Draft Flexible Capacity Needs Assessment for 2020

April 04, 2019

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1. Introduction

Each year, the ISO conducts an annual flexible capacity technical study to determine the flexible capacity needs of the system for up to three years into the future. This helps to ensure the ISO maintain system reliability as specified in the 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 flexible capacity needs assessment specifying the ISO's forecast monthly flexible capacity needs in year 2020.

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 study to allocate shares of the system flexible capacity[1] 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 of Overall Process

The ISO determines the quantity of flexible capacity needed each month to reliably address its flexibility and ramping needs for the upcoming resource adequacy year and publishes its findings in this flexible capacity needs assessment. The ISO calculates flexible capacity needs using the calculation method 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 2020 are based on the following dataset provide by the California Energy Commission for 2020:

1. CEC's 1-in-2 hourly IEPR forecast Managed Total Energy for Load[1], which looks at the following components:
    a. Baseline Consumption Load

[1] https://www.energy.ca.gov/2018_energypolicy/documents/index.html

b. Committed behind the meter photo-voltaic (PV) Generation
c. Additional achievable behind the meter PV generation
d. Additional achievable energy efficiency (AAEE)
e. Publically Owned Utility (POU) AAEE

1) System-wide flexible capacity needs for 2020 are greatest in the non-summer months and range from 12,355 MW in July to 18,803 MW in February 2020. .

2) The minimum amount of flexible capacity needed from the “base flexibility” category is 52 percent of the total amount of installed or available flexible capacity in the summer months (May – September) and 35 percent of the total amount of flexible capacity for the non-summer months (October – April).

3) The ISO established the time period of the must-offer obligation for resources counted in the “Peak” and “Super-Peak” flexible capacity categories as the five-hour periods of hour ending HE16 through HE20 for January through April and October through December; HE16 through HE20 for May through September. These hours are the same from those in Final Flexible Capacity Needs Assessment for 2019.

4) The ISO published advisory requirements for the two years following the upcoming Resource Adequacy (RA) year at the ISO system total levels as shown in Figure 2.

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

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

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

Where:

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

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

For the 2020 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 2020-2022 minute-by-minute net load using all expected and existing grid connected wind and solar resources and the CEC 1-in-2 Hourly IEPR load forecast. The ISO used the most recent year of minute-by-minute actual load information to formulate a smoothed minute-by-minute 2020-2022 load forecast.

2) Calculate the monthly system-level three-hour upward net load ramp needs using the minute-to-minute net load forecast;

3) Calculate the percentages needed in each category in each month and add the contingency reserve requirements into the categories proportionally to the percentages established calculated in step 2;

4) Analyze the distributions of both the 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 for all months within a season; and

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

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 grid-connected fleet of variable energy resources. After obtaining this data from all LSEs, the ISO constructed the forecast minute-by-minute load, wind, and grid connected solar before calculating the net load curves for 2020 through 2022.

4.1 Building the Forecasted Variable Energy Resource Portfolio

To collect the necessary data, the ISO sent a data request on December, 2019 to the scheduling coordinators for all LSEs representing load in the ISO balancing area[3]. The deadline for submitting the data was January 15, 2019. At the time of the draft report, the ISO had received data from all LSEs. The data request asked for information on each wind, grid connected 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. Since the

[3] A reminder notice was also sent out in early January, 2019.

CEC's load forecast accounted for the expected behind-the-meter production, there was no need for the CAISO to include the behind-the-meter production in the net load calculation. Also, 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, the ISO requested additional information as to whether the resource is or would be dynamically scheduled into the ISO. The ISO only included external resources in the flexible capacity requirements assessment if they were dynamically scheduled to the ISO. Based on the 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 contractually 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 curves[4] for 2020. 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)[3]

Resource Type	Existing MW (2018)	2019 MW	2020 MW
ISO Solar PV	9,362	10,539	11,773
ISO Solar Thermal	1,178	1,108	1,028
ISO Wind	4,609	4,696	4,744
Incremental behind-the-meter Solar PV		1,263	1,330
Total Variable Energy Resource Capacity in the 2018 Flexible Capacity Needs Assessment	15,149	17,606	18,875
Non ISO Resources All external VERS not-firmed by external BAA	1,067	1,091	1,096
Total internal and non-firmed external VERs	16,216	18,697	19,971
Incremental New Additions in Each Year		2,481	1,274

Table 1 aggregates the variable energy resources system wide. Additionally, for existing solar and wind resources, the ISO used the most recent full year of actual solar output data available, which was 2018. For future wind resources, the ISO scaled the overall one-minute wind production for each month of the most recent year by the expected future capacity

4 Net-load load is defined as load minus wind production minus solar production minus behind-the-meter solar PV production.

3 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.

divided by the installed wind capacity for the same month of the most recent year. Specifically, to develop the wind profiles for wind resources, the ISO used the following formula:

$$2020\ W_{Mth\_Sim\_1\text{-}min} = 2018W_{Act\_1\text{-}min} * 2020W_{Mth\ Capacity} / 2018W_{Mth\ Capacity}$$

To develop one-minute transmission connected solar profiles for 2020, the ISO used the actual one-minute profiles for 2018 using the following formula:

$$2020S_{Mth\_Sim\_1\text{-}min} = 2018S_{Act\_1\text{-}min} * 2020S_{Mth\ Capacity} / 2018S_{Mth\ Capacity}$$

Given the amount of incremental wind and solar resources expected to come on line, this approach allows the ISO to maintain the load/wind/solar correlation for the forecasted wind and solar capacity outputs.

