BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to Oversee the Resource Adequacy Program, Consider Program Refinements, and Establish Forward Resource Adequacy Procurement Obligations	Rulemaking 19-11-009 (Filed November 7, 2019)

TRACK 3B.1 PROPOSALS OF THE CALIFORNIA INDEPENDENT SYSTEM OPERATOR CORPORATION

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Date: January 28, 2021

EXECUTIVE SUMMARY

The CAISO presents four independent proposals to reform the Commission's existing resource adequacy program. These proposals are summarized below:

> **Proposal 1: Resource Adequacy Import Requirements** – The Commission should set minimum requirements for resource adequacy imports. Specifically, the Commission should require that its load serving entities (LSEs) procure only resource adequacy imports that provide: (1) source and balancing authority area specification, (2) an attestation the import is committed solely to the CAISO, (3) minimum transmission service delivery requirements, and (4) availability to meet a 24x7 must offer obligation. The CAISO would incorporate these requirements into its tariff.
>
> **Proposal 2: Effective Load Carrying Capability Methodology for Variable-Output Demand Response** – The Commission should adopt an effective load carrying capability methodology to calculate qualifying capacity values for variable-output demand response resources beginning in the 2022 resource adequacy year.
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> **Proposal 3: Availability Limited Resource Procurement** – The Commission should ensure central procurement entities and/or LSEs procure sufficient resource adequacy resources in each local capacity area and sub-area accounting for availability-limited resource characteristics. The Commission should leverage the CAISO's hourly load and resource analysis from its 2021 and 2025 Local Capacity Technical Studies to guide procurement of availability-limited resources for the 2023 resource adequacy year.
>
> **Proposal 4: Increased PRM for 2022** – In the Commission's Electric Reliability proceeding regarding summer 2021 resource needs, the CAISO recommended the Commission adopt a 17.5% PRM that considers resource needs during the 8:00 p.m. hour for June through October 2021. The CAISO recommends the Commission adopt this same approach for summer 2022 as well.

The CAISO looks forward to working collaboratively with the Commission to develop these proposals and continue improving the resource adequacy program to meet changing system conditions and resource needs.

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I. Introduction

The California Independent System Operator Corporation (CAISO) hereby provides its final proposals for Track 3B.1 per the December 11, 2020 *Assigned Commissioner's Amended Track 3.B and Track 4 Scoping Memo and Ruling* (Amended Scoping Memo) and Administrative Law Judge Chiv's January 11, 2021 E-mail Ruling Regarding Track 3B.2 Proposals (Ruling). The CAISO submits proposals to (1) update the resource adequacy import requirements, (2) adopt an effective load carrying capability (ELCC) for variable-output demand response resources, (3) provide guidance for availability-limited resource procurement, and (4) increase the planning reserve margin for 2022.

The CAISO previously submitted these proposals in Track 3B.2 of this proceeding on December 18, 2020. Since that filing, the CAISO has substantively updated its resource adequacy import requirement proposal and its proposal to increase the planning reserve margin for 2022. In particular, the CAISO reduced the recommended planning reserve margin increase based on further evaluation of requirements as part of the Commission's ongoing rulemaking to address summer 2021 electric reliability needs.[1] The CAISO's proposals for the Commission to adopt an ELCC for variable-output demand response and provide guidance for availability-limited resource procurement remain substantively unchanged from the Track 3B.2 filing.

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[1] Rulemaking (R.) 20-11-003.

II. Discussion

A. Proposal 1: Resource Adequacy Import Requirements

The CAISO proposes that the Commission modify its resource adequacy import rules to ensure its LSEs have access to sustainable, reliable, and dependable resource adequacy imports, recognizing that California competes for imported energy and transmission service across a broad and diverse west-wide market. The Commission's resource adequacy policy framework is integral in guiding LSE capacity procurement, which is made available to the CAISO for managing the system needs. Thus, it is important that the capacity is available, reliable, and dependable. Given California's reliance on imports to support reliability, it is important LSE's secure dependable resource adequacy import capacity and transfer capability in advance to meet California's system's capacity and energy needs, particularly as supply tightens across the west due to the changing regulatory landscape and resource retirements.

Under current Commission resource adequacy rules, energy contracts with non-resource specific system resources whose energy can be transferred using low priority non-firm transmission service across the entire delivery path can count as resource adequacy capacity. Moreover, there is no requirement the physical resources supporting the resource adequacy import be specified or provide assurance that the capacity is committed solely to the California LSE, and consequently the CAISO, for the duration of the resource adequacy showing. Such arrangements do not adequately ensure reliability and deliverability, especially during challenging CAISO and West-wide system conditions, and they do not address speculative supply and double counting concerns. As supply conditions across the Western interconnection continue to tighten in the coming years, these gaps in the existing resource adequacy import rules and CAISO tariff will make import supplies less dependable and pose a risk to system reliability.

Speculative supply and double counting concerns remain unresolved under the Commission's Track 1 decision in this proceeding. Under the current rules, resource adequacy importers can continue to source and sell speculative capacity and fulfill resource adequacy must offer obligations using last-minute bilateral energy purchases. There is no assurance these bilateral energy purchases are anything but excess energy from resources that were never committed to California in the first instance and have no express obligation to sell to or hold capacity for California. When system resources are constrained across the west, there is no guarantee this "excess energy" will still be available to meet California LSEs' needs. Instead, such energy will more likely flow to the native load of the entities that paid for that capacity upfront or to the highest bidder. Furthermore, failure to impose a transmission delivery requirement and allowing resource adequacy import energy to flow on hourly non-firm transmission means there is no assurance sufficient transmission transfer capability will be available to deliver energy to California, even if excess energy is available in the system. Hourly non-firm transmission has the lowest priority and is the first transmission product transmission owners curtail. During challenging system conditions across the west—when the CAISO expects limited resource availability and most needs resource adequacy imports to be delivered—there is a substantial risk (1) the import may not be deliverable because transmission curtailment due to the use of low priority transmission, or (2) the import energy will be delivered elsewhere because it was not exclusively committed to California LSEs.

For these reasons, the Commission should transition to a resource adequacy import framework that requires resource-specific capacity be dedicated solely to California and secured in advance using high priority transmission service. This will ensure secured power flows to California, particularly during stressed west-wide system conditions. In its ongoing resource adequacy enhancements initiative, the CAISO is considering setting minimum requirements for imports to provide resource adequacy capacity effective beginning with the 2023 resource adequacy year.[2] These minimum requirements are discussed below. The CAISO believes its proposal will most effectively address the concerns described above and better ensure the availability of dependable and dedicated imports to meet California's energy needs. The Commission should adopt the CAISO's proposed minimum resource adequacy import requirements to address these concerns.

The CAISO's proposed resource adequacy import requirements are consistent with requirements Transmission Providers across the west impose through their Open Access Transmission Tariffs (OATT) for serving native and network load with import resources. Under the FERC *pro forma* OATT, entities serving their own network load[3] most commonly rely on network integration transmission service to deliver generation to load. Network integration

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[2] The CAISO proposes a "bridge" year for the 2022 resource adequacy year with binding implementation for the 2023 resource adequacy year to allow a reasonable transition to the new resource adequacy import framework.
[3] In addition to the Transmission Provider's load serving function serving native load.

transmission service is specifically designed for load serving entities to identify and contractually designate load to be served by resources delivered using this type of transmission service.[4] Under network integration transmission service, load serving entities must designate sufficient network resources to serve their current and forecasted designated network or native load and, in turn, the transmission provider is obligated to plan and construct its transmission system to ensure delivery of those designated and forecasted network resources to serve the current and forecasted network or native load.[5] Load serving entities designate network resources to serve network or native load, which grants firm network integration transmission service rights for the delivery of the generation.[6] The network resource designation process requires resources to meet certain informational requirements depending upon whether those resources are located on-system (within the balancing authority area) or off-system (outside of the balancing authority area).[7]

The requirements applicable to off-system network resources serving network or native load under transmission provider OATTs and business practices are similar to the requirements proposed by the CAISO in this proceeding. A load serving entity seeking to designate an off-system network resource must provide: (a) the source balancing authority area where the resource is located;[8] (b) the transmission arrangements supporting delivery of the "off-system" resource, which must be on firm or conditional firm transmission[9] across intervening transmission systems to the border with the balancing authority area, for the duration of the

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[4] FERC *pro forma* Open Access Transmission Tariff, sections 28.3 and 28.6 (2013), https://www.ferc.gov/sites/default/files/2020-05/pro-forma-OATT.pdf.

[5] *Id.,* at section 28.2.

[6] *Id.*, at section 28.3.

[7] *Id.*, at section 29.2.

[8] *Id.,* at section 29.2(v) – "For each off-system Network Resource, such description shall include: identification of the Network Resource as an off-system resource…identification of the control area from which the power will originate." Through their business practices, some Transmission Providers may request the identification of the name of the off-system resource as well. For example, Idaho Power Company requires the submission of a Network Resource Designation Form which requests the identification of the resource name in addition to the source balancing authority area. (The form can be found on Idaho Power OASIS website under the "Network Customer Information" tab, and further under "Network Customer Forms" - https://www.oasis.oati.com/ipco/).

[9] In Order 890, paragraph 1091, FERC clarified the requirement that off-system designated network resources sourced in other balancing authority areas must be delivered on firm or conditional firm transmission service. Some Transmission Providers may permit that off-system designated network resources be delivered on firm or conditional firm service to the border with the balancing authority area from the point where the load serving entity takes title to the generation which generally is at the source, or potentially a hub point.

designation period; and (c) an attestation the capacity is under contract and not committed to any other third parties.[10] Independent system operators and regional transmission organizations impose similar requirements on imports providing resource adequacy or capacity.[11] Similar to the CAISO's proposed requirements these requirements are intended to ensure import resources dedicated to serving load are not speculative and provide greater assurance of delivery to the border with the balancing authority area even when there are supply shortages or conditions across intervening systems may be transmission constrained.

Along with this proposal, the CAISO provides recent data regarding resource adequacy import bidding practices, which indicates a significant reduction in high economic bids over the last two years. The Commission's Track 1 decision imposed must flow, self-scheduling requirements on non-resource specific resource adequacy imports based, in part, on August 2018 data indicating 13.8% of non-resource specific resource adequacy import average hourly bids were above \$500/MWh. However, data from the last two years shows a significant reduction in non-resource specific resource adequacy import average hourly bids above \$500/MWh to a low of 2.0% in August 2020. Considering this significant reduction in high resource adequacy import bids—and taking into account the incentives the CAISO proposal sets for resource adequacy imports to bid economically and competitively at marginal cost—it may be prudent for the Commission to consider whether the must flow, self-scheduling requirements are still

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[10] FERC *pro forma* Open Access Transmission Tariff, sections 28.3 and 28.6 (2013)., at section 29.2(viii) – "A statement signed by an authorized officer from or an agent of the Network Customer attesting that all of the network resources listed pursuant to Section 29.2(v) satisfy the following conditions: (1) the Network Customer owns the resource, has committed to purchase generation pursuant to an executed contract, or has committed to purchase generation where execution of a contract is contingent upon the availability of transmission under Party III of the Tariff; and (2) the Network Resources do not include any resources, or any portion thereof, that are committed for sale to non-designated third party load or otherwise cannot be called upon to meet the Network Customer's Network Load on a non-interruptible basis, except for purposes of fulfilling obligations under a reserve sharing program." Some Transmission Providers may incorporate in their tariff or business practices additional or slightly different attestation requirements than the FERC's pro forma tariff but consistent with the concepts described in the FERC pro-forma tariff attestation. (*See* section 29.2 of Bonneville Power Administration's *Open Access Transmission Tariff* – https://www.bpa.gov/transmission/Doing%20Business/Tariff/Documents/bpa-oatt-TC-20-settlement-tariff-100119.pdf – and Idaho Power Company Network Resource Designation Form cited and linked in an earlier footnote).

[11] The CAISO provided a detailed overview of other independent system operator and regional transmission organization attestation requirements in its August 7, 2020 Initial Track 3B Proposals. *See* http://www.caiso.com/Documents/Aug7-2020-InitialTrack3BProposals-Comments-AdditionalProcess-ResourceAdequacy-R19-11-009.pdf at p. 24.

necessary to address the Commission's original concerns.

1. Background

The CAISO previously submitted a proposal for resource adequacy imports in Track 1 of this proceeding to address potential speculative import supply and double counting by limiting opportunities for physical withholding.[12] The CAISO has further refined this proposal since its Track 1 filing. The changes the CAISO has made are detailed in the CAISO's draft final proposal for the Resource Adequacy Enhancements initiative published on December 17, 2020.[13] The CAISO also submitted this proposal in Track 3B.2 on December 18, 2020. The current proposal reflects additional updates made since that filing.

2. Proposal

The Commission should set minimum requirements for the resource adequacy imports its LSEs procure. Specifically, the Commission should require that its LSEs procure only resource adequacy imports that provide: (1) source and balancing authority area specification, (2) an attestation the import is committed solely to the CAISO, (3) minimum transmission service delivery requirements, and (4) availability to meet a 24x7 must offer obligation. The CAISO presented the first three elements of this proposal in its December 18, 2020 Track 3B.2 filing. The fourth element, implementing a 24x7 must offer obligation, is new to this filing. The CAISO would incorporate these requirements into its tariff. The CAISO discusses these four elements in detail below.

a. Source Specification for Resource Adequacy Eligible Imports

The CAISO proposes that only source-specific imports should be eligible to provide resource adequacy capacity. Non-resource specific system resources would not be eligible to provide resource adequacy capacity. Specifically, three types of imports would be eligible to provide resource adequacy import capacity:

1. Dynamically scheduled resource-specific system resources;
2. Pseudo-tied resources; and

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[12] CAISO Resource Adequacy Track 1 Proposal, R.19-11-009, February 28, 2020.

