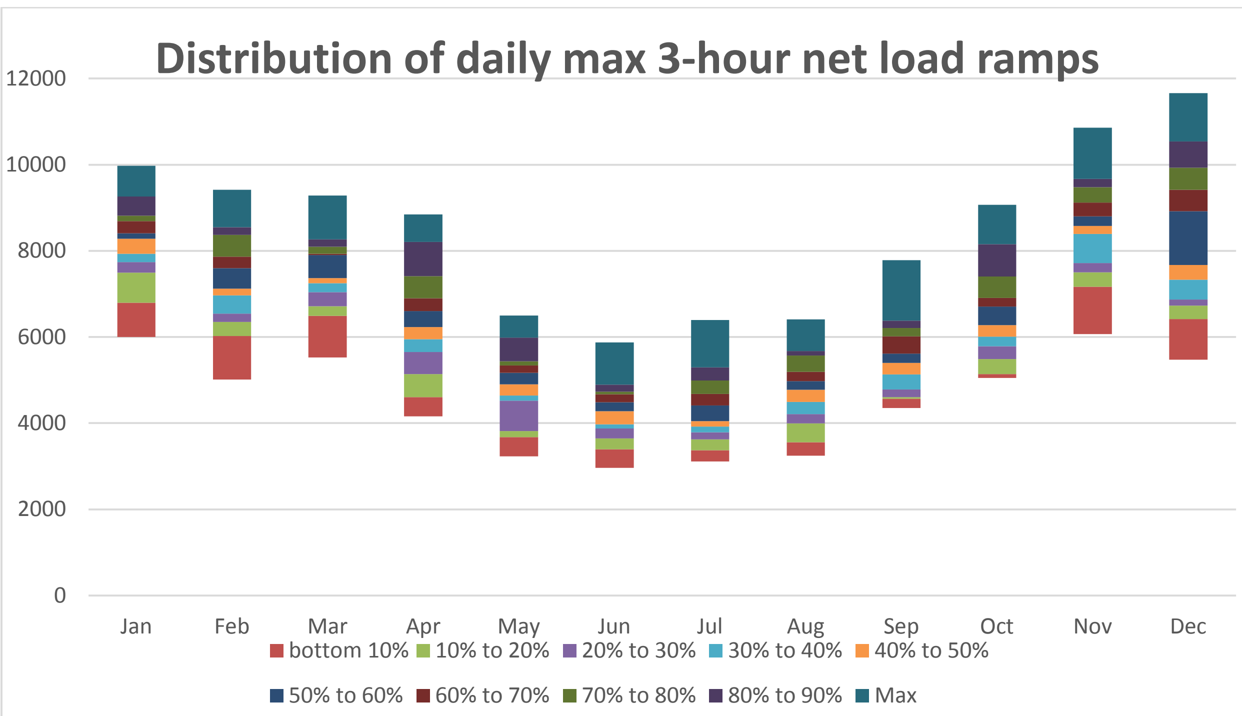
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Super-Peak Flexibility	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Peak Flexibility	27%	28%	27%	31%	13%	9%	2%	7%	9%	21%	46%	40%
Base Flexibility	68%	67%	68%	64%	82%	86%	93%	88%	86%	74%	49%	55%