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 obtained hourly incremental behind-the-meter solar PV production data from the CEC, which was used to generate one-minute of behind-the-meter solar profiles. If this hourly solar PV production data is not factored into the model, 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 the calculation of the monthly three hour net load ramps. Including this incremental capacity allows the ISO to more accurately capture the forecasted monthly three-hour net load ramps. Because behind-the-meter resources are solar PV, the ISO included the contribution of the incremental behind-the-meter solar PV 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.

4.2 Building Minute-by-Minute Net Load Curves

The ISO used the CEC 2018 Integrated Energy Policy Report (IEPR) 1-in-2 hourly load forecast (Managed Total Energy for Load) to develop minute-by-minute load forecasts for each month.[4] The ISO scaled the actual load for each minute of each hour of 2018 using an expected CEC's load growth factor for the corresponding hour.

[4] https://www.energy.ca.gov/2018_energypolicy/documents/cedu_2018-2030/2018_demandforecast.php

$$2020\ L_{Mth(i)Day(y)Hour(z)\_sim\_1\text{-}min} = 2018\ L_{Mth(i)Day(y)Hour(z)\_Act\_1\text{-}min} * 2020\ L_{Mth(i)Day(y)Hour(z)\_Forecast} / 2018 L_{Mth(i)Day(y)Hour(z)\_Actual}$$

Where:

i = 1 through 12

y = 1 through 29 (February 2020); 30 or 31 depending on the month

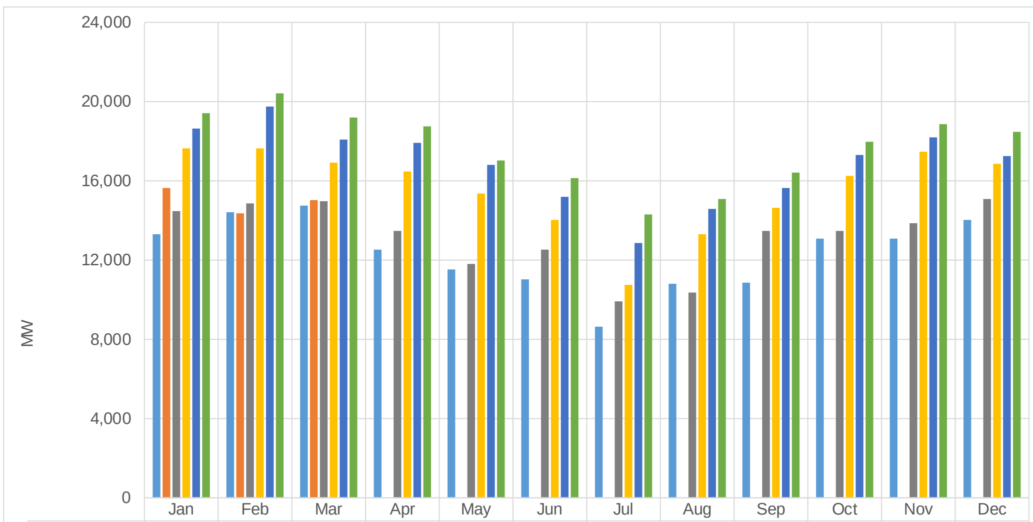
z = 1 through 24

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 grid connected output of the wind and solar from the load to generate the minute-by-minute net load curves, which is necessary to conduct the flexible capacity needs assessment.

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

The ISO, using the net load forecast developed in Section 4, calculated the maximum three-hour net load ramp for each month of 2020. Figure 1 shows the ISO system-wide largest three-hour net load ramp for each month of 2020 compared with each month of the actual three-hour net load ramp for 2018 and the first two full months of 2019.

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



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018 (Actual)	13,326	14,440	14,777	12,553	11,571	11,057	8,679	10,805	10,866	13,082	13,087	14,059
2019 (Actual)	15,639	14,360	15,070									
2019 Recom.	14,506	14,889	14,971	13,509	11,808	12,524	9,967	10,393	13,511	13,510	13,898	15,129
2020	17,638	17,653	16,943	16,518	15,398	14,053	10,792	13,304	14,672	16,285	17,481	16,905
2021	18,680	19,782	18,105	17,951	16,807	15,227	12,880	14,592	15,673	17,325	18,189	17,269
2022	19,444	20,449	19,220	18,792	17,026	16,172	14,323	15,087	16,425	18,014	18,869	18,503