[13] Attachment C, Resource Adequacy Enhancements Draft Final Proposal Phase 1 and Sixth Revised Straw Proposal, section 5.1.2, December 17, 2020.

3. Non-dynamic resource-specific resource adequacy imports[14] that consist of:
    a. a single resource;
    b. a specified portfolio or aggregation of resources within a single balancing authority area; or
    c. a balancing authority area's pool of resources.

Each type of import eligible to provide resource adequacy capacity will be required to identify the name of the physical resource(s) supporting the import and the single balancing authority area where the resource(s) is/are located. To the extent the import type is a non-dynamic resource-specific resource adequacy import consisting of a balancing authority area's pool of resources (system resources), only the single balancing authority area where the resources are located will need to be identified.

Non-resource specific firm energy contracts cannot address speculative supply or double counting concerns. As such, non-resource specific system resources are not a substitute for advanced procurement of real, physical, and dedicated resource-specific capacity. Accordingly, contracts that do not identify or specify resources in support of the resource adequacy contract should not count as resource adequacy capacity. Economy energy contracts and related hedging mechanisms can help mitigate day-ahead and real-time market price risk, but they cannot ensure real physical supply is dedicated solely to CAISO LSEs, which is the purpose of the resource adequacy program.

Requiring source specification for import resource adequacy resources will treat such resources more comparably to internal resource adequacy resources. Adopting a source specification requirement for import resources will require host balancing authorities and suppliers to secure fuel and plan their resource commitments to meet their own needs and import commitments to the CAISO. The CAISO recommends the Commission require resource adequacy import capacity contracts include source specification as noted above. The CAISO proposes that, effective for the 2023 resource adequacy year, the CAISO tariff would require identification of the physical resources supporting resource adequacy imports and the balancing authority area sourcing them, for the duration of the showing.

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[14] New term defined in the Resource Adequacy Enhancements Draft Final Proposal to more specifically define imports for resource adequacy purposes and differentiate these from Non-Dynamic Resource Specific System Resources which may not provide resource adequacy.

b. Attestation Requirement

The Commission should require all resource adequacy import contracts to have defined source specification demonstrating real, physical supply at the time of resource adequacy showings. Further, resource adequacy import contracts should include an attestation consistent with the proposal below or ensure the terms of the contract meet the attestation requirements. The CAISO proposes that, effective for the 2023 resource adequacy year, the CAISO tariff would require Scheduling Coordinators for suppliers to submit an attestation stating the supply plan meets following:

1. The resource(s) supporting the proposed RA Import is/are:
    a. Owned by the Load Serving Entity for which the RA Import would provide RA capacity; or
    b. Contractually obligated by the seller of the resource(s) supporting the proposed RA Import to provide RA Capacity to the Load Serving Entity.
2. The quantity of RA Capacity on the Supply Plan from the proposed RA Import can be provided by the resource(s) supporting the proposed RA Import without securing capacity from additional resources.
3. The portion of the of capacity from the resource(s) supporting the proposed RA Import is surplus to the obligations of that resource(s) to serve load or meet other commitments in the Host Balancing Authority Area.
4. The portion of capacity from the resource(s) supporting the proposed RA Import has not been, and will not be, sold or otherwise committed to any party other than the Load Serving Entity to which the proposed RA Import would provide RA Capacity.
5. Delivery to the CAISO Balancing Authority Area of the RA Capacity shown on the Supply Plan can only be interrupted because of:
    a. A transmission curtailment;
    b. An Outage on the resource(s) supporting the RA Import; or
    c. Reliability reasons as determined under the Host Balancing Authority Area's FERC tariff.
6. Transmission service of proper firmness has been reserved for delivery to the CAISO Balancing Authority Area of the proposed RA Import.

Under current resource adequacy import rules, the CAISO and the Commission cannot determine whether resource adequacy imports are double-counted for load serving purposes. Neither LSEs nor import providers are required to demonstrate their resource adequacy import capacity has not been sold to a third party, is not being used to meet capacity obligations in another balancing authority area, is not committed to a reserve sharing program, and is not providing reserves in the host BAA (in which case it could be recalled during stressed West-wide system conditions).

The proposed attestation requirements will help ensure import contracts provide California with high quality, dedicated, capacity and energy services when needed. The first two components of the attestation ensure the resource adequacy capacity is committed solely to California LSEs, and consequently to the CAISO. If the capacity is, or will be, committed to other parties or uses during the period of the resource adequacy showing, the attestation requirement will not be met. Additionally, the resource adequacy capacity can only be interrupted by the host balancing authority area for reliability reasons, a transmission curtailment on a path on which the energy is being delivered to the CAISO, or for a plant outage for non-reliability reasons. Contracts that allow interruption in performance at the discretion of the seller or for non-reliability reasons, would not meet this requirement.

Contracts with force majeure interruption provisions satisfy this attestation requirement because a force majeure event would either lead to a plant outage or a host balancing authority area taking action for reliability reasons. Lastly, as will be discussed later, at the time the Scheduling Coordinator submits the supply plan, transmission arrangements must be secured and in place for delivery of the resource adequacy import to the CAISO in accordance with the proposed transmission firmness requirements. Waiting until the day or hour prior to delivery to secure the necessary and sufficiently firm transmission would not meet this requirement because it places the CAISO at risk for non-delivery to the extent the transmission is unavailable. As indicated above and in prior filings, other independent system operators and regional transmission organizations impose similar requirements to the requirements the CAISO proposes here.[15]

To count as resource adequacy capacity, import contracts must provide source specific

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[15] *See* CAISO Initial Track 3B Proposals, http://www.caiso.com/Documents/Aug7-2020-InitialTrack3BProposals-Comments-AdditionalProcess-ResourceAdequacy-R19-11-009.pdf at p. 24.

information and the described attestation by established deadlines for the applicable year-ahead and month-ahead resource adequacy showings, with the exception that the fourth element of the attestation, which is applicable only in the month-ahead showings. Alternatively, the import contracts should ensure the resource adequacy import capacity can meet the CAISO tariff requirements, which will incorporate the requirements described in this proposal.

The CAISO recognizes there may be additional costs associated with more rigorous source-specification and attestation requirements, but the additional reliability and capacity security benefits are warranted given growing competition for scarce supply in the west. Requiring forward source specification from real, physical capacity committed to serving only the CAISO will address speculative import supply and bidding behavior concerns by ensuring LSEs secure only actual physical resource capacity to serve California's reliability needs. These requirements make resource adequacy imports more dependable and treat them more comparably to that of resource adequacy resources located in the CAISO balancing authority area.

c. Transmission Service Requirements

The CAISO also recommends the Commission adopt a Firm point-to-point transmission service requirement on the last transmission leg to the CAISO (intertie), and a minimum Monthly Non-Firm point-to-point transmission service requirement on all intervening transmission legs for all resource adequacy imports. Specifically, resource adequacy contracts should specify NERC Transmission Service Reservation Priority 7-F on the last transmission leg to the CAISO and a Transmission Service Reservation Priority 5-NM or higher priority for all intervening transmission legs. For reference, NERC's transmission service priorities are listed below in Table 2.[16] Some Transmission Providers offer conditional firm transmission service with a Reservation Priority 6-CF, and those upstream transmission arrangements can also support resource adequacy import delivery.

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[16] NERC transmission service reservation priority table found here: https://www.nerc.com/pa/rrm/TLR/Pages/Transmission-Service-Reservation-Priorities-.aspx

Table 2: NERC Transmission Service Reservation Priorities

Transmission Service Reservation Priorities		
Priority	**Acronym**	**Name**
0	NX	Next-hour Market Service
1	NS	Service over secondary receipt and delivery points
2	NH	Hourly Service
3	ND	Daily Service
4	NW	Weekly Service
5	NM	Monthly Service
6	NN	Network Integration Transmission Service from sources not designated as network resources
7	F	Firm Point-to-Point Transmission
	FN	Network Integration Transmission Service from Designated Resources

The firm transmission requirement on the last transmission leg to the CAISO will ensure resource adequacy imports have the highest level of deliverability on paths where flows are generally near the total transfer capability limits, *e.g*., at the California-Oregon Border (COB) and the Nevada-Oregon Border (NOB) interties. Firm transmission service (7-F priority) is the last type of transmission service to be curtailed, after all the lower priority transmission service types have been curtailed. Requiring transmission service no lower than Monthly Non-Firm point-to-point (5-NM priority) on all other transmission legs beyond the interties will provide added flexibility for suppliers to secure transmission across the different transmission systems where there are multiple paths for traversing the transmission networks to reach desired points of delivery, while still providing greater deliverability assurance than other transmission service level options.

Transmission service on upstream transmission legs can be a higher priority than 5-NM, including conditional firm (CF) service which, if offered by the Transmission Provider, has a level 6-CF priority in addition to permitting delivery on firm transmission service (7-F priority). Under this framework, weekly, daily, hourly duration, lower priority, non-firm transmission service would not support delivery of resource adequacy imports, but they can still be used for economic energy and energy hedging.

In addition, under this framework, the commitments made regarding the firmness of the energy arrangement, described above, would still hold, and would better ensure committed import resource adequacy is actually deliverable when needed even when those intervening transmissions systems or paths are experiencing transmission constraints.

d. 24x7 Must Offer Obligation

The CAISO also recommends that resource adequacy imports have the necessary contractual availability to meet a 24x7 (24 hours, 7 days per week) must offer obligation into the CAISO market. A 24x7 availability structure will help further ensure that, similar to resources located within the CAISO balancing authority area, resource adequacy imports are available during challenging system conditions regardless of time of day or day of the week.

Current Commission rules permit the contracting of resource adequacy imports with a 16x6 availability (16 hours, 6 days per week). The unavailability of these resources during eight hours of the day or a day of the week may have adverse impacts on reliability. During the last Labor Day weekend, September 2020, the CAISO experienced challenging system conditions on a Saturday and Sunday. Resource adequacy imports with a 16x6 availability structure may not be available during critical periods which are becoming increasingly unpredictable. Consistent with other elements of its proposal, the CAISO believes a robust resource adequacy import framework is critical to ensuring the reliability and dependability of these resources in enabling the CAISO to manage the system and this includes ensuring that these resources are contracted for, and available, on a 24x7 basis.

3. Policy Implementation

The Commission should consider adopting a two-step implementation process for new resource adequacy import requirements. The first step should be to use the 2022 resource adequacy compliance year as a bridge to transition to the new framework. For 2022, the Commission should encourage LSEs to provide resource adequacy import contracts with source specification information and firm transmission as outlined above. Load-serving entities should also use 2022 to modify existing import contracts or enter into new ones as appropriate. Step two would implement full compliance with the resource adequacy import proposal for the 2023 resource adequacy compliance year.

4. Summary

The Commission and the CAISO should work collaboratively to implement the following minimum resource adequacy import requirements:

A. Eligible source specific import types:
   1. Non-dynamic resource-specific resource adequacy imports that are:
      i. a single resource;
      ii. a specified portfolio or aggregation of resources within a single balancing authority area; or
      iii. a balancing authority area's pool of resources.
   2. Dynamically scheduled resource-specific system, and
   3. Pseudo-tied resources.

B. Attestation requirement:
   1. The resource(s) supporting the proposed RA Import is/are:
      i. Owned by the Load Serving Entity for which the RA Import would provide RA capacity; or
      ii. Contractually obligated by the seller of the resource(s) supporting the proposed RA Import to provide RA Capacity to the Load Serving Entity.
   2. The quantity of RA Capacity on the Supply Plan from the proposed RA Import can be provided by the resource(s) supporting the proposed RA Import without securing capacity from additional resources.
   3. The portion of the of capacity from the resource(s) supporting the proposed RA Import is surplus to the obligations of that resource(s) to serve load or meet other commitments in the Host Balancing Authority Area.
   4. The portion of capacity from the resource(s) supporting the proposed RA Import has not been, and will not be, sold or otherwise committed to any party other than the Load Serving Entity to which the proposed RA Import would provide RA Capacity.
   5. Delivery to the CAISO Balancing Authority Area of the RA Capacity shown on the Supply Plan can only be interrupted because of:
      i. A transmission curtailment;

        ii. An Outage on the resource(s) supporting the RA Import; or
        iii. Reliability reasons as determined under the Host Balancing Authority Area's FERC tariff.
    6. Transmission service of proper firmness has been reserved for delivery to the CAISO Balancing Authority Area of the proposed RA Import.

C. Transmission Service Requirements:
    1. Firm transmission service (7-F priority) on the last transmission leg to the CAISO; and
    2. Transmission service no lower than monthly non-firm transmission service (5-NM priority) on all upstream transmission legs. This could include monthly non-firm transmission service (5-NM priority), conditional firm service (6-CF priority), or firm transmission service (7-F priority).

D. 24x7 Availability:
    1. Resource adequacy imports will be subject to a 24x7 must offer obligation.

E. Implementation:
    1. Two-step process with 2022 as a transition year and full compliance in 2023 under the new resource adequacy import framework.

