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Demand Response Qualifying Capacity
Load Impact Protocols Informed by Loss of Load Expectation (LIP + LOLE)

The current load impact protocols (LIP) estimate the ex-ante load reduction for demand response (DR) on an hourly basis for a five-hour event from 4-9 pm (HE17-21). The load reduction is based upon both a 1 in 2 and 1 in 10 peak load assumption. For Resource Adequacy, the qualifying capacity is the simple average of the load reduction for the five hours to calculate a single monthly value utilizing the 1 in 2 peak load assumption.[1] The shortcoming of this approach is that the hourly load reduction value in terms of reliability from 4-9 pm is not identical. For example, a load reduction during 6-8 pm would be used more often to maintain reliability than a reduction from 4-6 pm. If a DR program does not have a constant load reduction over time, such as A/C cycling, then the simple average does not consider value differences across hours.

The results from system reliability modeling can be utilized to develop hourly weights that can be used to determine the weighted average of load reduction for an assumed demand response event. This offers the following benefits:

- The hourly load reduction is matched to its value to affect grid reliability as measured from the reliability model
- The proposal does not require time-intensive and costly modeling of the reliability impacts of individual DR programs
- It is a simple additional step to the current process using the load impact protocols
- It captures interactive or saturation impacts because all resources and weather scenarios are imbedded in the reliability results

Loss of Load Probability and Loss of Load Expectation

The CEC[2] and CPUC[3] have performed reliability modeling to determine if the current resource portfolio or a future resource plan will achieve the desired reliability metric of no more than 1 day in 10 years of not being able to serve load.[4] The reliability model will run multiple scenarios for load (based upon historical weather patterns) and resource availability. The resources included are all existing resources and, in the case of a forecast, will include adjustments for anticipated new resources or retirements. The reliability model will also include various scenarios for unit forced outages. An output of the reliability model is unexpected served energy (EUE) for each scenario. Most of the scenarios will have no unserved energy because the expected capacity on the system is greater than the expected peak load. The number of scenarios that have unserved energy compared to the total number of runs yields the loss of load probability (LOLP). For each scenario that has unserved energy, this can occur in different hours or months. When all the scenarios are combined, an hourly LOLP results which shows

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[1] The qualifying capacity is grossed up by the planning reserve margin which includes a factor for load variation, so to prevent double counting of weather events the 1 in 2 peak load is used.

[2] CEC Staff Report, September 9, 2021, Energy System Reliability: Midterm Reliability Analysis, CEC-200-2021-009

[3] CPUC performs reliability modeling for its Integrated Resource Plan to develop a preferred system plan in the 2030+ years to meet reliability, renewable, and emission targets.

[4] This translates to 0.1 day/year.

the distribution across time and months. These LOLP hours tend to occur during the periods of hottest weather. For the CAISO system, the hottest weather occurs most frequently in August and September.

For the use in developing weights in the proposal, the LOLP is converted to a relative expectation (loss of load expectation or LOLE) by dividing the hourly probably by the annual sum of the hourly values. The resulting hourly LOLE for the entire year will sum to 100%. The hourly LOLE results can be used as weights applied to the average of the hourly load impacts from the LIP.

In July 2021, the CAISO and its consultant E3 performed a reliability analysis in support of its effective load carrying capability study (ELCC) proposal which produced LOLE for 2020 as shown below.[5] The results show that expected loss of load only occurs in August and September and during the hours of 4-10 pm (HE17-22). Because hot weather events can occur in June and July, the Summer monthly hourly results should be combined into a summer hourly LOLE, as shown in the grand total line, to be used as weights.