Again, the addition of the 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

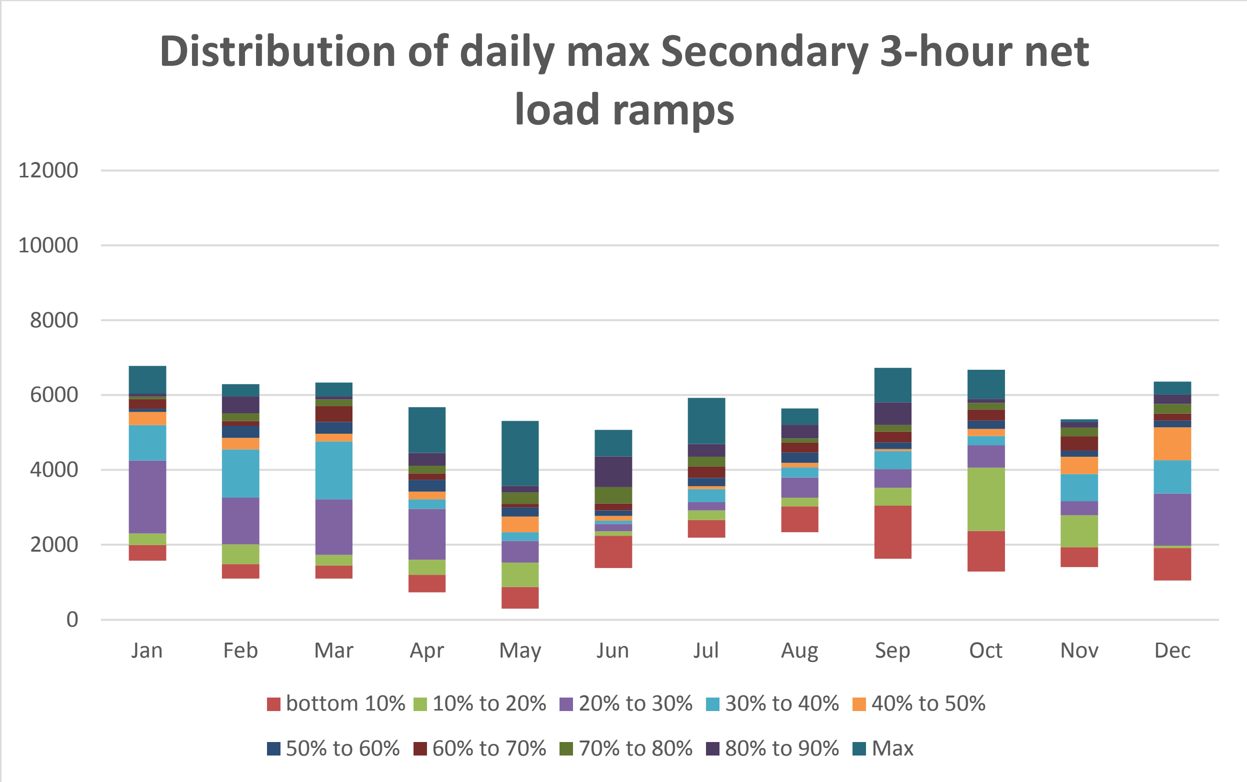
To determine the seasonal percentages for each category, the ISO analyzed the distributions of the largest three-hour net load ramps for the primary and secondary net load ramps to determine appropriate seasonal demarcations for the base flexibility category. The secondary net load ramps provide the 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



[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.

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



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, particularly May - August. Further, the daily secondary three-hour net load ramps are also similar except for June - August. 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.

Figure 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.

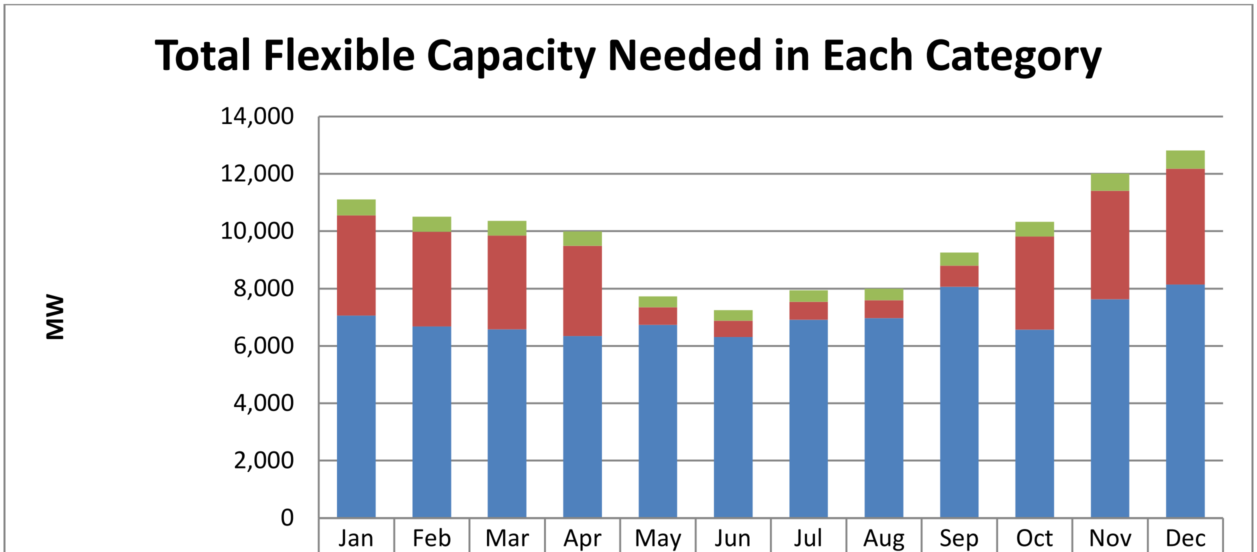
Second, adding flexible capacity procurement to the RA program will increase the process and information requirements. Maintaining a seasonal demarcation that is consistent with the current RA program will reduce the potential for errors in resource adequacy showings.

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 64 percent of the ISO system flexible capacity need for the non-summer months and 87 percent for the summer months. Peak flexible capacity resources could be used to fulfill up to 36 percent of non-summer flexibility needs and 13 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 2014 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 summer months. The ISO's proposed system-wide flexible capacity categories are provided in Figure 6.

[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.