5. Additional data on resource adequacy import bidding practices

In the Track 1 decision, the Commission established a requirement that non-resource specific resource adequacy imports must be self-scheduled, or alternatively can be economically bid within a -$150 MWh to $0 MWh range. This limitation was intended as a measure to eliminate speculative supply by imposing a must flow obligation for non-resource specific resource adequacy imports and was based, in part, on August 2018 data published by the Department of Market Monitoring (DMM)[17] indicating that 13.8% of non-resource specific resource adequacy import average hourly bids were above $500/MWh. The concern was the frequency of high bids by non-resource specific resource adequacy imports indicated the potential of speculative supply through high bids to avoid a CAISO award and then sell the energy elsewhere.

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[17] Department of Market Monitoring (DMM), Special Report: Import Resource Adequacy (September 10, 2018) at 1-2, available at: http://www.caiso.com/Documents/ImportResourceAdequacySpecialReport-Sept102018.pdf.

The CAISO believes its proposals will effectively address the concerns identified in the Track 1 proceeding, rendering the bidding requirements adopted therein unnecessary. The CAISO's proposed changes will ensure capacity is dedicated to CAISO LSEs and backed by high priority transmission service secured in advance, thus reducing the speculative nature of any supply. Below the CAISO provides updated data on resource adequacy import bidding practices for the Commission to consider in determining whether the must flow/self-scheduling requirements the Track 1 decision imposed on non-resource specific resource adequacy is still appropriate.

New data reviewing the frequency of high non-resource specific resource adequacy import bids indicates a significant decrease in the number of instances average hourly bids exceeded $500/MWh and reached the $1000/MWh energy bid cap. As indicated above, 13.8% of non-resource specific resource adequacy import average hourly bids in August 2018 were above $500/MWh. Figure 1 shows non-resource specific resource adequacy imports' average hourly high bids above $500/MWh for August 2019 decreased to 2.8%, and Figure 2 shows the same analysis for August 2020 with average hourly high bids above $500/MWh decreasing to 2.0%,

Figure 1: Average hourly non-resource specific resource adequacy imports offered by bid price (weekday hours) – August 2019.

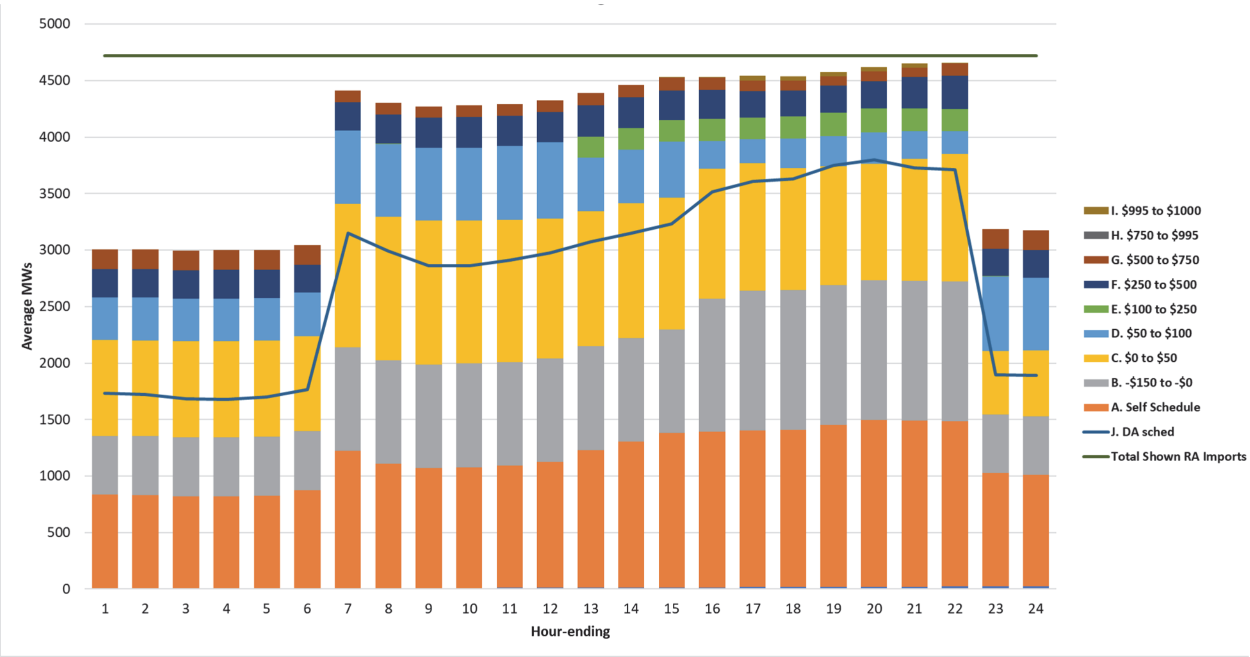


Figure 2: Average hourly non-resource specific resource adequacy imports offered by bid price (weekday hours) – August 2020.

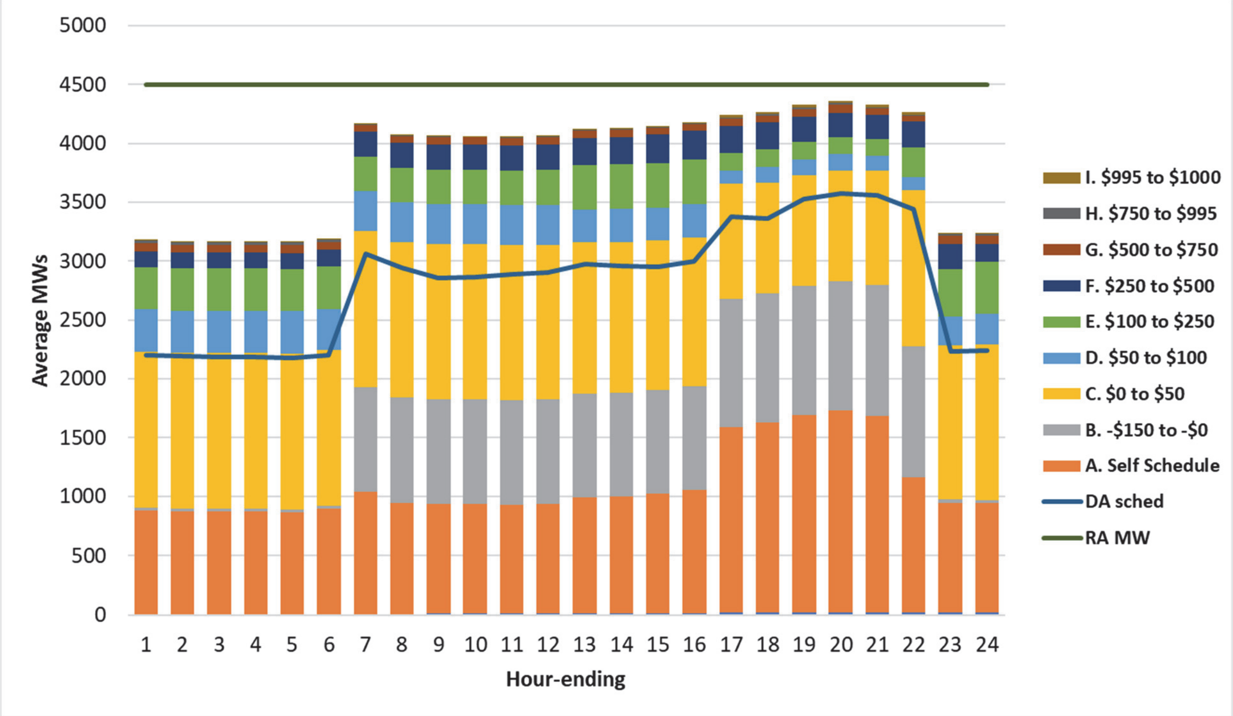
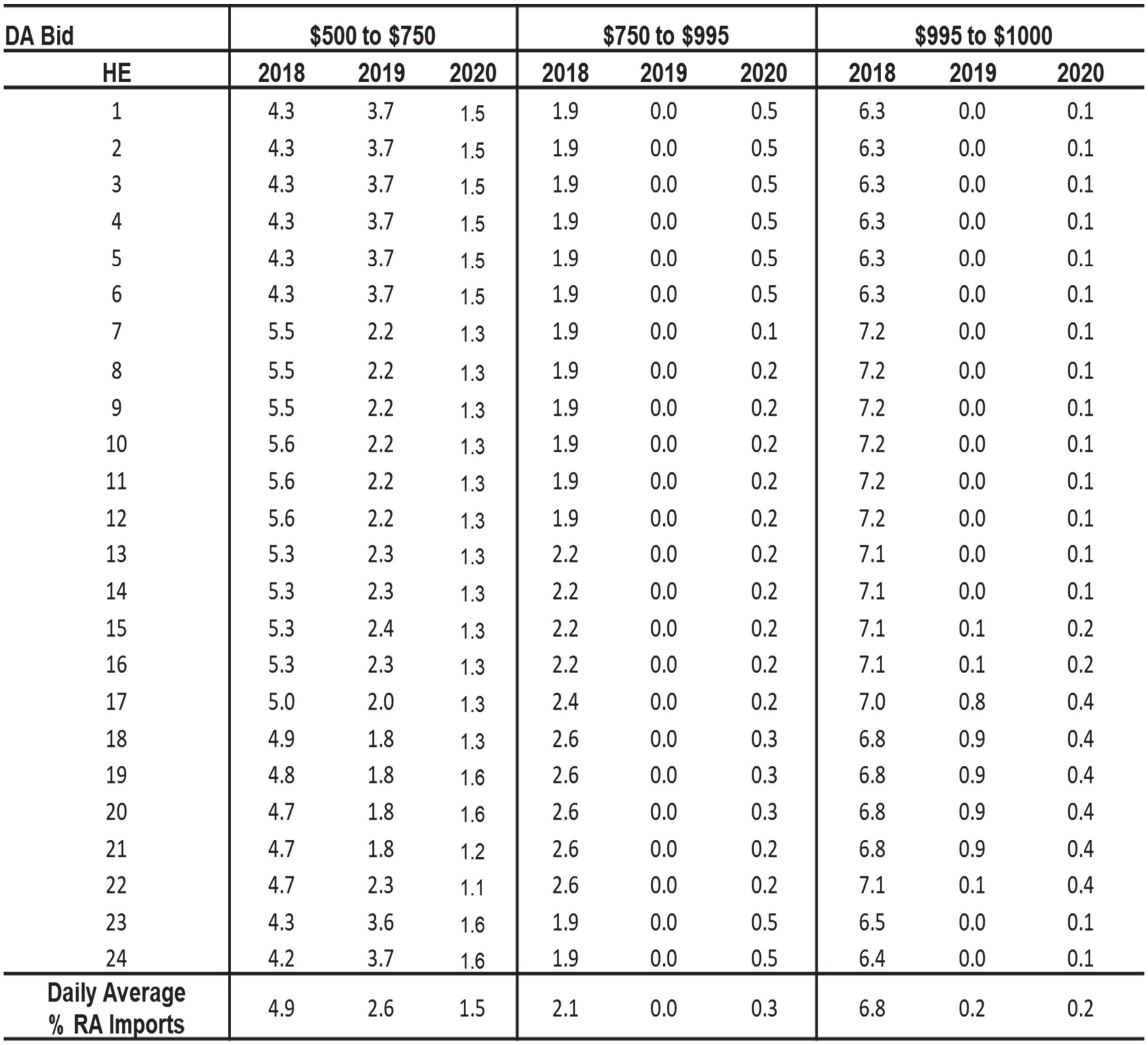


Figure 3 compares the percent of day-ahead (DA) bids above $500/MWh based on daily averages across the month for the month of August from 2018 to 2020 for non-resource specific resource adequacy imports. The data indicates the percent of bids above $500/MWh has decreased significantly for every hour of the day during the month of August from 2018 to 2020. Finally, 6.8% of bids in August 2018 were at or near the energy bid cap of $1000/MWh, but this number decreased to 0.2% for August of 2019 and 2020.

Figure 3: Percent of non-resource specific resource adequacy import day ahead bids above $500/MWh for August 2018, 2019, and 2020.



