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DR ELCC Guide: Using LIP-Informed Profiles to Calculate DR ELCC in SERVM

Developed for CAISO

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Vignesh Venugopal, Sr. Consultant
Zach Ming, Director

44 Montgomery Street, Suite 1500
San Francisco, CA 94104

vignesh.venugopal@ethree.com

415.391.5100

Energy+Environmental Economics

Acronyms and Descriptions

Acronym	Name	Description
API	Agricultural and Pumping Interruptible	DR program to suspend agricultural pumping
BIP	Base Interruptible Program	Participants are offered capacity credits for reducing their demand up to a pre-determined level in response to an event call
CBP	Capacity Bidding Program	DR program where aggregators work on behalf of utilities to enroll customers, arrange for load reduction, receive and transfer notices and payments
DR	Demand Response	Reductions in customer load that serve to reduce the need for traditional supply-side resources
ELCC	Effective Load Carrying Capability	Equivalent perfect capacity measurement of an intermittent or energy-limited resource, such as DR
LCA	Local Capacity Area	Transmission constrained load pocket for which minimum capacity needs are identified for reliability
LIP	Load Impact Protocol	Protocols prescribed by the CPUC for accurate and consistent measuring (and forecasting) of DR program performance
LOLP	Loss of Load Probability	Probability of a load shedding event due to insufficient generation to meet load + reserve requirements
NQC	Net Qualifying Capacity	A resource’s contribution toward meeting RA after testing, verification, and accounting for performance and deliverability restrictions
PDR	Proxy Demand Response	Resources that can be bid into the CAISO market as both economic day-ahead and real-time markets providing energy, spin, non-spin, and residual unit commitment services
PRM	Planning Reserve Margin	Capacity in excess of median peak load forecast needed for reliability
RA	Resource Adequacy	Resource capacity needed for reliability
RDRR	Reliability Demand Response Resource	Resources that can be bid into CAISO market as supply in both economic day-ahead and real-time markets dispatched for reliability services

SAC	Smart AC Cycling	Direct air conditioner load control program offered by PG&E
SDP	Summer Discount Plan	Direct air conditioner load control program offered by SCE
SEP	Smart Energy Program	SCE program wherein a smart thermostat provider adjusts A/C usage in response to an event
LCR	Local Capacity Requirement	Resources procured by SCE (incl. DR) for local capacity needs in the LA Basin
SubLAP	Sub-Load Aggregation Point	Defined by CAISO as relatively continuous geographical areas that do not include significant transmission constraints within the area
IOU	Investor-Owned Utilities	PG&E, SCE and SDG&E
3PDRP	3rd Party Demand Response Providers	Non-utility demand response providers
DRP	Demand Response Providers	IOUs and 3PDRPs
DRAM	Demand Response Auction Mechanism	An IOU DR program where resources are procured through an auction mechanism from third party providers. Winning resources must bid resources directly into the CAISO market

The ELCC Guide

1 Introduction

This guide defines a clear process for calculating ELCCs for individual event-based DR programs administered by the IOUs and 3rd party DR providers that would form the basis for QC accreditation used by the CPUC in the RA proceeding. These programs are listed in Table 1. Sub-divisions of these programs are listed to account for different characteristics of residential and commercial participants and to account for different notification periods – day-ahead (DA) v/s day-of (DO), for example.

Table 1: Preliminary List of Demand Response Programs to be Covered

DR Provider	DR Programs
PG&E	BIP, CBP (DA Res, DA Non-Res), SAC
SCE	API, BIP (15-min, 30-min), CBP (DO, DA), SDP (Res, Com), LCR
SDG&E	AC Saver (DO Res, DO Com, DA Res, DA Com), CBP (DO, DA), BIP
3rd Party DR	All non-DRAM programs

Calculating ELCCs involves several key steps including developing a model and model inputs, clearly defining the characteristics and limitations of DR programs, including both hourly availability and use limitations, and ensuring that interactions between DR programs and other resources are properly accounted for. This guide seeks to clearly define each step and outline the process that should be followed for calculating DR ELCCs.