2018 (Actual) 2019 (Actual) 2019 Recom. 2020 2021 2022

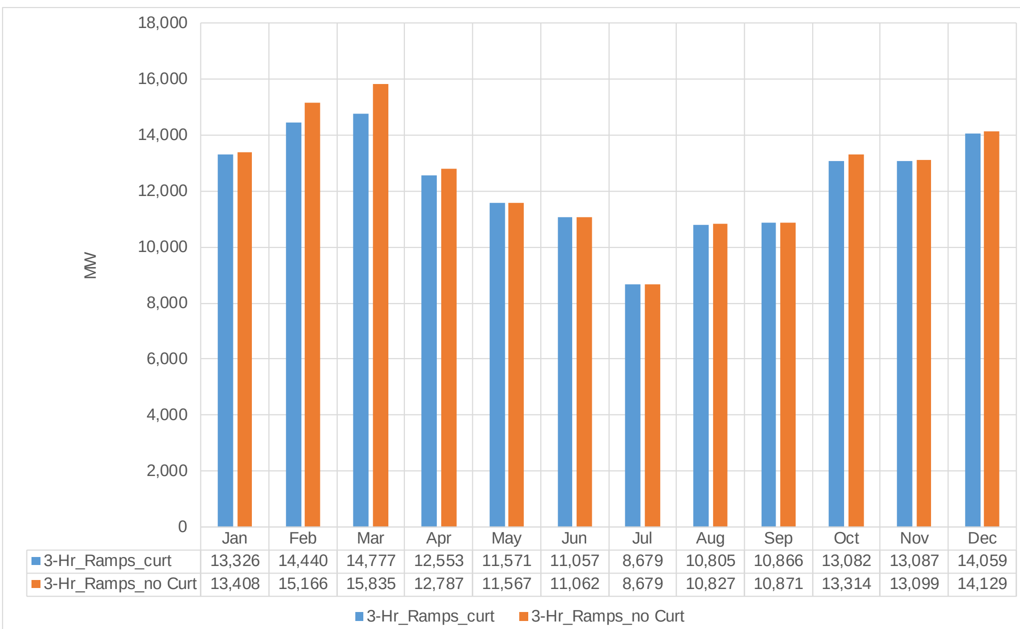
http://www.energy.ca.gov/2018_energypolicy/documents/2019-02-21_business_meeting/2019-02-21_hourly_forecasts.php

The results for the non-summer months of 2020 are higher than those predicted in the summer months. This is consistent with historical trends.

As part of the 2020 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.

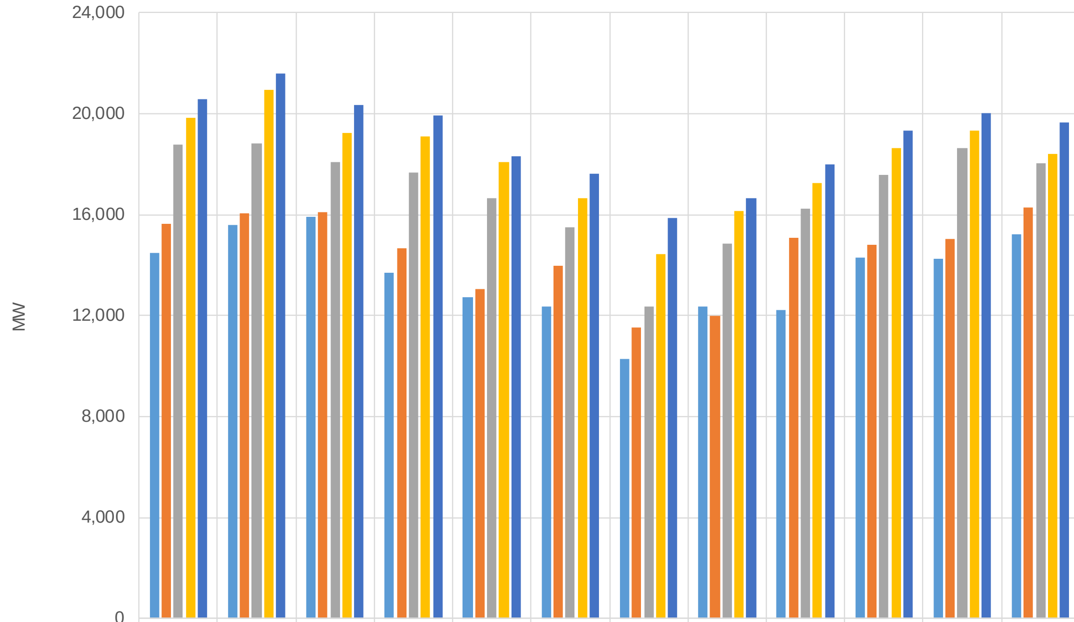
It is important to note that the actual three-hour net load ramps may have curtailments present in the actual data used. Depending on the time of day the curtailments occur, it can have an effect on reducing the three-hour ramp by raising the “belly of the duck.”

Figure 2:   The ISO 2018 Maximum Monthly 3-Hour Ramps With/Without Curtailments



Finally, the ISO summed the monthly largest three-hour contiguous ramps and the maximum of the most severe contingency or 3.5 percent of the forecast peak-load for each month. This sum yields the ISO system-wide flexible capacity needs for 2020. The monthly flexible capacity needs for 2020 together with the actual monthly flexible capacity needed for 2018 are shown in Figures 3 below.