DA Bid	$500 to $750			$750 to $995			$995 to $1000		
HE	2018	2019	2020	2018	2019	2020	2018	2019	2020
1	4.3	3.7	1.5	1.9	0.0	0.5	6.3	0.0	0.1
2	4.3	3.7	1.5	1.9	0.0	0.5	6.3	0.0	0.1
3	4.3	3.7	1.5	1.9	0.0	0.5	6.3	0.0	0.1
4	4.3	3.7	1.5	1.9	0.0	0.5	6.3	0.0	0.1
5	4.3	3.7	1.5	1.9	0.0	0.5	6.3	0.0	0.1
6	4.3	3.7	1.5	1.9	0.0	0.5	6.3	0.0	0.1
7	5.5	2.2	1.3	1.9	0.0	0.1	7.2	0.0	0.1
8	5.5	2.2	1.3	1.9	0.0	0.2	7.2	0.0	0.1
9	5.5	2.2	1.3	1.9	0.0	0.2	7.2	0.0	0.1
10	5.6	2.2	1.3	1.9	0.0	0.2	7.2	0.0	0.1
11	5.6	2.2	1.3	1.9	0.0	0.2	7.2	0.0	0.1
12	5.6	2.2	1.3	1.9	0.0	0.2	7.2	0.0	0.1
13	5.3	2.3	1.3	2.2	0.0	0.2	7.1	0.0	0.1
14	5.3	2.3	1.3	2.2	0.0	0.2	7.1	0.0	0.1
15	5.3	2.4	1.3	2.2	0.0	0.2	7.1	0.1	0.2
16	5.3	2.3	1.3	2.2	0.0	0.2	7.1	0.1	0.2
17	5.0	2.0	1.3	2.4	0.0	0.2	7.0	0.8	0.4
18	4.9	1.8	1.3	2.6	0.0	0.3	6.8	0.9	0.4
19	4.8	1.8	1.6	2.6	0.0	0.3	6.8	0.9	0.4
20	4.7	1.8	1.6	2.6	0.0	0.3	6.8	0.9	0.4
21	4.7	1.8	1.2	2.6	0.0	0.2	6.8	0.9	0.4
22	4.7	2.3	1.1	2.6	0.0	0.2	7.1	0.1	0.4
23	4.3	3.6	1.6	1.9	0.0	0.5	6.5	0.0	0.1
24	4.2	3.7	1.6	1.9	0.0	0.5	6.4	0.0	0.1
Daily Average % RA Imports	4.9	2.6	1.5	2.1	0.0	0.3	6.8	0.2	0.2

In addition, the CAISO's proposed resource adequacy import requirements will incentivize competitive economic bidding by resource adequacy imports. First, resource adequacy imports must be source specific and, through the attestation, must be committed solely to a California LSE, and consequently to the CAISO, for the duration of the resource adequacy showing. This incentivizes them to economically bid, at competitive levels, to receive market awards because the capacity has been committed only to the CAISO. Second, through the proposed transmission delivery requirement, resource adequacy imports must be delivered to the

CAISO on firm transmission across the interties and transmission no lower than monthly non-firm service on all other upstream legs. If the importer does not currently hold those transmission rights, it will have to procure them, and thus will be incentivized to economically bid at marginal cost to recover its costs. Third, separate from this proposal but through its Resource Adequacy Enhancements initiative, the CAISO is also proposing to extend the must offer obligation for resource adequacy imports into the real-time market. Resource adequacy imports will need to remain available not only in day ahead, but also through real-time, to meet their 24x7 must offer obligation. Thus, they no longer will be able to bid high in the day-ahead market to avoid an award and then sell their energy elsewhere. Lastly, as the CAISO raises the energy offer cap from $1000/MWh to $2000/MWh pursuant to FERC Order No. 831, the CAISO will implement a price screening methodology for resource adequacy import bids above $1000/MWh and will reduce these to the greater of the highest resource specific verified cost, the maximum allowable import bid index, or $1000/MWh. This will discourage unsupported high resource adequacy import bids intended to avoid an award in the CAISO market.

Considering the new data indicating a significant decrease in high non-resource specific resource adequacy import bids, and the protections that CAISO's proposal provides to incent competitive economic bidding by resource adequacy imports, the Commission should reconsider the current must flow/self-scheduling requirement for resource adequacy imports. Retaining the Track 1 bidding limitation in light of the data and the CAISO proposal may further, and unnecessarily, impact the effectiveness of resource adequacy imports meeting system needs and decrease liquidity.

B. Proposal 2: Effective Load Carrying Capability Methodology for Variable-Output Demand Response

The Commission should adopt an effective load carrying capability (ELCC) methodology to calculate qualifying capacity values for variable-output demand response resources beginning in the 2022 resource adequacy year.

1. Background

Variable-output demand response resources are demand response resources whose resource adequacy qualifying capacity value can vary over the course of a day, month, or season because of production schedules, duty cycles, availability, seasonality, temperature, occupancy, and many other factors. Their unique characteristics can limit their use. These include strict use-limitations such as availability during limited hours, days of the week (such as weekends), or seasons. Demand response's load reduction capability is more akin to a variable energy resource (which the Commission evaluates using an ELCC methodology) than a conventional, fixed-capacity fuel-backed resource.

The Commission's current counting methodology for demand response—the load impact protocol (LIP)—does not consider the use-limitations, limited energy, and carbon offsetting capabilities, or the variable nature of most demand response in establishing qualifying capacity (QC) values. As such, the LIP is limited in its ability to assess demand response resources' actual contribution to reliability. The LIP was more relevant when the resource adequacy program's primary concern was meeting gross peak capacity needs, but that is no longer the primary concern. At that time, energy sufficiency was a non-issue because the remaining gas, nuclear, and hydro resources could support system energy needs. However, circumstances have changed dramatically. The LIP may be a useful tool for estimating hourly operational capabilities, but the Commission should discontinue using it to assess the capacity value of demand response resources because it can overvalue the contribution these resource make to grid reliability under current and expected future conditions.

The Commission should ensure any adopted demand response capacity counting methodology meets the following principles:

- **Assesses demand response's contribution to reliability across the year or seasons** – An approved qualifying capacity counting methodology should evaluate how demand response contributes to system reliability under a loss of load expectation, which considers how demand response contributes to the overall system reliability. This contrasts to the LIP, which is a resource/program specific peak hour(s) evaluation that does not consider overall system needs.
- **Assesses demand response's capacity value as a variable resource** – Demand response resources are not fixed capacity resources, and any approved qualifying capacity valuation methodology must appropriately value the variable load curtailment nature of demand response and how its variability affects system reliability.
- **Assesses demand response's interactive effects with other resources** – Use- and availability-limited resources, like demand response, can saturate alongside similar use-limited resources as incremental amounts of similar resource types add less and less

additional capacity value to the system.

- **Is an industry-accepted capacity valuation methodology** – Loss of load expectation methodologies and evaluating a variable energy resources' contribution to reliability using ELCC is an accepted and growing industry-accepted capacity valuation practice.

The Commission recently adopted a new maximum cumulative capacity (MCC) bucket construct that allows LSEs to procure demand response resources for up to 8.3 percent of their total system resource adequacy requirement. The new limit allows demand response "growth of approximately 100 percent over the current levels when accounting for the 15 percent [PRM] adder."[18] This potential growth in demand response as a percentage of total installed system resource capacity necessitates establishing a proper and industry-accepted qualifying capacity counting methodology that ensures the resource adequacy program appropriately reflects demand response resources' contribution to meeting system reliability.

2. Proposal

The Commission should approve using an ELCC methodology to assess the qualifying capacity of variable-output demand response resources. Unlike the LIP, an ELCC methodology more accurately captures the value of demand response by accounting for its use- and energy-limitations and variable-output nature in the context of overall grid needs. Additionally, an ELCC methodology assesses how the capacity value of supply-side demand response, as a peak reduction resource, declines and saturates as other energy-limited resources—like battery storage—compete to serve the same peak capacity hours.

The CAISO engaged Energy+Environmental Economics (E3) to develop an ELCC methodology for variable-output demand response (E3 ELCC Study). This study used actual 2019 bid data provided by Pacific Gas & Electric Company (PG&E) and SCE to calculate the ELCC values for individual demand response programs.[19] The CAISO submitted the E3 ELCC study with its initial proposals on August 7, 2020. For this final proposal, the CAISO includes an updated E3 ELCC Study based on modified bid information from SCE. The CAISO

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[18] Decision 20-06-031, *Decision Adopting Local Capacity Obligations for 2021-2023, Adopting Flexible Capacity Obligations for 2021, and Refining the Resource Adequacy Program*, June 30, 2020, p. 57. The CAISO separately opposes incorporating a PRM adder for demand response resources.

[19] As a result of the initial E3 ELCC Study, SCE identified and made modifications to their bids to increase the MW amount offered. E3 updated the study to incorporate change and to compare the ELCC to the NQC net PRM and T&D loss adders, rather than NQC. This updated study is included in Attachment A.

recommends the Commission use bid data to develop ELCC values because bids should reflect the true availability of the resource considering both program parameters, such as hours of availability per day and variability caused by weather sensitivity, as well as other factors previously enumerated. Though bid data is likely the most robust information available to evaluate demand response availability, the Commission should require regular testing to ensure bids accurately reflect resource capabilities.

The E3 ELCC Study evaluated demand response as a resource of "last resort" on both a "first in" and "last in" basis. A "first in" ELCC measures marginal ELCC as if the resource was the only intermittent or energy-limited resource on the system, ignoring interactive effects of other resources. A "last in" ELCC measures the marginal ELCC after all other intermittent or energy-limited resources have been added to the system, thus capturing all interactive effects with other resources.

The E3 ELCC Study found the LIP methodology overvalues demand response capacity contributions by 19 to 30 percent. Notably, this overvaluation compares the LIP-derived NQC without the PRM and T&D losses versus the ELCC.[20] The E3 ELCC study more accurately reflects demand response resource reliability contributions for two main reasons: (1) demand response resources, in aggregate, do not bid into the CAISO market at levels equal to their net qualifying capacity because of variability and use-limitations, and (2) scheduling coordinators for demand response bid at times that are either not optimal or are for insufficient durations to earn full capacity value relative to system needs.

The E3 ELCC Study also developed an ELCC methodology that can evaluate different classes of demand response resources with different use and availability limitations. The E3 ELCC study achieved this result by allocating the overall demand response resource category ELCC to individual programs based on expected output during peak, maximum number of calls per year, and maximum duration per call. This addresses the purported concern that demand response programs are too heterogeneous to apply an ELCC methodology. This also addresses the Commission's Track 2 Decision request to specifically address bidding and dispatch

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[20] Attachment A, E3 ELCC Study, p.14.

assumptions.[21] The E3 ELCC Study found the determining factors are when, where, how much, and how fast the end-uses collectively respond and deliver load curtailment to the system. In other words, it is the demand program design that matters, not the specific and heterogeneous underlying end-uses that make up a demand response resource. In fact, demand response program designs are generally more similar than dissimilar when it comes to their use, availability, and response time–the factors that drive capacity value.

The Commission should apply an ELCC methodology to supply-side demand response to modify its qualifying capacity value in ways relevant and meaningful to the needs of the transforming grid. The Commission should leverage the CAISO's work to consider how Energy Division staff can further vet and apply an ELCC methodology to supply-side demand response. The E3 ELCC Study demonstrates it is possible and appropriate to use an ELCC methodology to assess the value of demand response. Importantly, adopting an ELCC methodology for demand response consistent with the CAISO's aforementioned principles would enable the CAISO to justify and seek FERC approval of tariff revisions to treat demand response as a variable energy resource, similar to wind and solar resources. This would exempt demand response from RAAIM and eliminate the obligation for demand response to bid a fixed capacity amount.

An ELCC methodology more accurately reflects the capacity value for demand response resources than the LIP. In addition, the resulting ELCC values will allow the CAISO to adopt necessary tariff revisions to incorporate demand response resources into existing market processes more effectively. The Commission should affirmatively decide to transition to an ELCC methodology by the end of this Track 3.B cycle, with a new ELCC methodology employed for the 2022 resource adequacy program year.

C. Proposal 3: Availability Limited Resource Procurement

The Commission should ensure central procurement entities and/or LSEs procure sufficient resource adequacy resources in each local capacity area and sub-area while accounting for availability-limited resource characteristics. The Commission should leverage the CAISO's hourly load and resource analysis from its 2021 and 2025 Local Capacity Technical (LCT)

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[21] Track 2 decision requested: "Future proposals to develop ELCC values for DR and storage should include specific proposals regarding the bidding and dispatch that should be assumed for different DR programs and energy storage facilities operating in the market and how these should be modeled in ELCC studies."

Studies to provide guidance regarding availability-limited resource procurement for the 2023 resource adequacy year.

1. Background

Availability-limited resources are resources with significant dispatch limitations, such as limited duration hours (*e.g.*, per year, season, month, or day) or event calls (*e.g.*, per year, season, month or consecutive days) that limit the resources' ability to respond to a contingency event within a local capacity area. This definition is currently limited to resources that count towards meeting a local capacity area or sub-area need, but similar considerations may apply on the system level as the number of storage resources increase. In 2018 testimony, the CAISO described the proposed hourly load and resource analysis it would develop to inform this proceeding and corresponding load serving entity (LSE) or central buyer procurement efforts.[22] The CAISO included this testimony as Attachment B to its August 7 initial proposals.

In Decision (D.) 19-06-026 the Commission adopted the definition and agreed "it is important to consider availability limited resources, particularly when constructing new resources." The Commission also recognized the need "to work closely with the CAISO to ensure that availability needs are met in all local reliability areas."[23] The CAISO's proposal provides new local capacity area details that will enable the Commission to direct procurement efforts to ensure local reliability needs are met.

2. Proposal

The Commission should ensure central procurement entities and/or LSEs procure sufficient resource adequacy resources in each local capacity area and sub-area while accounting for availability-limited resource characteristics. The CAISO completed the first phase of the hourly load and resource analysis in its 2021 and 2025 Local Capacity Technical (LCT) Studies.[24] For this first phase, the CAISO focused on identifying minimum availability requirements for battery storage resources to meet local area needs.[25] The CAISO presented the

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[22] *See* Attachment B to the CAISO's August 7, 2021 initial proposals.

[23] Decision (D.) 19-06-026, *Decision Adopting Local Capacity Obligations for 2020-2022, Adopting Flexible Capacity Obligations for 2020, and Refining the Resource Adequacy Program*, July 5, 2019, p. 53.

[24] This work was completed as part of the CAISO's 2021 Local Capacity Technical (LCT) Study. *See* Attachment C to the CAISO's August 7 initial proposals.