Figure 6: System-wide Flexible Capacity Need in Each Category for 2016



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Super-Peak Flexibility	555	525	518	499	387	362	397	400	463	517	600	641
Peak Flexibility	3,495	3,307	3,262	3,144	614	575	630	635	735	3,252	3,779	4,034
Base Flexibility	7,053	6,674	6,582	6,345	6,730	6,306	6,908	6,963	8,061	6,563	7,626	8,142

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)[14]

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.[15] 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.[16] 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] The 3.5 percent of forecasted peak load for each LSE was always greater than the MSSC. Therefore the MSSC is not referenced in this equation.

[15] Some small LRAs had negative contributions to the flexible capacity needs.

[16] 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[17]

	Average of Load contribution 2016	Average of solar thermal contribution 2016	Average of solar PV contribution 2016	Average of Wind contribution 2016
January	50%	-4%	-46%	-1%
February	52%	-5%	-41%	-2%
March	43%	-8%	-46%	-2%
April	41%	-8%	-53%	2%
May	22%	-10%	-61%	-8%
June	18%	-11%	-78%	7%
July	88%	-3%	-15%	6%
August	55%	-6%	-45%	6%
September	54%	-7%	-40%	1%
October	29%	-9%	-60%	-2%
November	46%	-7%	-46%	-1%
December	53%	-6%	-39%	-2%

As Table 2 shows, Δ Load may not be the largest contributor to the net load ramp during the summer months. This is because the incremental solar PV helps mitigate 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 May and June. 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 2014 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 2014. Then, using the 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 2014 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

[17] 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.

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.[18] 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[19]

		2016			2017		
	Δ Load	Δ PV[20]	Δ Solar Thermal	Δ Wind	Δ PV Fixed	Δ Solar Thermal	Δ Wind
January	92%	96.66%	100.00%	90.86%	95.24%	100.00%	90.94%
February	96%	96.67%	100.00%	90.90%	95.24%	100.00%	90.94%
March	95%	96.74%	100.00%	90.90%	95.34%	100.00%	90.94%
April	90%	96.74%	100.00%	90.90%	95.34%	100.00%	90.85%
May	98%	96.74%	100.00%	90.90%	95.34%	100.00%	90.85%
June	95%	96.74%	100.00%	90.90%	95.34%	100.00%	90.82%
July	96%	95.98%	100.00%	90.90%	95.35%	100.00%	90.80%
August	95%	95.98%	100.00%	90.90%	95.35%	100.00%	90.80%
September	95%	95.98%	100.00%	91.23%	95.35%	100.00%	90.80%
October	96%	96.04%	100.00%	91.22%	95.35%	100.00%	90.80%
November	95%	96.05%	100.00%	91.25%	95.35%	100.00%	90.80%
December	94%	96.30%	100.00%	91.08%	95.39%	100.00%	90.80%

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 of individual LSEs will only be provided to its jurisdictional LRA as per section 40.10.2.1 of the ISO tariff.

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18 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.

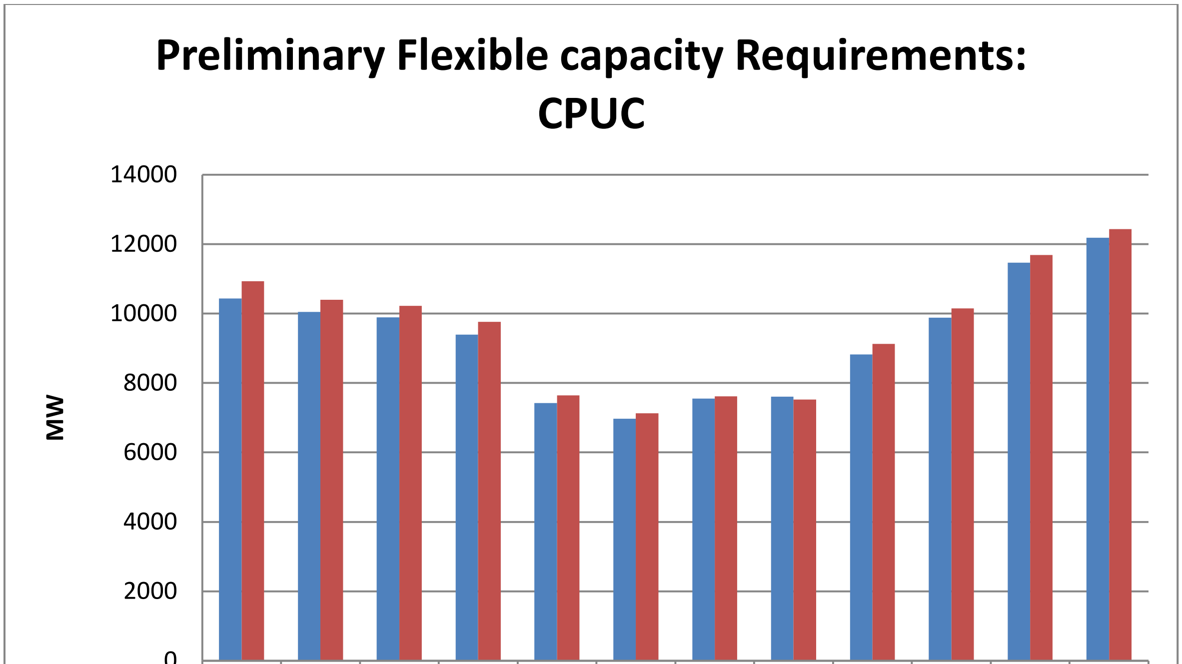
19 Because of the geographic differences in the output, at some times one LRA's resources could be reducing the net-load ramp while another's could be increasing it.