Figure 3:   The ISO System Monthly Maximum Three-Hour Flexible Capacity Requirements



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018 (Actual)	14,476	15,590	15,927	13,703	12,721	12,373	10,300	12,380	12,216	14,298	14,237	15,209
2019	15,656	16,039	16,121	14,659	13,074	13,965	11,538	11,973	15,100	14,797	15,048	16,279
2020	18,788	18,803	18,093	17,668	16,665	15,496	12,355	14,877	16,257	17,579	18,631	18,055
2021	19,830	20,932	19,255	19,101	18,082	16,662	14,429	16,150	17,248	18,627	19,339	18,419
2022	20,594	21,599	20,370	19,944	18,310	17,610	15,866	16,643	18,004	19,329	20,019	19,660

2018 (Actual) 2019 2020 2021 2022

6. Calculating the Seasonal Percentages Needed in Each Category

As described in the ISO Tariff sections 40.10.3.2 and 40.10.3.3, the ISO divided its flexible capacity needs into various categories based on the system's operational needs. These categories are based on the characteristics of the system's net load ramps and 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 a maximum amount of flexible capacity that can come from resources that only meet the criteria to be counted under the peak flexibility or super-peak flexibility categories.

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

Base Flexibility: Operational needs determined by the magnitude of the largest three-hour secondary net load[8] ramp

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8 The largest daily secondary three-hour net-load ramp is calculated as the largest net load ramp that does not correspond with the daily maximum net-load ramp. For example, if the daily maximum three-hour net-load

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

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

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

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.

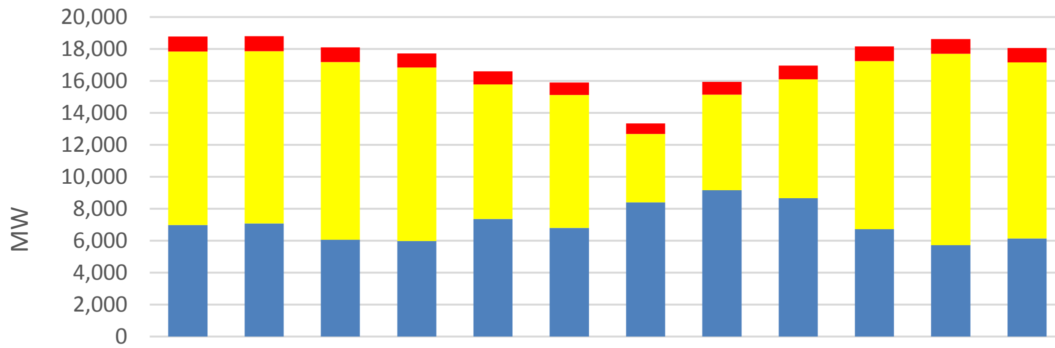
6.1 Calculating the Forecast Percentages Needed in Each Category in Each Month

Based on the categories defined above, the ISO calculated the system level needs for 2020 based only on the maximum monthly three-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 three-hour net load ramp. The ISO distributed contingency reserve based on the proportions of the corresponding categories.

The calculation of flexible capacity needs for each category for 2020 is shown in Figure 3.

Figure 3: ISO System-Wide Flexible Capacity Monthly Calculation by Category for 2020

ramp occurs between 5:00 p.m. and 8:00 p.m., then the largest secondary ramp would not be overlap with the 5:00 p.m. - 8:00 p.m. period



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Super-Peak Flexibility	939	940	905	886	830	796	667	797	848	908	932	903
Peak Flexibility	10,865	10,779	11,122	10,858	8,422	8,308	4,287	5,987	7,441	10,522	11,973	11,016
Base Flexibility	6,983	7,084	6,067	5,974	7,352	6,807	8,394	9,152	8,668	6,728	5,727	6,136

In the 2020 results, we continue to see the base category percentage reduce which is related to the changes of the net load shape primarily due to solar and load.

6.2 Analyzing Ramp Distributions to Determine Appropriate Seasonal Demarcations

To determine the seasonal percentages for each flexible capacity category, the ISO analyzed the distributions of the largest three-hour net load ramps for the primary and secondary net load ramps to determine appropriate seasonal demarcations for the base flexibility category. The secondary net load ramps provide the ISO with the frequency and magnitude of secondary net load ramps. Assessing these distributions helps the ISO identify seasonal differences that are needed for the final determination of percent of each category of flexible capacity. The primary and secondary net load ramp distributions are shown for each month in Figures 4 and 5, respectively.