[25] For example, the CAISO queue registered 69,193 MW of energy storage projects in June 2020. *See* slide 3:

methodology and results in the CAISO's annual local capacity requirements stakeholder process.[26] In later phases, the CAISO will study other availability-limited resources, such as demand response.

The CAISO's analysis estimated the battery storage resource characteristics—specifically the capacity (MW), energy (MWh), and discharge duration—required to seamlessly integrate into each local area and sub-area.[27] For battery storage resources to displace other local area resources, there must be sufficient transmission capability and local area generation resources, under the most limiting contingency, to recharge the batteries in anticipation of an outage continuing through a night and into the next day's peak load period.

The following example illustrates how to interpret the battery storage analysis. The example uses a peak day forecast load profile for the Placer sub-area.[28]

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http://www.caiso.com/Documents/Briefing-Renewables-EnergyStorage-Generator-Interconnection-Queue-Presentation-July2020.pdf

[26] No stakeholders expressed concern with, or opposed the CAISO's methodology or results. *See*: http://www.caiso.com/Documents/ISOResponsestoComments_2021and2025FinalLocalCapacityRequirementsTechnicalStudyResults.pdf

[27] For more details on methodology and analysis results, *see* Attachment C to the CAISO's August 7 initial proposals, Section 2.4: Estimate of Battery Storage Needs due to Charging Constraints in both the 2021 and 2025 Local Capacity Technical Studies.

[28] The CAISO reproduced this figure from the 2021 LCT Study. The full 2021 LCT Study was attached to the CAISO's August 7 initial proposals as Attachment C thereto.

Figure 4: Placer LCR Sub-area 2021 Peak Day Forecast Profiles

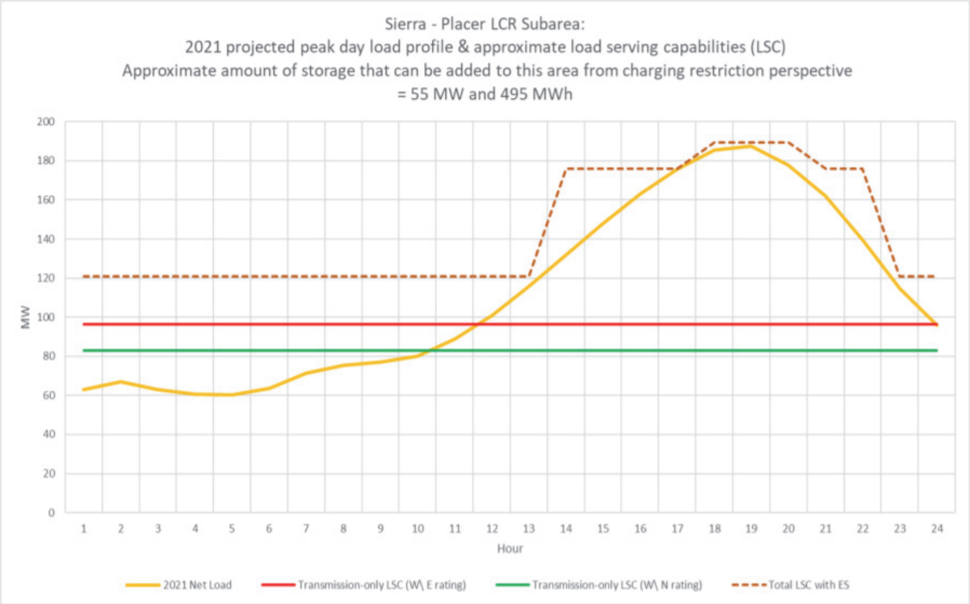

Figure 4 illustrates the load serving capabilities (LSC) in the Placer sub-area under three different scenarios. The brown dotted line reflects the total LSC with energy storage. This reflects the maximum level of battery storage in this sub-area that would still allow for recharging the battery under contingency conditions. The line provides the three dimensions CAISO used to evaluate battery storage characteristics: MW, MWh, and discharge duration. The approximate difference between the highest[29] and lowest point of the line is 55 MW, which represents the maximum battery capacity the Placer sub-area can accommodate. The approximate area under this line bounded by the lowest point of the line (120 MW) is 495 MWh, which is the energy requirement the battery storage needs to serve. The current resource adequacy program does not capture this energy requirement. The maximum required discharge duration is 10 hours, measured as the widest gap in the curve, between the thirteenth and twenty-third hour. Again, local resource adequacy requirements do not currently consider duration requirements. The CAISO has provided the same analysis for local capacity and sub-area in both the 2021 and 2025 LCT Studies.[30]

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[29] The height differences are approximate as is the energy under the Total LSC with ES line.

[30] This includes each local area and sub-area except "non-flow-through" areas.

Under this example, the central procurement entity should ensure that if it procures 55 MW of battery storage, the storage should also deliver 495 MWh of energy with a maximum required discharge duration of 10 hours.[31] Furthermore, battery storage procured in excess of 55 MW would not offset the need for other local area resources due to charging limitations. Each LCT Study provides a summary table noting what resource types incremental battery storage resources would replace. In the 2021 LCT Study, the 55 MW (495 MWh) of incremental battery procurement in the Placer sub-area would only offset other required local area resources, which are mostly hydro resources.[32]

Installing battery storage with insufficient resource characteristics—in terms of MW, MWh or duration—will not result in a one-for-one reduction in local area or sub-area resource requirements. The overall resource adequacy portfolio for a local area or sub-area must include incremental capacity beyond the minimum LCR need (in MWs) if LSEs procure battery storage beyond the area charging capability or with incorrect resource characteristics (MW, MWh and duration). If LSEs do not provide resources with sufficient resource characteristics to meet contingency requirements, the CAISO may need to use the expanded local capacity procurement back stop authority it is contemplating in its Resource Adequacy Enhancements stakeholder initiative.

The CAISO proposes that starting in 2023, the Commission require central procurement entities and/or LSEs, as appropriate, to procure sufficient resource adequacy resources to account for identified availability limitations. LSEs should use the CAISO's analysis in the 2021 and 2025 LCT Studies immediately to inform battery storage procurement and recognize each sub-area and local area has different resource requirements that may not be satisfied by new resources with minimum four-hour duration requirements. These studies can also inform the type of and level of retirement possible with additional battery storage procurement. Although it will be difficult for individual LSEs to coordinate on procurement in multi-LSE sub-areas and local areas, the CAISO believes the responsible local capacity central procurement entities will

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[31] This example assumes no batteries have previously been procured and all conditions remain the same in the Placer sub-area between the study and 2023.

[32] *See* Attachment C to the CAISO's August 7 initial proposals, Table 3.1-3 2021 Battery Storage Characteristics Limited by Charging Capability, 2021 LCT Study, p. 27.

be better positioned to use the analyses to coordinate procurement across LSEs starting in 2023.

D. Proposal 4: Increased PRM for 2022

In the Commission's Electric Reliability proceeding regarding summer 2021 resource needs, the CAISO recommended the Commission adopt a 17.5% PRM that considers resource needs during the 8:00 p.m. hour for the months of June through October 2021.[33] The CAISO recommends the Commission also adopt this same approach for summer 2022. This increased PRM should serve as an interim measure to maintain reliability prior to implementing other more permanent proposals, particularly the UCAP proposal. Once UCAP is implemented, the PRM could be adjusted downward, as described in the CAISO's UCAP proposal.

III. Conclusion

The CAISO appreciates the opportunity to submit proposals.

Respectfully submitted,

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Date: January 28, 2021

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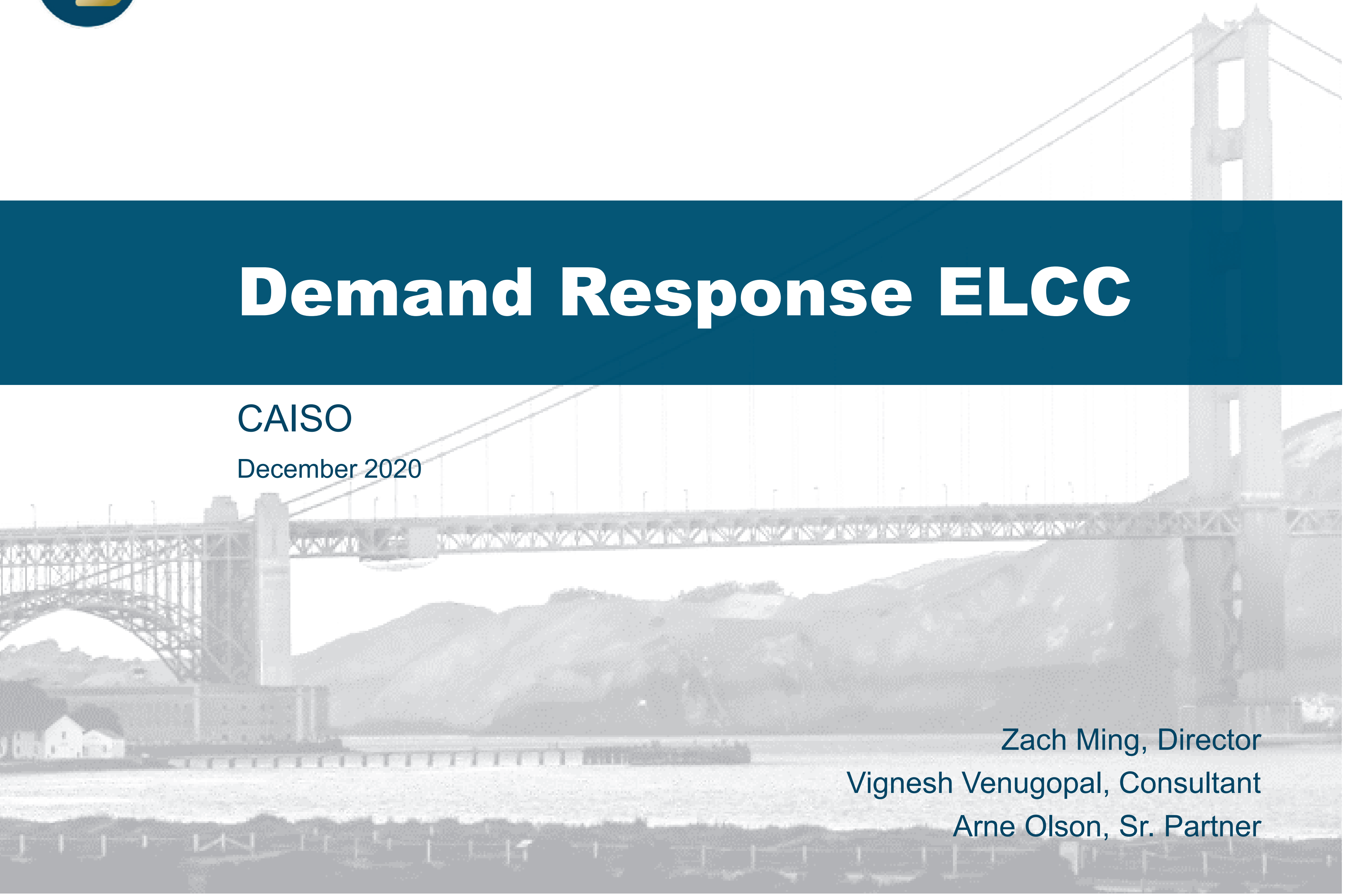
[33] *See* Opening Testimony of Jeff Billinton on behalf of the CAISO in R.20-11-003. (http://www.caiso.com/Documents/Jan11-2021-OpeningTestimony-JeffBillinton-ReliableElectricService-ExtremeWeatherEvent-R20-11-003.pdf).

Attachment A

Energy+Environmental Economics (E3)

ELCC Methodology for Variable-Output Demand Response Study

Energy+Environmental Economics



Demand Response ELCC

CAISO

December 2020

Zach Ming, Director
Vignesh Venugopal, Consultant
Arne Olson, Sr. Partner

Overview

- **In May 2020, E3 publicly released a study quantifying the reliability contribution of demand response in the CAISO**
  - This original study is contained in slides 3 – 35 of this presentation
- **In December 2020, E3 publicly released an update of the study based on new information provided by SCE**
  - This updated study results are contained in slides 36 – 40 of this presentation

Energy+Environmental Economics

Original Demand Response ELCC Study

CAISO ESDER Stakeholder Meeting

May 27, 2020

Zach Ming, Director
Vignesh Venugopal, Consultant

Overview

Background

- California has a unique approach to capacity procurement, where the CPUC administers a Resource Adequacy (RA) program to ensure sufficient resources to maintain an acceptable standard of reliability, but the CAISO retains ultimate responsibility for the reliable operation of the electricity system
- The CAISO was concerned that demand response (DR) was being overcounted in the Resource Adequacy program based on observed demand response bid data

Project

- The CAISO retained E3 to investigate the reliability contribution of DR relative to its capacity value in the CPUC administered RA program
- To the extent that DR is overvalued, the CAISO asked E3 to suggest solutions to issue
- E3 provided technical analysis to support the CAISO in this effort

Disclaimer required by the California Public Utilities Commission

This report has been prepared by E3 for the California Independent System Operator (CAISO). This report is separate from and unrelated to any work E3 is doing for the California Public Utilities Commission. While E3 provided technical support to CAISO preparation of this presentation, E3 does not endorse any specific policy or regulatory measures as a result of this analysis. The California Public Utilities Commission did not participate in this project and does not endorse the conclusions presented in this report.