This guide has been developed under the assumption that ELCCs would be calculated by the CPUC in the SERVM model, which is already used to calculate ELCCs for wind and solar in the RA proceeding. Utilizing this model will both leverage model development that has already been undertaken and ensure consistency across the accreditation of all resources in the RA proceeding.

The guide is structured as follows:

- **Section 2: Inputs and Assumptions**
- **Section 3: Running SERVM**
- **Section 4: Outputs and Allocating Interactive Effects**

2 Inputs and Assumptions

2.1.1 Set Up SERVM Model

Calculating ELCCs for any resource requires a model with a representation of *all* loads and resources. These inputs include hourly load, capacities and generating characteristics of all resources such as natural gas, nuclear, hydro, solar, wind, and energy-limited resources like pumped and battery storage. The existing SERVM model run by the CPUC already contains these inputs and can be leveraged to calculate DR ELCCs.

2.1.2 Develop DR Hourly Availability

The ELCC of DR is highly dependent on the hourly availability profile of each program and the extent to which the DR resource is available during the hours in which the system needs it most for reliability. Hourly variability of DR programs can vary based on month, hour of day, day-type (weekday/weekend), weather, etc. There are two options to characterize the hourly availability of DR resources- 1) develop DR availability profiles (like wind or solar) over a large period of historical weather conditions or 2) develop DR availability profiles for a set of representative days that can be used to estimate DR availability over a longer weather record. Each option is described more fully below.

1. **Develop DR availability profiles over larger period of historical weather conditions**
    a. Temperature data from 1998-2017 (the weather years modeled in SERVM) will be collected from all the weather stations that the DRPs deem are best to estimate load impacts from their DR participants
    b. DRPs would feed this weather data into the regression model trained for the LIP process and produce DR availability outputs for weather modeled in SERVM
2. **Develop DR availability profiles for a set of representative days**
    a. CPUC would provide DRPs with weather data for a set of representative days. The set of representative days should cover the full expected range of DR availability across different months, day-types (e.g., weekday/weekend), and temperature conditions
    b. DRPs would provide expected hourly DR availability for each program on each representative day
    c. CPUC would then take the DR for each representative day and map to the historical weather record, creating a full DR availability profile

The hourly availability profiles would be developed without regard for call constraints. This would enable use of this hourly profile as an hourly nameplate- equivalent for DR programs, and call constraints can be enforced during dispatch in SERVM.

Table 2: Preliminary Template for Hourly Availability Data Transfer for Each DR Program

Day[1]	Hour	Temperature	DR Availability (MW)[2]
	1		
	2		
	. . .		

This will reflect the conditions modeled in SERVM across weather years 1998-2017. DRPs will pick the appropriate weather stations based on where the DR program's participants are located

To be provided by the DRPs. This will be LIP-informed and will need to account for *all* participants in the DR program of interest. One such table will need to be filled for each DR program to be modelled. For programs that are not sensitive to weather, availability in each month, day-type etc. as appropriate may be provided.

[1] May span across some representative days or all days across all weather-years modeled in SERVM.

[2] This may take the form of MW/MW nameplate. For example, if SERVM needs to be run for 2023 and 2024 using the same profiles, the normalized profile could be used in conjunction with the MW nameplate for 2023 and 2024 separately provided by the DRPs. DR "Nameplate" in this context, is the single highest availability expected under all *weather* conditions from 1998-2017.

2.1.3 Develop DR Call Limitations

DR programs are often subject to call limitations that define the maximum number of times a DRP can call on customers to reduce load per month/season/year as well as how long customers will respond when called. For each modeled DR program, the DRPs should provide the CPUC with a set of call constraints that can be implemented in SERVM. In addition, any constraints associated with the notification period may also be provided.