Loss of Load Expectation for 2020 (Hour Ending)											
Sum of LOLE: Colur											
Month	**HE13**	**HE14**	**HE15**	**HE16**	**HE17**	**HE18**	**HE19**	**HE20**	**HE21**	**HE22**	**HE23**	**Grand Total**
1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
6	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
8	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.6%	0.7%	0.0%	0.0%	0.0%	3.3%
9	0.0%	0.0%	0.0%	0.0%	1.4%	25.2%	39.5%	21.8%	7.5%	1.4%	0.0%	96.7%
10	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
11	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
12	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Grand Total	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**1.4%**	**25.2%**	**42.1%**	**22.5%**	**7.5%**	**1.4%**	**0.0%**	**100.0%**

The LIP Informed by LOLE (LIP+LOLE) Proposal

The LIP estimate hourly load reductions for a DR event from 4 – 9 pm, which is consistent with the current CAISO availability assessment hours, i.e., the hours when it wants resources to be available for its expected greatest need.[6] Per the CPUC Maximum Cumulative Capacity (MCC) Buckets, DR programs must be available for 4 continuous hours, 4 – 9 pm, Monday-Saturday,

[5] http://www.caiso.com/Documents/SupplementalDataPursuant-StakeholderRequest.xlsx Note: the CAISO published results as hour beginning, which have been converted to hour ending to be consistent with LIP results.
[6] The CAISO publishes the availability assessment hours annually. The current hours can be found at: http://www.caiso.com/InitiativeDocuments/Final2022AvailabilityAssessmentHours.pdf

and May – September.[7] However, many DR programs are available for six hours and are not restricted to the 4 – 9 pm window and not limited to May-September. Depending on the distribution of the LOLE, the assumed DR call window in the LIP should be adjusted to match the system need and program parameters. Failure to make this adjustment would improperly penalize a DR program when it is available to be called for a longer period than what is assumed in the current LIP call window. For example, the BIP program is available for a 6-hour call, but the LIP assume only a 5-hour call from 4-9 pm.

The table below compares the results of using a simple average to the use of LOLE as a weighted average for Southern California's Base Interruptible Program[8] and its commercial Summer Discount Plan (SDP) for A/C cycling. Because BIP customers have a relatively flat load shape and the program is available for all six hours of the LOLE, the results of the simple average of HE17-21 and weighted average of HW17-22 (highlighted in yellow) are the same. Note, the load impact results for BIP were adjusted to show a 6-hour call.

The SDP has a load reduction that is the highest in the first hour and then declines as commercial load falls off due to customer fatigue and/or commercial business hours. In this case, the hourly load impacts make different contributions toward reliability across time. The use of hourly LOLE as weights will be a better measurement of the value of load reduction over the reliability event. In this case, the qualifying capacity is 19 MW instead of 20 MW. However, since SDP is available for a 6-hour call, in this example a positive value should exist for HE22, so the weighted average should be slightly higher.

[7] CPUC D.21-06-029 at 27.

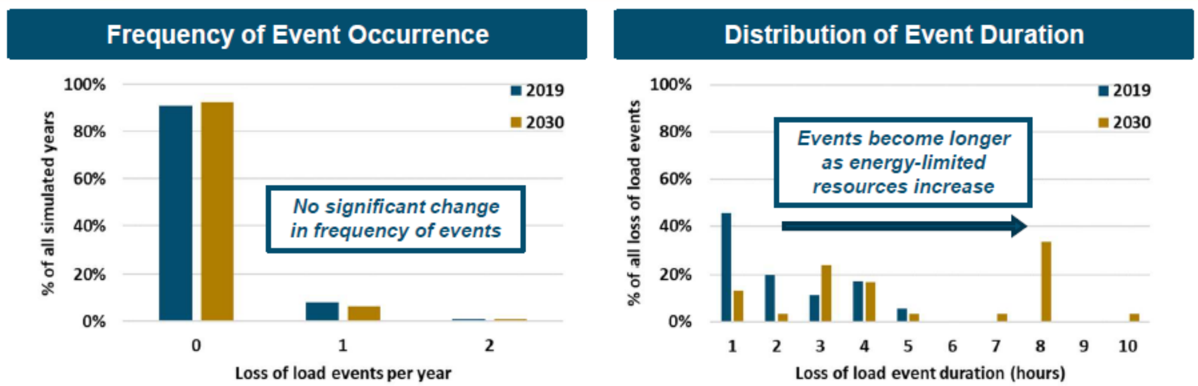
[8] A program for high load factor industrial customers which is available 24 x 7 hours for a 6-hour call.