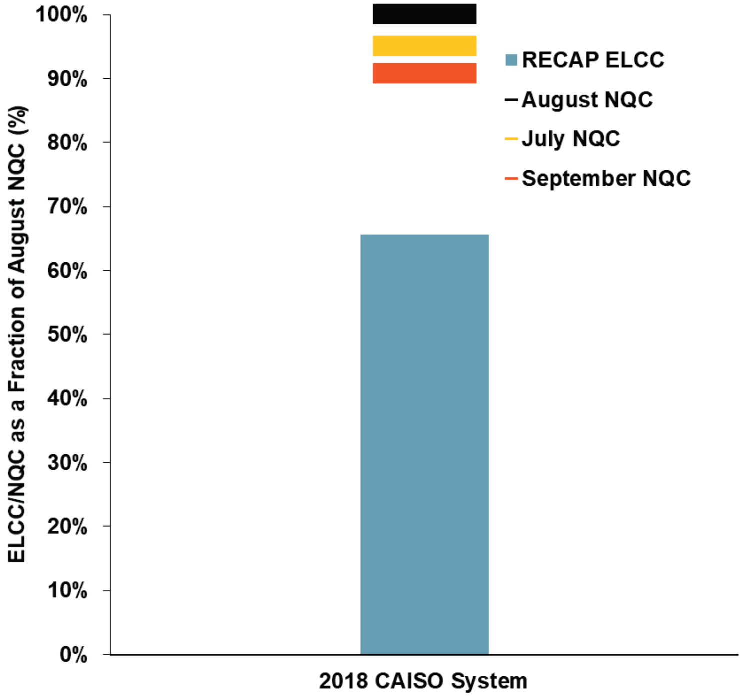
Outline

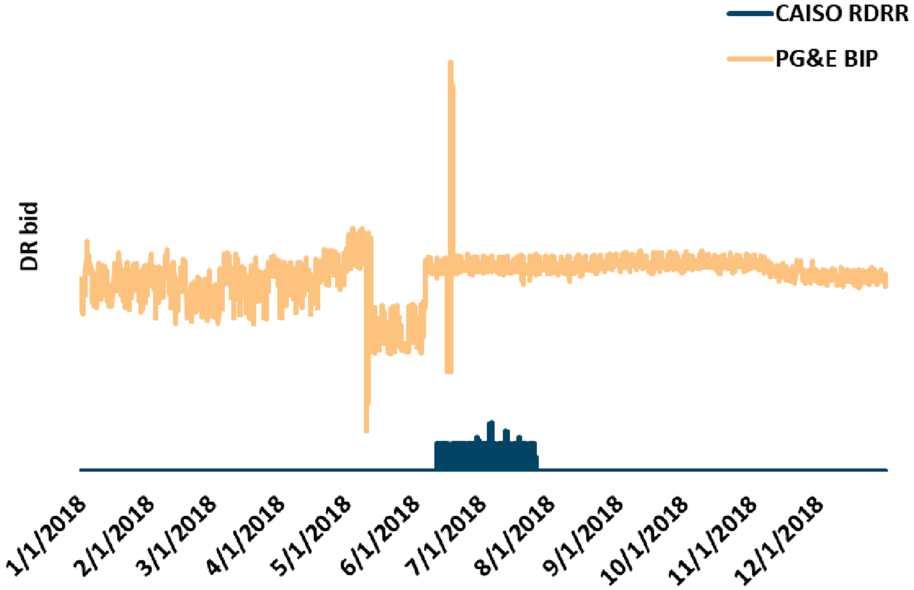
- Refresher on March 3 CAISO stakeholder meeting presentation
- Background on ELCC
- Performance of Existing DR
- Characteristics of DR Needed for ELCC
  - Time availability
  - # of calls / duration of calls
  - Penetration of DR
- Incorporating DR ELCC into Existing CPUC RA Framework
- Questions

Acronyms

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 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 fore 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
SubLAP	Sub-Load Aggregation Point	Defined by CQAISO as relatively continuous geographical areas that do not include significant transmission constraints within the area

Refresher on March 3 CAISO ESDER Meeting



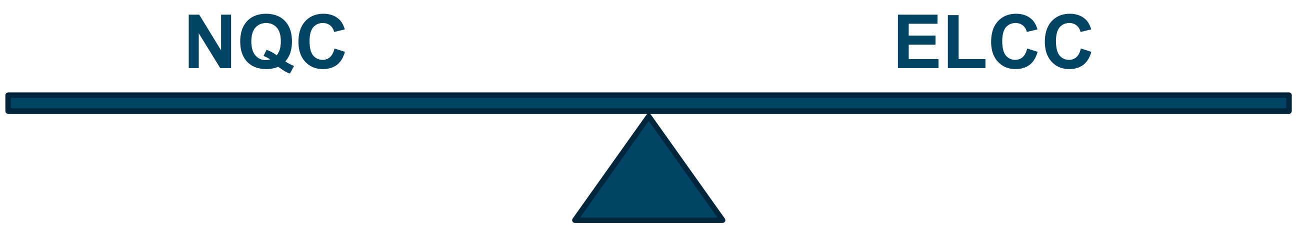


Established disconnect between ELCC and NQC

Provided E3 thoughts on how to match CAISO and utility DR bid data as well as techniques to extend this data over multiple historic weather years. Both points were addressed with the 2019 data.

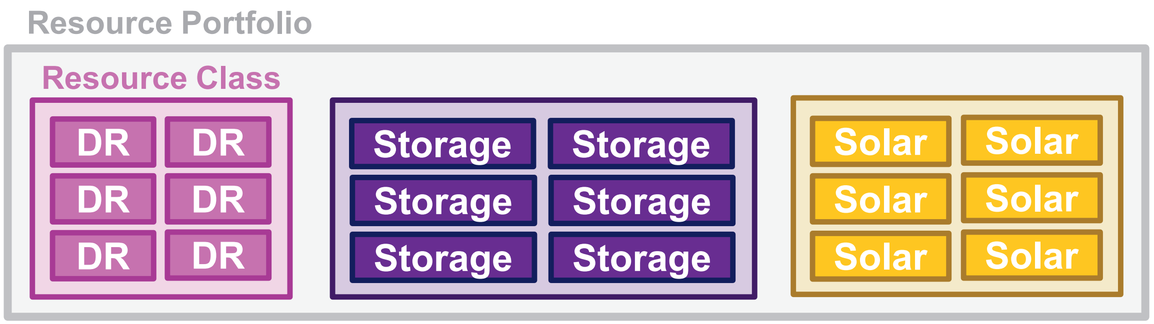
Key Questions to Answer

1) How are demand response programs performing today, relative to what they are being credited for?



2) What characteristics of demand response are needed today and in the future?

3) How should a resource adequacy program be designed to allocate and credit both DR in aggregate and individual DR programs?



Background on ELCC

Effective Load Carrying Capability (ELCC)

- **Effective Load Carrying Capability (ELCC) is a measure of the amount of equivalent perfect capacity that can be provided by an intermittent or energy-limited resource**
  - **Intermittent resources:** wind, solar
  - **Energy-limited resources:** storage, demand response
- **Industry has begin to shift toward ELCC as best practice, and the CPUC has been at the leading edge of this trend**

1 → 2 → 3

1. Calibrate existing system to target LOLE standard

If necessary, add or remove "perfect capacity" to achieve target standard

2. Add desired resource to portfolio

Addition of new source of generation will decrease LOLE relative to measurement in Step 1

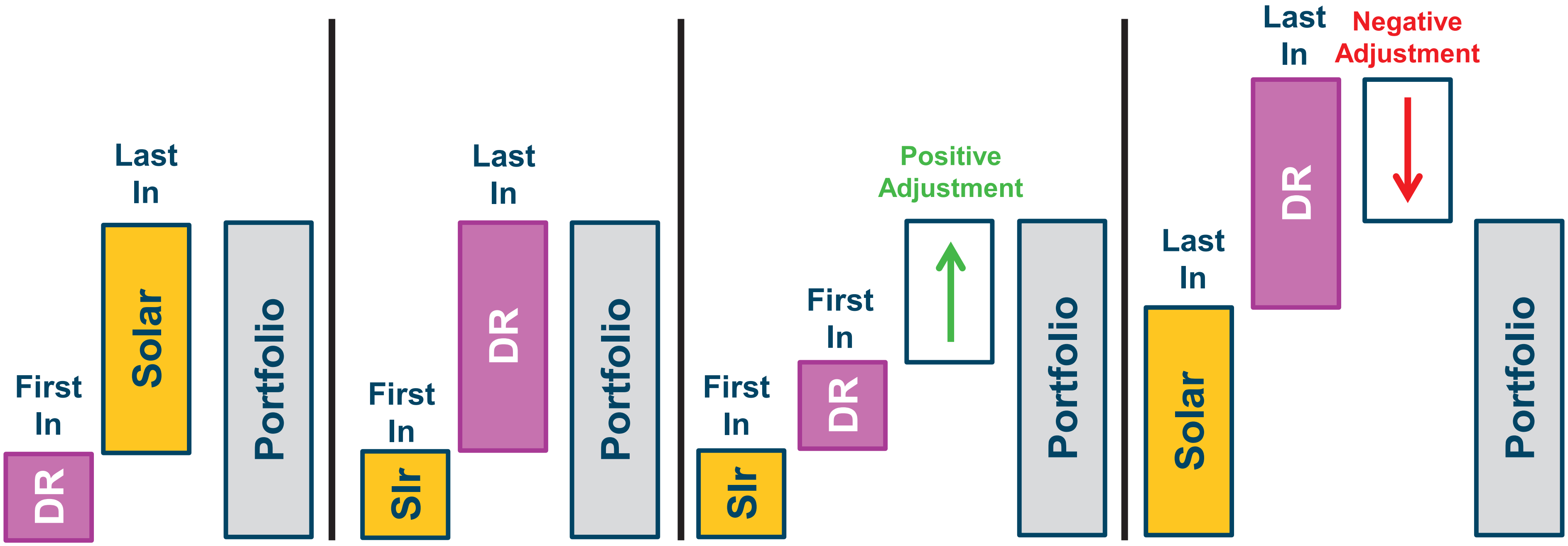
3. Remove perfect capacity until target LOLE is restored

Removal of perfect capacity results in increase in LOLE until original target is met

A resource's ELCC is equal to the amount of perfect capacity removed from the system in Step 3

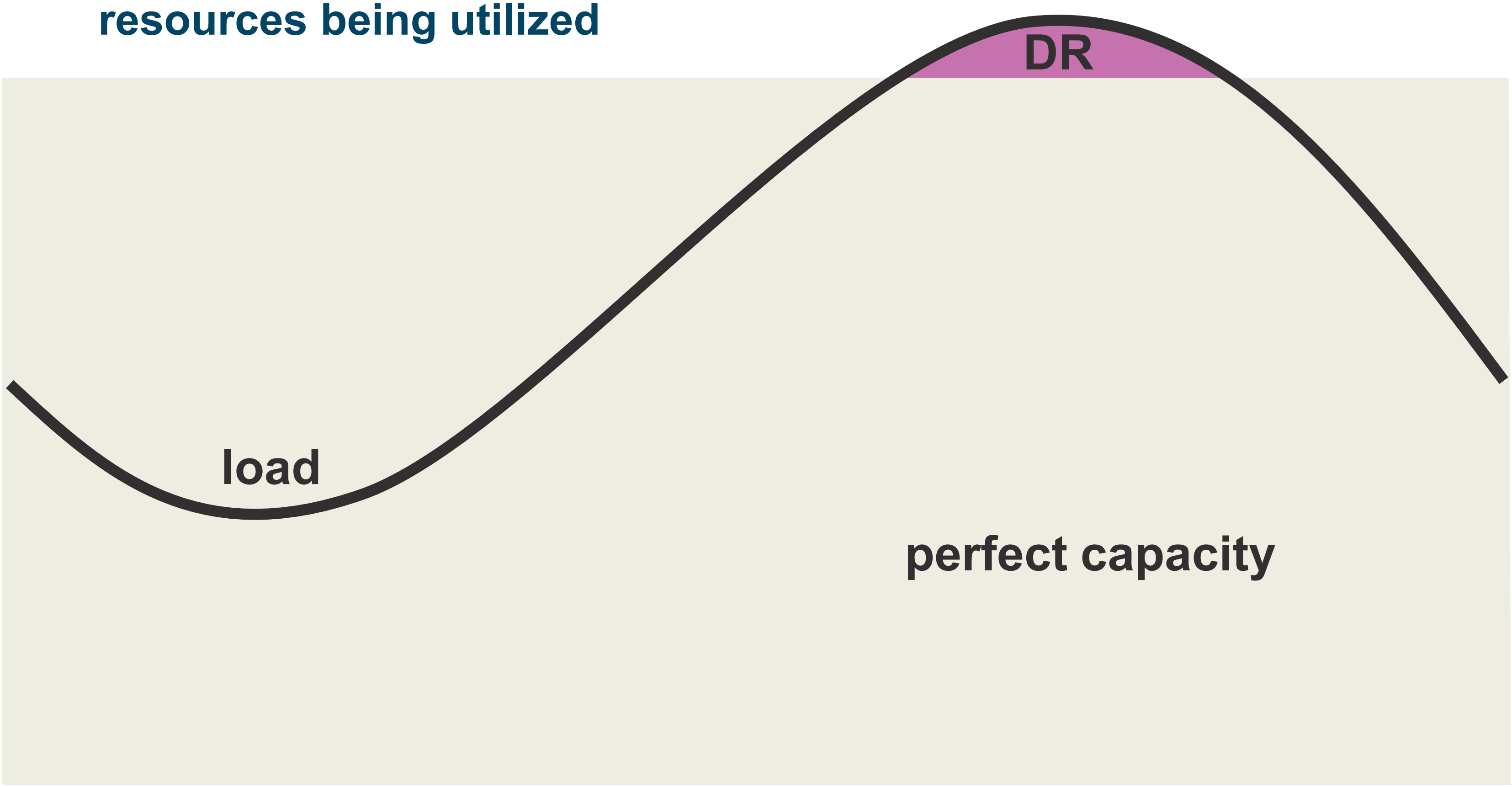
Measuring ELCC

- **There are multiple approaches to measuring the ELCC of a resource(s)**
  - **Portfolio ELCC:** measures the combined ELCC of all intermittent and energy-limited resources on the system
  - **First-In ELCC:** measures the marginal ELCC of a resource as if it were the only intermittent or energy-limited resource on the system, thus ignoring interactive effects
  - **Last-In ELCC:** measures the marginal ELCC of a resource after all other intermittent or energy-limited resources have been added to the system, capturing all interactive effects with other resources