Sometimes different participants in a program can be subject to different call constraints – for example, CBP. A weighted average (weights informed by number of customers and size of load subject to each of the call-constraint combinations) or the single call constraint combination that is applicable to most customers can be used in SERVM.

Table 3: Preliminary Template for Call Limitations

Variable Definition	Variable Type	Variable Value (Illustrative)
Limit on number of dispatch hours per day	Integer	6
Limit on number of dispatch hours per year	Integer	100
Price at which a DR resource dispatches and curtails load[1]	$	1000
This specifies the months in which the DR resource is available. End Month	Integer (1-12)	10

This specifies the months in which the DR resource is available. Start Month	Integer (1-12)	5
Limit on dispatches per month	Integer	5
Hours required ahead of dispatch to commit	Integer	24
PGE_Bay, PGE_Valley, SCE, SDGE (Choose 1 of 4 modeled zones representing CAISO)	String	SCE

To be provided by the DRPs. One such table will need to be provided for each DR program to be modeled.

[1] DR will always be dispatched for reliability. This input enables DR to *additionally* be dispatched for economic reasons If desired. The price can and will be set high enough to ensure that limited DR calls are never "wasted" and are effectively used to mitigate and avoid loss of load events.

2.1.4 Treatment of Local and System RA

LCRs are determined by CAISO in a separate process involving deterministic power flow studies focused on times when transmission contingencies occur. We may use the system wide ELCC of DR towards meeting LCRs too. This is consistent with the ELCC-based solar and wind accreditation today. It is also consistent with the evaluation of DR NQC based on the load impact in hours coincident with the *system* peak (and not *local* peak) under 1-in-2 conditions.

2.1.5 Aggregation of DR programs (Optional)

The most accurate method to calculate DR ELCCs would uniquely define and model each DR program in Table 1. However, calculating first-in and last-in ELCCs (explained in sections 3 and 4) for each DR program in each month will be computationally expensive. False precision may creep in with very small programs and adding detail after a certain point, will yield diminishing returns. DR programs may be aggregated based on location and similar characteristics a way that is deemed reasonable by stakeholders to reduce the complexity of the process.

2.1.6 Factors Not Considered in the Interim

To streamline the analysis and keep it manageable, the following factors are ***not*** proposed to be included in modeling DR ELCC:

1. No modeling of "snap-backs". For example, no increase in load in hours pre or post a DR event.
2. No modeling of "fatigue". For example, no change in the hourly availability in the 3rd week of July after SERVM calls on the DR resource in the 2nd week of July.

3 Running SERVM

Once all necessary SERVM model inputs and assumptions have been gathered, the CPUC will run the model to produce a set of values that can then be used to credit an ELCC value to each individual DR program. It is important to note that there is no single calculation that can be run for each DR program that can accurately reflect its ELCC contribution to system reliability in conjunction with its interactions with all other resources. For this reason, a set of calculations must be performed as described below. These calculations will need to be repeated for each month to get monthly ELCCs, as they are developed for solar and wind today.

3.1.1 *Calculate Portfolio ELCC of All Resources*

- Calculate aggregate portfolio ELCC of all intermittent and energy-limited resources in SERVM. The "portfolio" should include wind, solar, storage, and DR.

3.1.2 *Calculate First-In ELCC for each resource class*

- "First-in" ELCC is calculated for each resource class (wind, solar, storage, DR) as the marginal ELCC for a small increment of that class on a system with only perfect resources. In other words, a system with no solar, wind, hydro, storage, or DR.

3.1.3 *Calculate Last-In ELCC for each resource class*

- "Last-in" ELCC is calculated for each resource class (wind, solar, storage, DR) as the marginal ELCC for a small increment of that class on a system with all resources expected to be online in that year. In other words, a system with solar, wind, hydro, storage, and DR.