Figure 4: Distribution of Daily Primary Three-hour Net Load Ramps for 2020

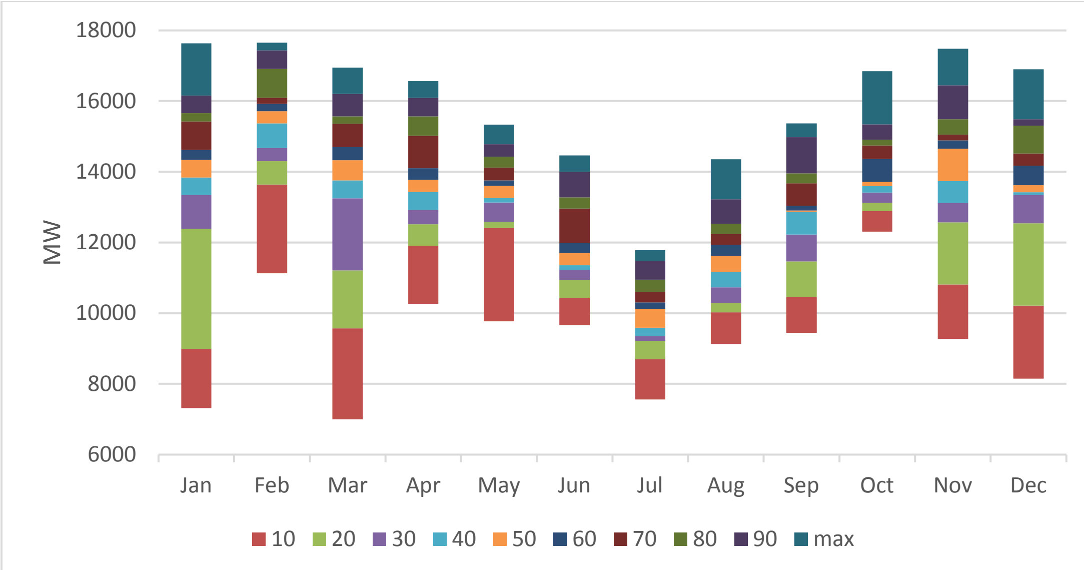
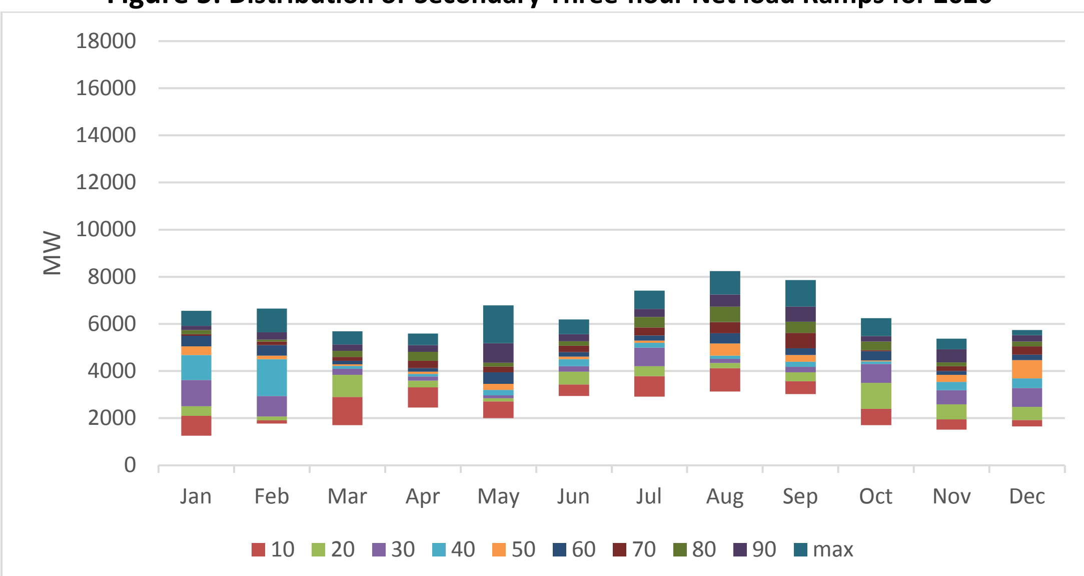


Figure 5: Distribution of Secondary Three-hour Net load Ramps for 2020



As Figure 4 shows, the distribution (*i.e*. the height of the distribution for each month) of the daily maximum three-hour net load ramps are smaller during the summer months. The maximum three-hour net load ramps for May and September are more variable than other months. This is due in large part to these months being transitional months where some days are similar to summer days, while other days are similar to non-summer days. In other words, these months can exhibit a wide range of daily net-load profiles. 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. Accordingly, the ISO must ensure there is sufficient base ramping for all days of the month. 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 4 and 5 show a distinct transition between seasons that 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.

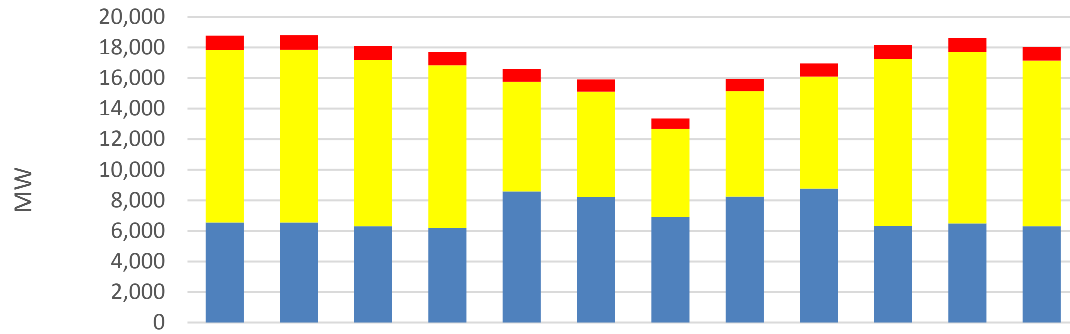
First, it mitigates the impact that variations in the net load ramp in any given month can have on determining the amounts for the various flexible capacity categories for a given season. For example, a month may have either very high or low secondary ramps that are simply the result of the weather in 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 35 percent of the ISO system flexible capacity need for the non-summer months and 52 percent for the summer months. Peak flexible capacity resources could be used to fulfill up to 35 percent of non-summer flexibility needs and 52 percent of summer flexible capacity needs. The super-peak flexibility category is fixed at a maximum five percent across the year. We have observed over the years that the base flexibility category percentages continue to lower where the peak flexible capacity percentages continue to rise. As with the increase in the flexible capacity need, the change is largely attributable to the continued growth of both grid connected and behind-the-meter solar. 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. As the gird connected solar and the incremental behind-the-meter solar continue to grow we are seeing an increase in the down-ramp associated with sunrise, especially during the shoulder months where there is minimal heating or cooling load. The ISO's proposed system-wide flexible capacity categories are provided in Figure 6.