"First-In" ELCC

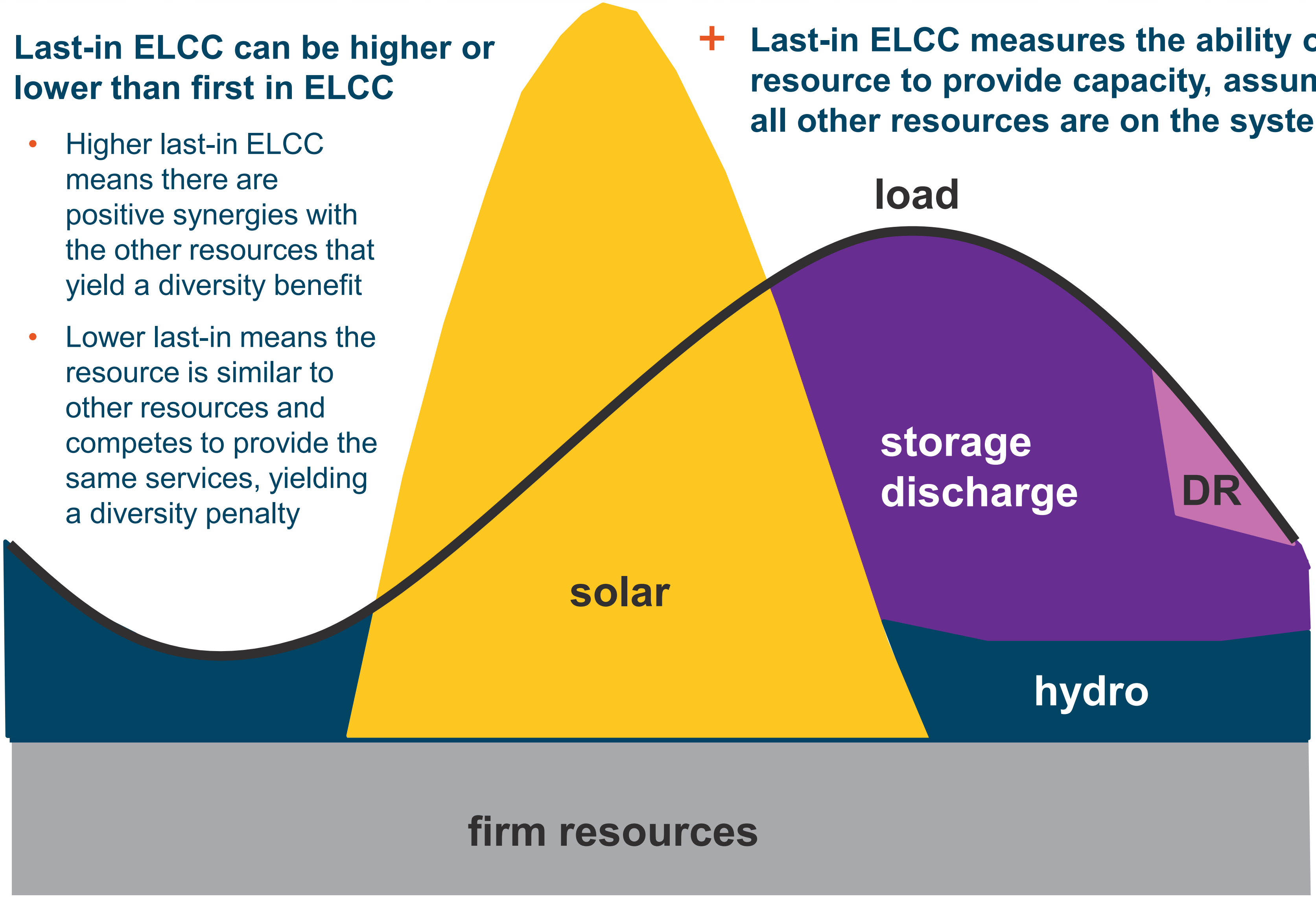
- First-in ELCC measures the ability of a resource to provide capacity, absent any other resource on the system
- This measures the ability of a resource to "clip the peak" and is often analogous to how many industry participants imagine capacity resources being utilized



"Last-In" ELCC

- **Last-in ELCC can be higher or lower than first in ELCC**
  - Higher last-in ELCC means there are positive synergies with the other resources that yield a diversity benefit
  - Lower last-in means the resource is similar to other resources and competes to provide the same services, yielding a diversity penalty

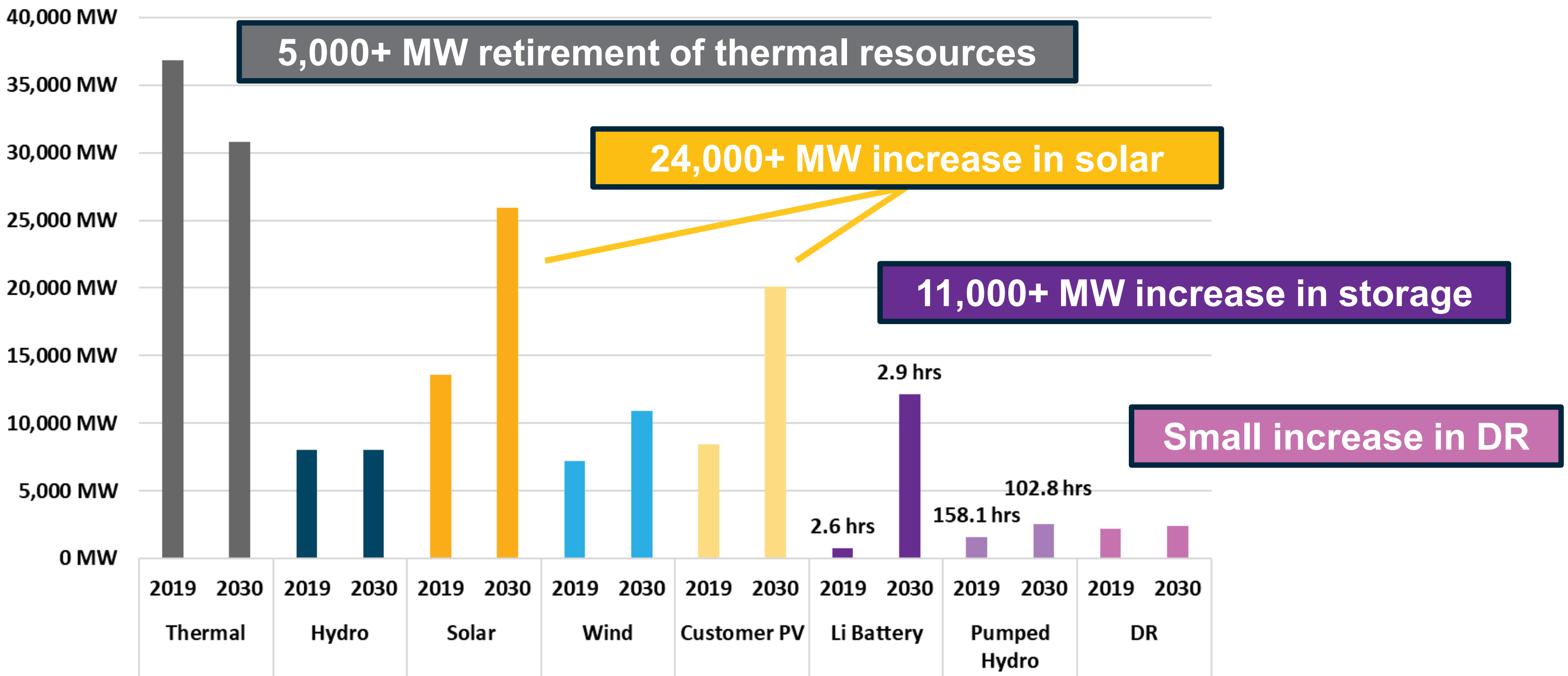
- **Last-in ELCC measures the ability of a resource to provide capacity, assuming all other resources are on the system**



Today (2019) vs. Future (2030)

- E3 analyzed the value of DR to the CAISO system today (2019) and the future (2030) to assess how coming changes to the electricity system might impact value
- Primary changes are on the resource side (shown below) with modest changes to loads (49 GW 2019 peak load vs 53 GW 2030 peak load)

2019 and 2030 CAISO Resource Portfolio



5,000+ MW retirement of thermal resources

24,000+ MW increase in solar

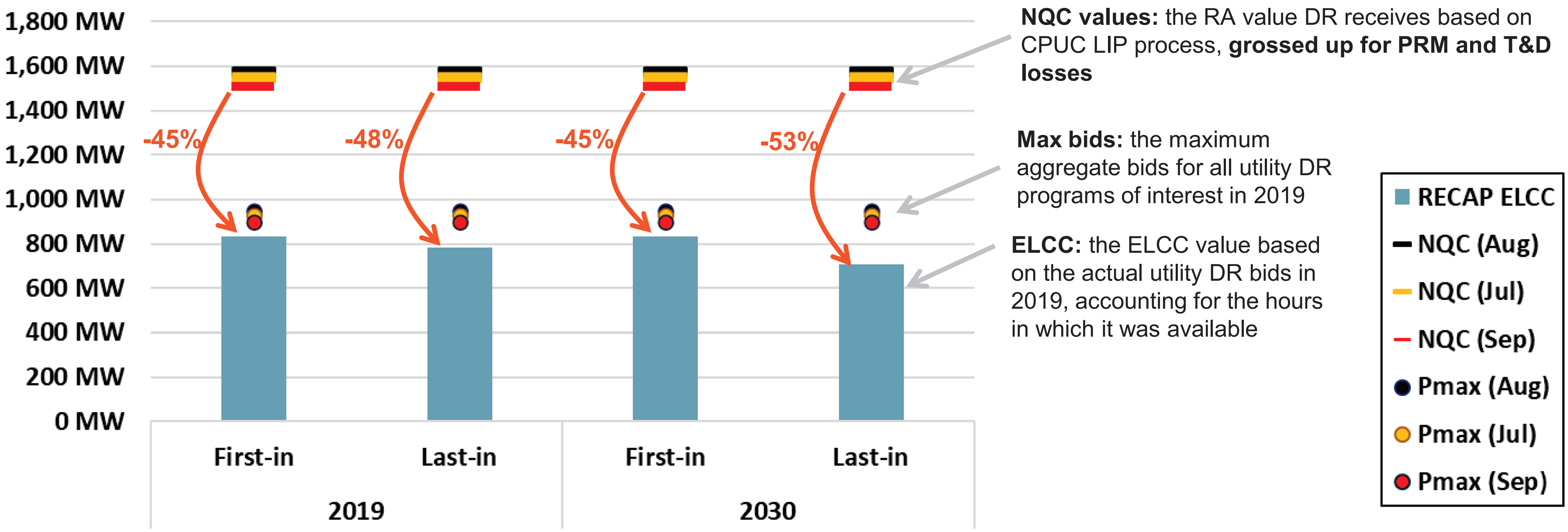
11,000+ MW increase in storage

Small increase in DR

Source: CPUC Integrated Resource Plan (IRP) Reference System Plan (RSP)

Performance of Existing PG&E and SCE event-based DR Programs

- **Demand response (DR) resource adequacy qualifying capacity is currently calculated using the load impact protocols (LIP), which are performed by the utilities under the oversight of the CPUC**
  - LIP uses regression and other techniques to estimate the availability of demand response during peak load hours
- **E3 has analysis suggests that LIP overvalues the capacity contribution DR relative to ELCC by 30%+ for two reasons:**
  1) DR does not bid into the CAISO market, in aggregate, at levels equal to its NQC value
  2) The times when DR is bid are either not at optimal times or not for long enough to earn full ELCC value



NQC values: the RA value DR receives based on CPUC LIP process, **grossed up for PRM and T&D losses**

Max bids: the maximum aggregate bids for all utility DR programs of interest in 2019

ELCC: the ELCC value based on the actual utility DR bids in 2019, accounting for the hours in which it was available

Load impacts are grossed up for transmission and distribution losses, as also the 15% PRM, owing to demand response being a demand reduction measure

$NQC = LI * 1.15\,(PRM) * T\&D\ loss\ factor$[1]

Load impacts for the year 2019 are referenced from the CPUC's RA Compliance documents[2]