3.1.4 *Calculate First-In ELCC for each DR program* [1]

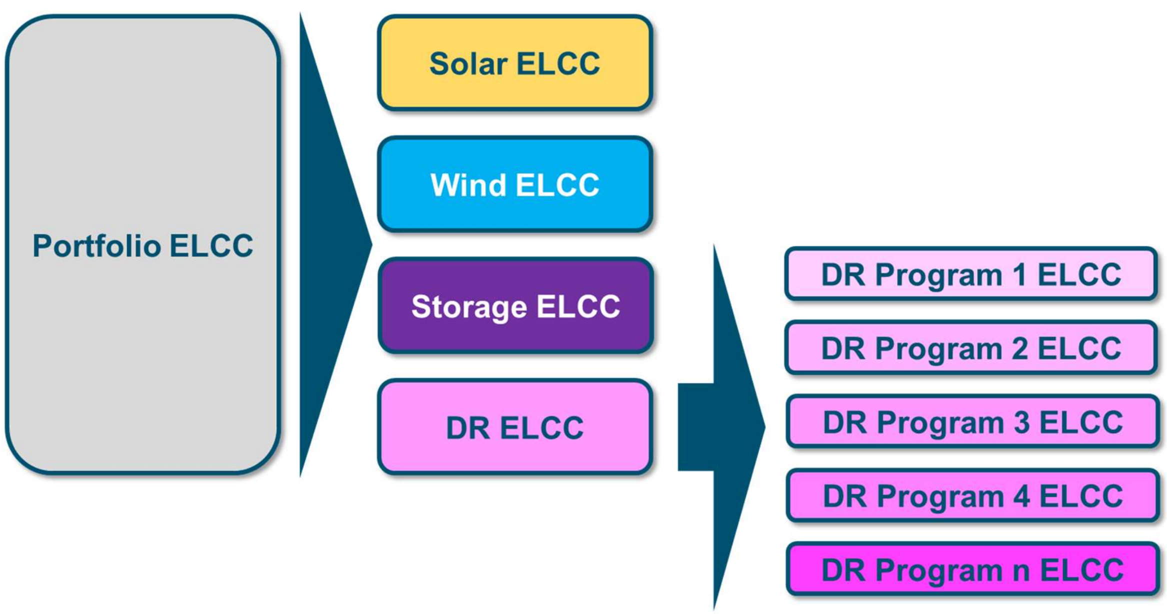
- "First-in" ELCC is calculated for each DR program as the marginal ELCC for a small increment of that DR program on a system with only perfect resources. In other words, a system with no solar, wind, hydro, storage, or DR.

3.1.5 Calculate Last-In ELCC for each DR program

- "Last-in" ELCC is calculated for each DR program as the marginal ELCC for a small increment of that DR program on a system with all resources expected to be online in that year. In other words, a system with [1]solar, wind, hydro, storage, and DR.

4 Outputs and Allocating Interactive Effects

Using the values calculated by the SERVM model in Section 3, the CPUC would calculate a final accredited ELCC value for each DR program to be used as its QC value in the RA program. This process will properly and fully account for synergistic and antagonistic interactive effects between resources, including for example the antagonistic interaction between storage and DR. This process will ensure that the sum total of all resources correctly sums to the Portfolio ELCC as calculated in Section 3. Broadly, the calculation process will involve allocating the Portfolio ELCC among each resource class and then allocating the DR class ELCC to each individual DR program as illustrated below.