20 Includes contributions from behind the meter solar.

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

	2016						2017					
	Δ Load	Δ PV Fixed	Δ Solar Thermal	Δ Wind	3.5% expected Peak Load	2016 Total	Δ Load	Δ PV Fixed	Δ Solar Thermal	Δ Wind	3.5% expected Peak Load	2017 Total
Jan	4534	4389	386	89	1032	10429	4348	5132	375	55	1018	10927
Feb	4683	3756	434	184	993	10050	4695	4278	540	-91	978	10400
Mar	3802	4168	730	209	986	9894	3814	4500	733	208	971	10225
Apr	3234	4548	695	-129	1041	9389	3239	4928	695	-129	1027	9759
May	1371	3830	646	443	1127	7417	1128	4307	644	453	1113	7646
Jun	1028	4422	661	-394	1250	6967	882	4645	715	-351	1236	7127
Jul	5394	891	181	-330	1410	7546	4201	2131	268	-385	1396	7612
Aug	3369	2747	407	-367	1450	7606	1989	3952	572	-430	1437	7520
Sep	3979	3018	563	-84	1348	8825	2569	4524	837	-142	1334	9123
Oct	2531	5209	861	128	1156	9886	2472	5539	867	127	1142	10147
Nov	4742	4774	764	133	1049	11462	4588	5095	678	295	1034	11691
Dec	5787	4431	646	259	1056	12179	5875	4606	653	261	1041	12437

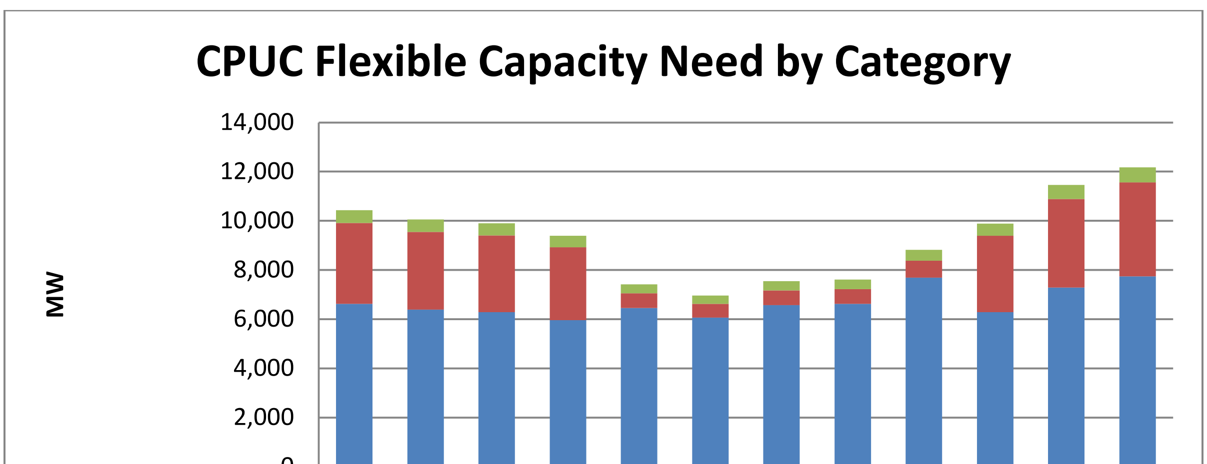
Figure 7: CPUC Jurisdictional LSEs' Contribution to Flexible Capacity Needs



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016 Total	10429	10050	9894	9389	7417	6967	7546	7606	8825	9886	11462	12179
2017 Total	10927	10400	10225	9759	7646	7127	7612	7520	9123	10147	11691	12437

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	Dec
Super-Peak Flexibility	521	502	495	469	371	348	377	380	441	494	573	609
Peak Flexibility	3,283	3,163	3,114	2,955	589	553	599	604	701	3,112	3,608	3,834
Base Flexiblity	6,625	6,384	6,285	5,964	6,458	6,065	6,570	6,622	7,683	6,280	7,281	7,737

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 believes 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 2017 in late 2015. 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.