Figure 6: System-wide Flexible Capacity Need in Each Category for 2020 -Adjusted



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Super-Peak Flexibility	939	940	905	886	830	796	667	797	848	908	932	903
Peak Flexibility	11,303	11,312	10,885	10,659	7,190	6,890	5,780	6,900	7,342	10,924	11,209	10,862
Base Flexibility	6,545	6,551	6,303	6,173	8,584	8,226	6,901	8,238	8,766	6,326	6,491	6,290

7. Allocating the Flexible Capacity Needs to Local Regulatory Authorities

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

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

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

2) Δ Load – LRA's average contribution to load change during 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 Three-hour net load changes x ISO total change in wind output during the largest Three-hour net load change

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

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

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

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

The above equation can be simply expressed as

$$\text{Flex Requirement} = \Delta NL_{2020} + R_{2020}$$

$$= \Delta L_{2020} - \Delta W_{2020} - \Delta S_{2020} + R_{2020}$$

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

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

Δ Ramp, NL = L – W – S, ΔNL = ΔL – ΔW – ΔS,

ΔNL_{2020} Net Load Ramp Req in 2020, $\Delta NL_{sc,2020}$ Net Load Ramp Allocation for SC in 2020,

pl_r_{sc} CEC peak load ratio, and finally, Σ summation of all SC.

In 2020, the ISO has forecasts from CEC L_{2020} , survey results from $W_{2020} = \Sigma W_{sc,\,2020}$, $S_{2020} = \Sigma S_{sc,\,2020}$, hence all the ramps $\Delta L_{2020}, \Delta W_{2020}, \Delta S_{2020}$, plus R_{2020}. Moreover, the ISO has the peak load ratio list from CEC, $\Sigma pl\_r_{sc} = 1$.

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

$$\text{Flex Need} = \Delta NL_{2020} + \Sigma pl\_r_{sc} * R_{2020}$$

$$= \Delta L_{2020} - \frac{\Sigma W_{sc,\,2020}}{W_{2020}} * \Delta W_{2020} - \frac{\Sigma S_{sc,2020}}{S_{2020}} * \Delta S_{2020} + \Sigma pl\_r_{sc} * R_{2020}$$

Since the ISO has no pre-knowledge of, $\Delta L_{SC,y+2}$, the load ramp at SC level in future year $y+2$ at the current year $y = 2018$, the allocation of ΔL_{2020} to SC has been more challenging. Over the years, the ISO has used different approaches to meet the challenge.

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

$$\frac{\Delta L_{sc,\,y}}{\Delta L_{y}} \Delta L_{y+2},$$

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

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

$$\Delta L_{sc,y+2} = L^{E}_{sc,y}\left(\frac{L^{E}_{y+2}}{L^{E}_{y}}\right) - L^{S}_{sc,y}\left(\frac{L^{S}_{y+2}}{L^{S}_{y}}\right),$$

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

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

This year, the ISO proposes a new formula which best utilizes $\Delta L_{sc,\,y}$ while the system ΔL_{y} is not in the denominator,

$$\Delta L_{2020} = \Delta L_{2018} + \left(\Delta L_{2020} - \Delta L_{2018}\right)$$

$$= \Sigma \Delta L_{sc,\,2018} + \frac{\Sigma L^{M}_{sc,\,2018}}{L^{M}_{2018}} * \left(\Delta L_{2020} - \Delta L_{2018}\right),$$

where ΔL_{2018} is the average load portion of top 5 maximum 2018 three-hour ramps while matching 2020 maximum 3h ramp on month and time, and L^{M}_{2018} is the average load at beginning and the end of points during those top 5 ramps. In 2020, each SC will receive:

$$\Delta L_{sc,\,2018} + \frac{L^{M}_{sc,\,2018}}{L^{M}_{2018}} * \left(\Delta L_{2020} - \Delta L_{2018}\right)$$

Therefore each SC's contribution $\Delta L_{sc,\,2018}$ will be explicitly projected into future year 2020, and any additional increase of $(\Delta L_{2020} - \Delta L_{2018})$ will be allocated by a load ratio share. The new calculation provides stable allocation for the load proportion.