		SCE-BIP		SCE-SDP-Commerical	
	Load Impact			Load Impact	
HE	LOLE	MW		MW	
16	0.0%	0		0	
17	1.4%	494		28.95	
18	25.2%	498		23.72	
19	42.1%	494		18.78	
20	22.5%	495		14.90	
21	7.5%	497		12.61	
22	1.4%	506		-2.81	
23	0.0%	164		-1.21	
	100.0%				
		LIP Avg of HE17-21	LIP weighted by LOLE HE17-22	LIP-Avg HE17-21	LIP weighted by LOLE HE17-21
		496	496	19.79	18.58
	SCE ExAnte LIP for PY2020 with 2021				
	Impacts for September call, 1 in 2 weather year				
	BIP HE22 adjusted to show full load reduction for 6 hour event				
	NOTE:Since SDP can be called for 6 hours, hourly values needs revision.				

Ideally, the LIP call window would be aligned with the hours of LOLE, i.e. a 6-hour DR program to match the 6 hours of LOLE. If the call hours (HE 17-21 or 4-9pm) from the LIP cannot be adjusted to align with the hourly LOLE distribution (in the example above HE 17-22), then the conversion from the LOLPs to the LOLE used for weights would be adjusted. This would be accomplished by removing the LOLP for HE22, summing the LOLP hours for HE17-21, so that the LOLE for HE 17-21 now sums to 100%. This would avoid unfairly weighting an hour of LOLE to have zero load reduction for HE22 when in fact it could provide some load reduction. To be clear, this would only occur if the 4-9pm LIP call cannot be adjusted for a longer duration capability of a DR. If there was a DR program that was only available for four hours, then the hours of LOLE should not be reduced to a 4-hour duration.

In the case when the DR program is available for less than the duration of the LOLE hours, it should be allowed to optimize its value. That is because it is consistent with a reliability model's dispatch of a 4-hour program to minimize expected unserved energy during a scenario if the outage lasts longer than 4 hours. Using the LOLE data above, a 4-hour program would be able to avoid 97% of the LOLE events. In a prior version of the CAISO DR ELCC study (for 2019) almost all the shortfall scenarios were 4 hours or less and roughly 5 percent of the scenarios had a 5-hour duration. Thus, the proposal appears consistent with what would result if the 4-hour DR program was estimated using an ELCC approach.

Finally, the CAISO DR ELCC study showed that for 2019, there were at most 2 loss of load events per year. Since DR programs must be available 24 hours a month, a 4-hour program could be called 6 times a month. The frequency limits of DR programs would not be a binding constraint in performing a more complex ELCC analysis. Therefore, the frequency of calls is not needed in the LIP+LOLE approach.



The Source of the LOLE Study

Both the CEC and CPUC have performed reliability studies, so either organization could provide the hourly LOLE results. The CEC Mid-Term Reliability Report published on September 30, 2021, included reliability analysis for 2022. Figure 9 of the Report included a distribution of when the unexpected unserved energy occurred, i.e., from HE 17 to HE 21. This data could be used for the 2023 RA compliance year. An alternative is that the CPUC could run reliability analyses to be used for DR. Finally, because this is an interim approach, the CAISO LOLE results from its July 2021 study (as shown above) could be utilized as the results appear consistent with the results from the CEC that HE17-21 is the period of greatest concern.

2022 Timeline

February – CEC issues Report to CPUC

March – Comments on CEC report to CPUC

April 1 – DR Providers submit LIP results to CPUC

April – CPUC issues order for use of LIP + LOLE, and provides the LOLE to be used by all parties

May – Parties submit LIP + LOLE results

June/July – Commission PD and Final decision for RA QC for DR