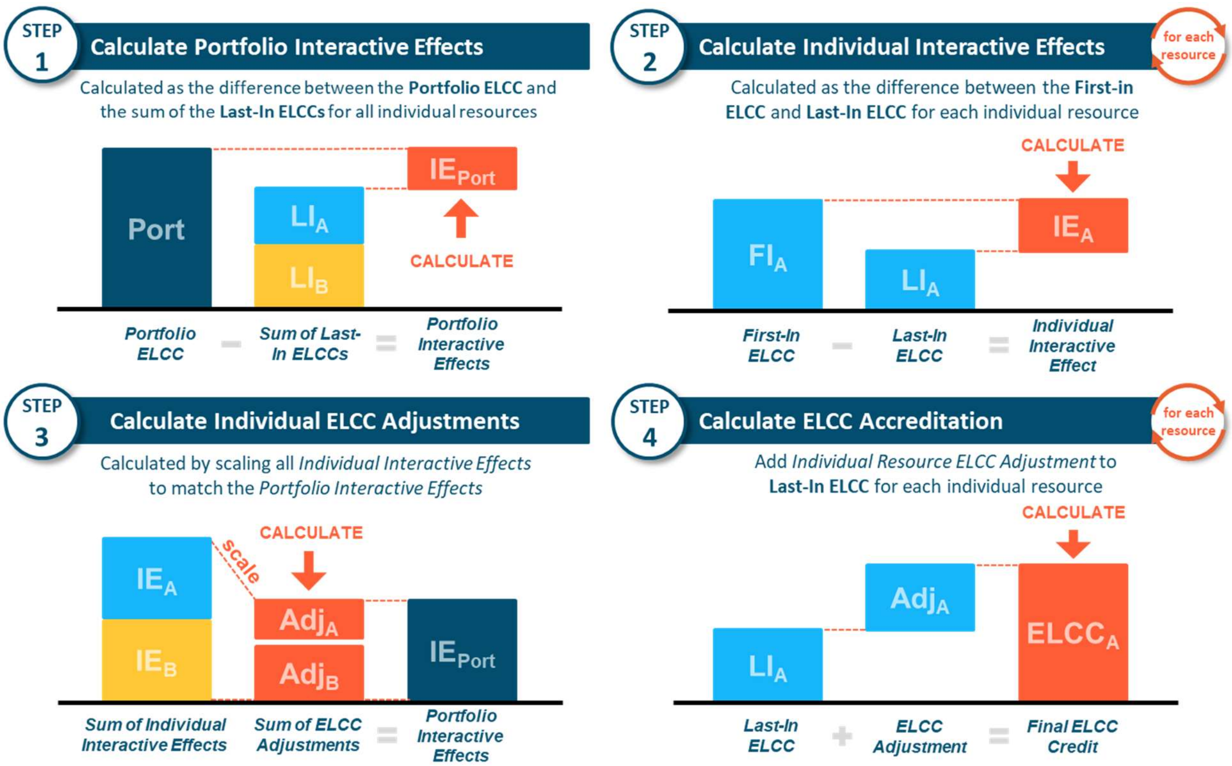


[1] Calculating the first-in and last-in ELCCs for each program in each month may become intractable. Aggregation of DR programs into DR sub-classes may be necessary, as outlined in Section 2.1.5

4.1.1 Allocation of Portfolio ELCC to Resource Classes

The allocation of the Portfolio ELCC to each resource class will be conducted using the "delta" method. An overview of the delta method is provided below, with more details on the mathematical formulas available here.[2]

In the first step, the Portfolio ELCC and individual resource class ELCCs would be utilized.



4.1.2 Allocation of DR Class ELCC to Individual DR Programs

The allocation of the DR class ELCC to each DR program will be conducted using the "delta" method. An overview of the delta method is provided in the section above. The DR class ELCC is an output of the first step that allocates the portfolio ELCC to each resource class. Treating the DR class ELCC as the "portfolio", that is then further allocated to each individual DR program using the delta method.

4.1.3 Additional outputs for stakeholder engagement

If time permits and functionality in SERVM already exists, following outputs could be generated to aid understanding of the process and the results-

1. Month-hour heat maps highlighting critical periods

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[2] https://www.ethree.com/wp-content/uploads/2020/08/E3-Practical-Application-of-ELCC.pdf

    a. Separately for weekends and weekdays
2. Statistics highlighting number and duration of DR events called
    a. For example, if only 5 events are called and no event lasts more than 4 hours, the reason why a 6-hr/event, 30 events/year DR program may get less than 100% ELCC could be attributed to its hourly variability