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

The ISO will make available all non-confidential working papers and data that the ISO relied on for the Final Flexible Capacity Needs Assessment for 2020. Specifically, the ISO will post materials and data used to determine the monthly flexible capacity needs, the contribution of CPUC jurisdictional load serving entities to the change in load, and seasonal needs for each flexible capacity category. This data is available for download as a large Excel file named "2020 Flexible Capacity Needs Assessment – 2020 Net Load Data" at: http://www.caiso.com/informed/Pages/StakeholderProcesses/FlexibleCapacityNeedsAssessmentProcess.aspx

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

Table 2: Contribution to Maximum Three-hour Continuous Net load Ramp for 2020

Month	Average of Load contribution 2020	Average of Wind contribution 2020	Average of Solar contribution 2020	Total percent 2020
January	43.11%	-1.61%	-55.28%	100%
February	39.86%	4.63%	-64.76%	100%
March	30.70%	-4.79%	-64.51%	100%
April	32.26%	-0.46%	-67.28%	100%
May	31.36%	-2.56%	-66.08%	100%
June	26.46%	-4.83%	-68.71%	100%
July	15.30%	2.43%	-87.13%	100%
August	24.06%	-1.89%	-74.05%	100%
September	27.26%	-1.36%	-71.39%	100%
October	34.39%	-1.57%	-64.04%	100%
November	38.87%	-5.43%	-55.69%	100%

December	44.27%	-0.94%	-54.80%	100%

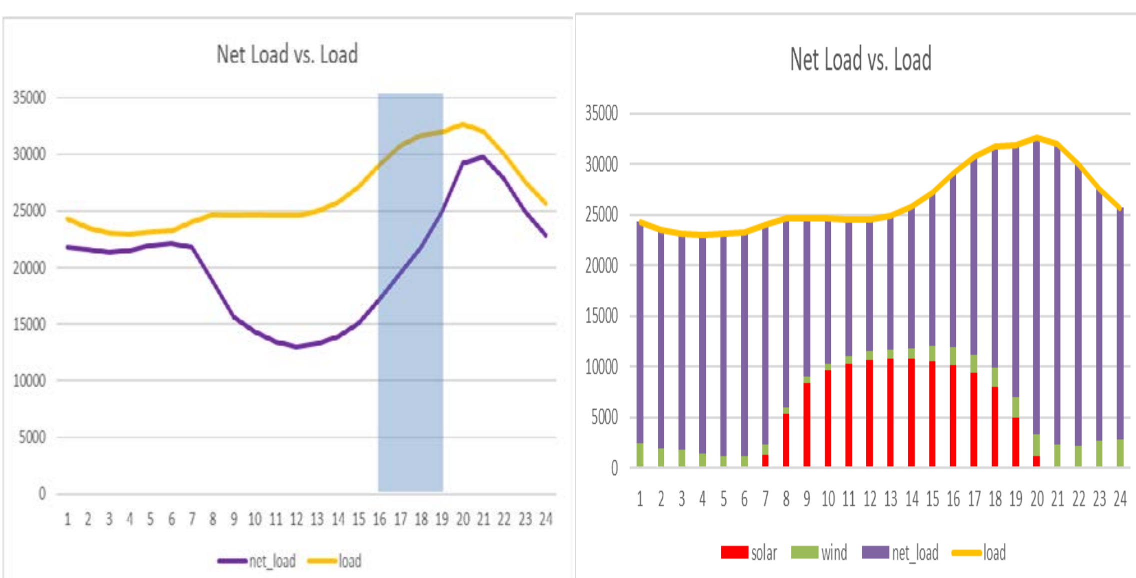
When looking at the contribution to the maximum three-hour continuous net load ramp shown in Table 2, the above total percentage is calculated as Load – Solar – Wind. When looking at August you get to 100% by following the below example.

Total Contribution is equal to: 24.06%– (-1.89%) – (-74.05%) = 100%

As Table 2 shows, Δ Load is not the largest contributor to the net load ramp because the incremental solar PV mitigates morning net load ramps. The solar resources are leading to maximum three-hour net load ramps during summer months that occur in the afternoon. This is particularly evident during July and August. This implies that the maximum three-hour net load ramp typically happens when sun is setting. The contribution of solar PV resources has increased relative to last year's study and remains a significant driver of the three-hour net load ramps. Since the CEC has behind meter solar imbedded in its 2020 hourly load forecast, the interplay between load and solar contributions will depend on the scales of future expansion of utility base solar PV and future installation of behind meter solar panels. The ISO anticipates more solar dominance in the ISO flexible needs in the coming years.

Figure 7 illustrates the behavior of load, wind, and solar when the net load reaches its maximum. In this example, the load ramp has only about 25% contribution to the net load ramp.

Figure 7: Examples of load contribution to net load ramp



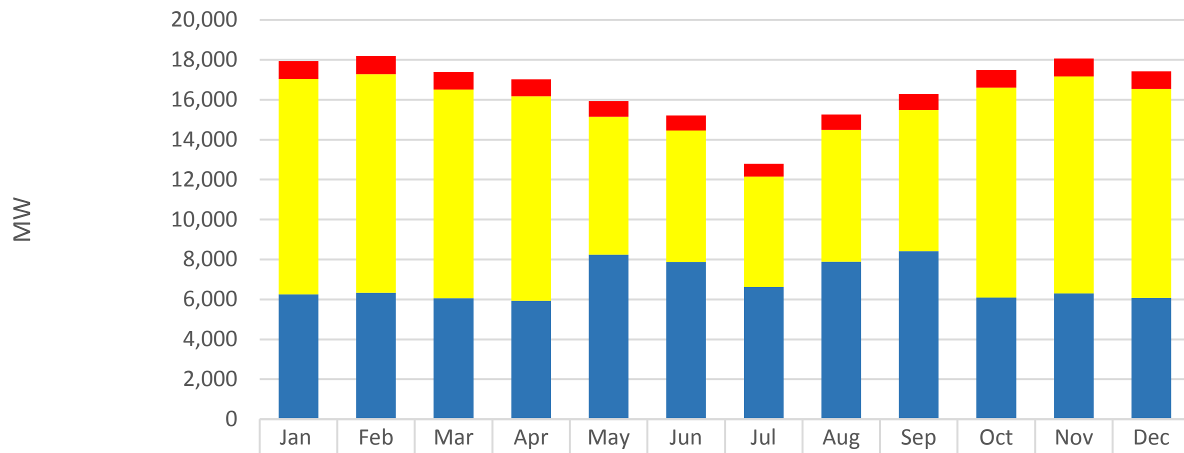
The CPUC allocations are shown in Table 3 and Figure 8. The contributions calculated for other LRAs will only be provided the contribution of its jurisdictional LRA as per section 40.10.2.1 of the ISO tariff.

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

Month	Load	Wind	Solar	reserve	Total Allocation
January	7,311	-273	-9,305	1,046	17,935
February	7,029	786	-10,905	1,046	18,194
March	5,137	-781	-10,425	1,046	17,389
April	5,278	-73	-10,632	1,046	17,029
May	4,741	-378	-9,661	1,158	15,938
June	3,742	-673	-9,490	1,316	15,221
July	1,847	276	-9,802	1,426	12,799
August	3,410	-261	-10,153	1,438	15,262
September	4,164	-201	-10,485	1,445	16,294
October	5,730	-255	-10,310	1,193	17,490
November	6,800	-915	-9,305	1,046	18,066
December	7,394	-150	-8,831	1,046	17,422

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 7.

Figure 8: CPUC Flexible Capacity Need in Each Category for 2020



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Super-Peak Flexibility	897	910	869	851	797	761	640	763	815	874	903	871
Peak Flexibility	10,790	10,946	10,461	10,245	6,902	6,591	5,542	6,609	7,056	10,522	10,869	10,481
Base Flexiblity	6,248	6,339	6,058	5,933	8,240	7,869	6,617	7,890	8,424	6,093	6,294	6,069

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). The average net load curves for each month provide the most reliable assessment of whether a flexible capacity resource would be greatest benefit to the stability of ISO. The ISO analyzes the morning and afternoon ramps to ensure the must-offer obligation lines up with the calculated maximum three-hour net load movement. The selection of the five-hour period by season (Summer May-Sep; Winter Nov-Dec, Jan-Apr) has two major inputs: it should cover the hours with maximum three hour ramp and it occurs during the continuous net load ramp, which is typically correlated to the solar ramp down during sunset. Table 4 shows the hours in which the maximum monthly average net load ramp began.

Table 4: 2020 Forecasted Hour in Which Monthly Maximum Three-Hour Net load Ramp Began

	Three Hour Net Load Ramp Start Hour (Hour Beginning)			
Month	14:00	15:00	16:00	17:00
January	31			
February	18	10		
March	4	10	17	
April		3	26	1
May		3	21	7
June			27	3
July	1	3	27	
August		19	12	
September	2	28		
October	3	28		
November	30			
December	31			

The ISO believes that the appropriate flexible capacity must-offer obligation period for peak and super-peak flexible capacity categories is HE 16 through HE 20. For winter season, the net load flattens or slightly decreases starting HE 20 during the majority of the Winter Season months. The ISO continues to watch the behavior of the shoulder seasons (March through April, and September) as you can see some characteristics look similar to the current summer season patterns. For the winter season; the ISO believes overall that the appropriate flexible capacity must-offer obligation period for peak and super-peak flexible capacity categories is HE 16 through HE 20 for January through April and October through December. These hours are the same from those in Final Flexible Capacity Needs Assessment for 2019.

Table 5: Summary of MOO hours proposed by ISO for 2020

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HE16-HE20	v	v	v	v	v	v	v	v	v	v	v	v

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HE16-HE20	v	v	v	v	v	v	v	v	v	v	v	v

In summary, based on the data for all daily maximum three hour net load ramps, the ISO believes that the appropriate flexible capacity must-offer obligation period for peak and super-peak flexible capacity categories is HE 16 through HE 20 for January through April and October through December; HE 16 through HE 20 for May through September. These hours are the same from those in Final Flexible Capacity Needs Assessment for 2019.

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

9. Next Steps

The ISO will commence the flexible capacity needs assessment to establish the ISO system flexible capacity needs for 2021 in early 2020. 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.