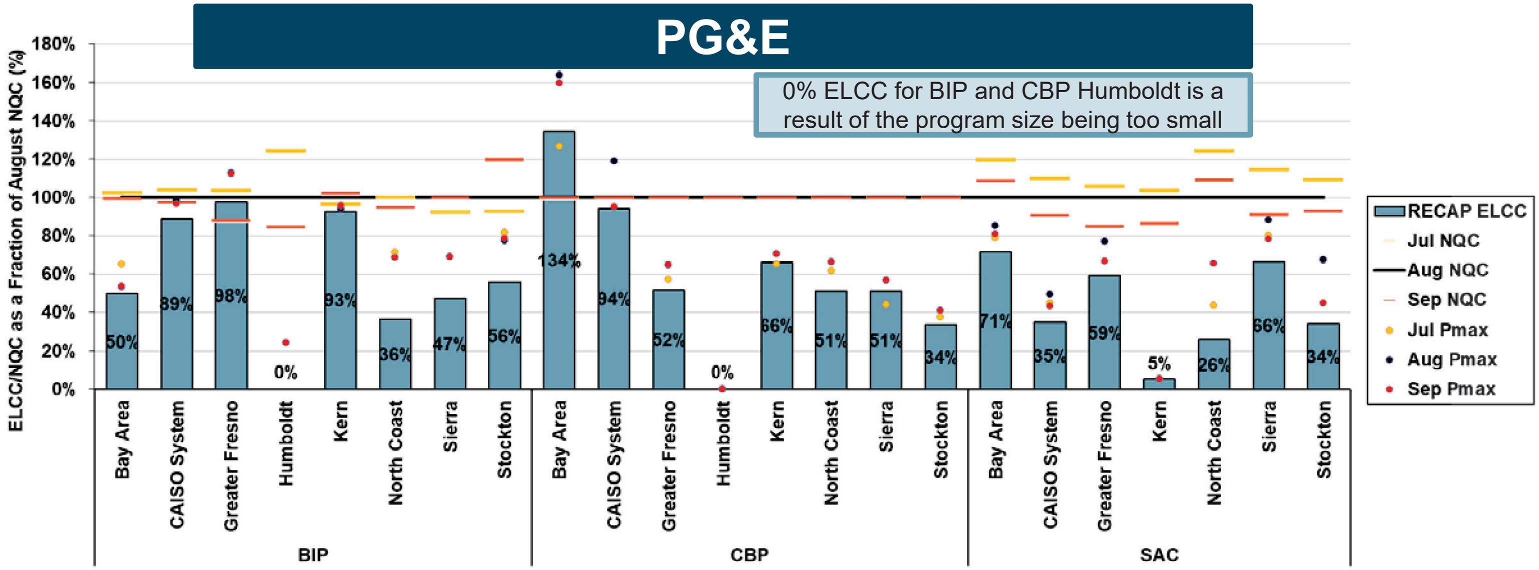
Load impacts are defined on an LCA level from 1 pm to 6 pm, Apr to Oct, and from 4 pm to 9 pm in the rest of the year, both with and without line losses

[1] CPUC 2019 RA Guide

[2] CPUC 2019 IoU DR Program Totals

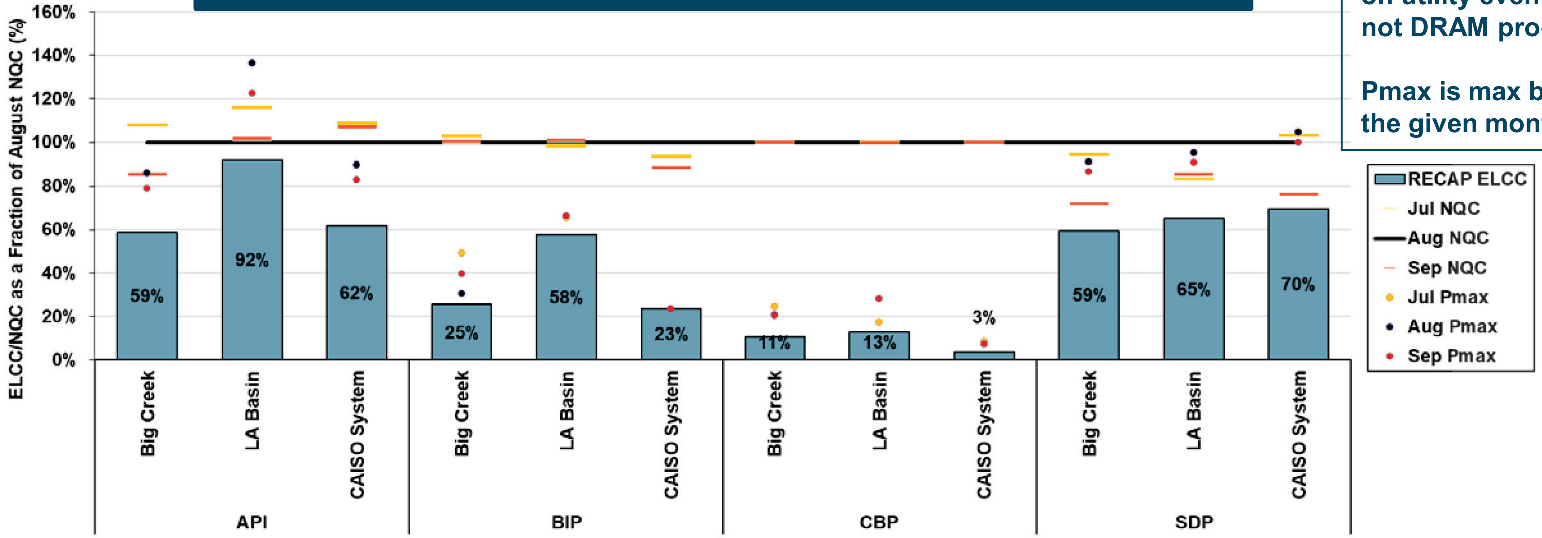
First-in ELCC of PG&E and SCE Programs

PG&E



0% ELCC for BIP and CBP Humboldt is a result of the program size being too small

SCE



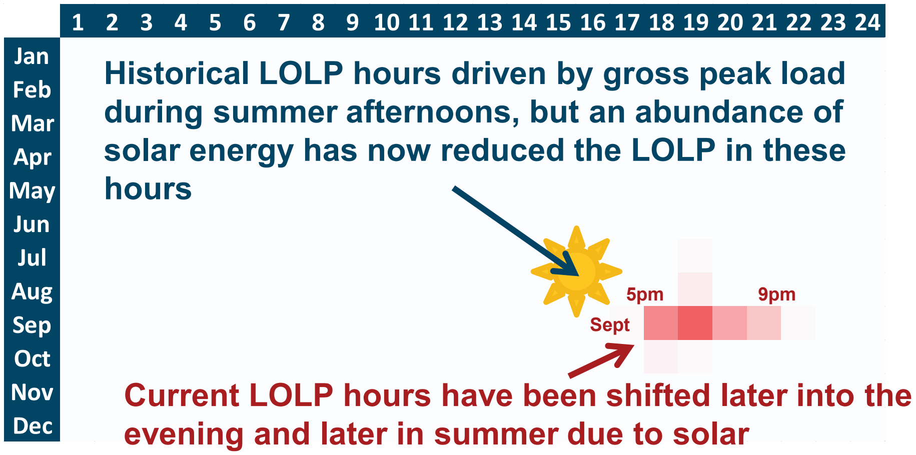
These results just focus on utility event-based DR, not DRAM programs

Pmax is max bid placed in the given month

Time Window Availability Needs for DR in 2019 & 2030

- Month/hour (12x24) loss of load probability heat maps provide a quick overview of "high risk" hours
- Key findings from this project are showing that strong interactions between storage and DR may elongate the peak period by 2030

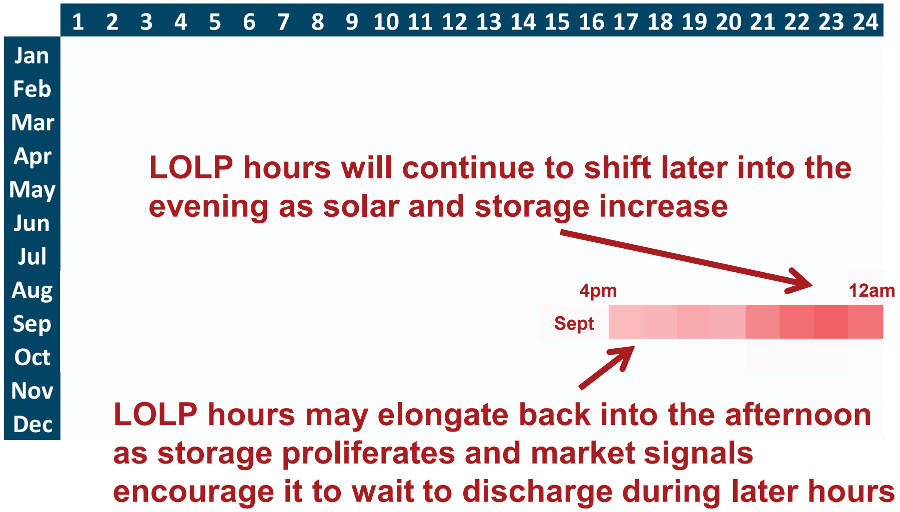
LOLP in 2019



Historical LOLP hours driven by gross peak load during summer afternoons, but an abundance of solar energy has now reduced the LOLP in these hours

Current LOLP hours have been shifted later into the evening and later in summer due to solar

LOLP in 2030



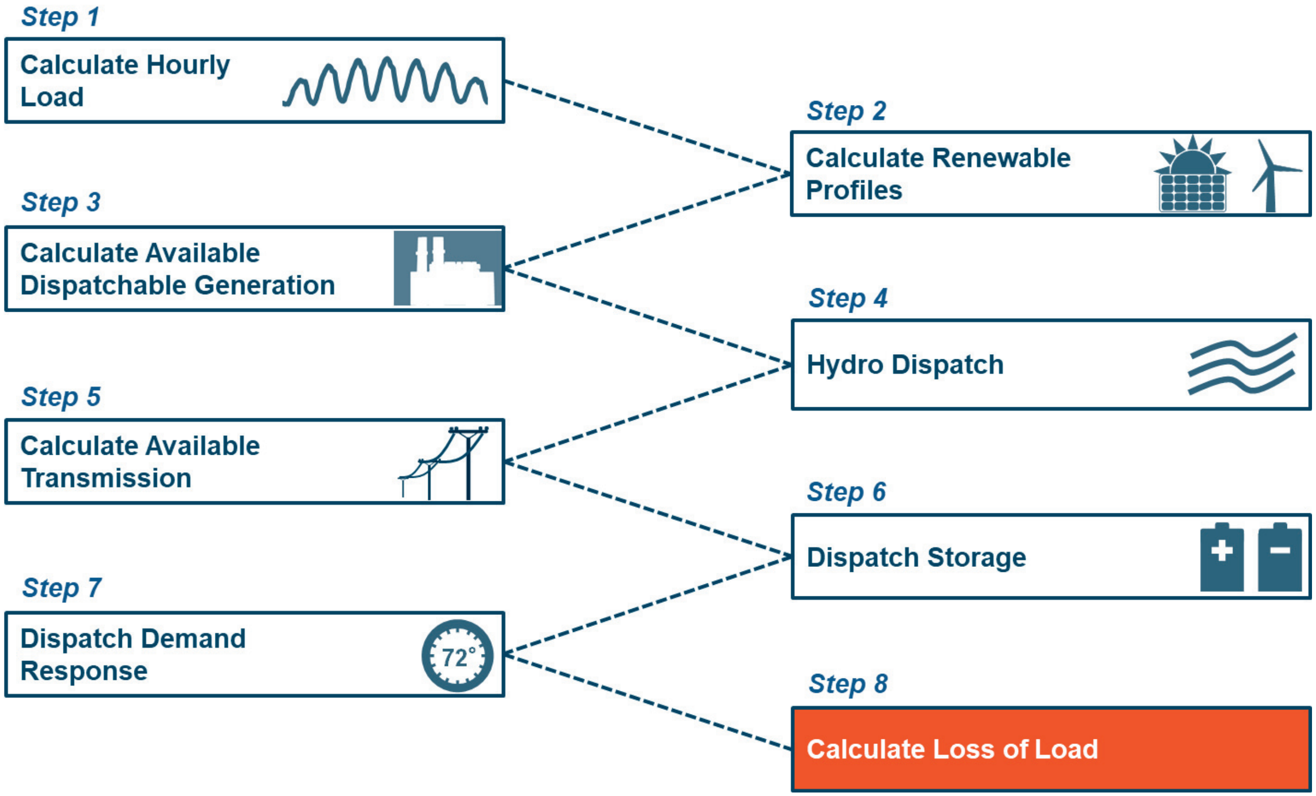
LOLP hours will continue to shift later into the evening as solar and storage increase

LOLP hours may elongate back into the afternoon as storage proliferates and market signals encourage it to wait to discharge during later hours

DR Interaction with Storage

- Historically, DR is dispatched as a resource of “last resort” which is how RECAP dispatched DR
- A system with high penetrations of storage require much more coordination in the dispatch of DR and storage in order to achieve maximum reliability

E3 RECAP Model Methodology



Step 1
Calculate Hourly Load

Step 2
Calculate Renewable Profiles

Step 3
Calculate Available Dispatchable Generation

Step 4
Hydro Dispatch

Step 5
Calculate Available Transmission

Step 6
Dispatch Storage

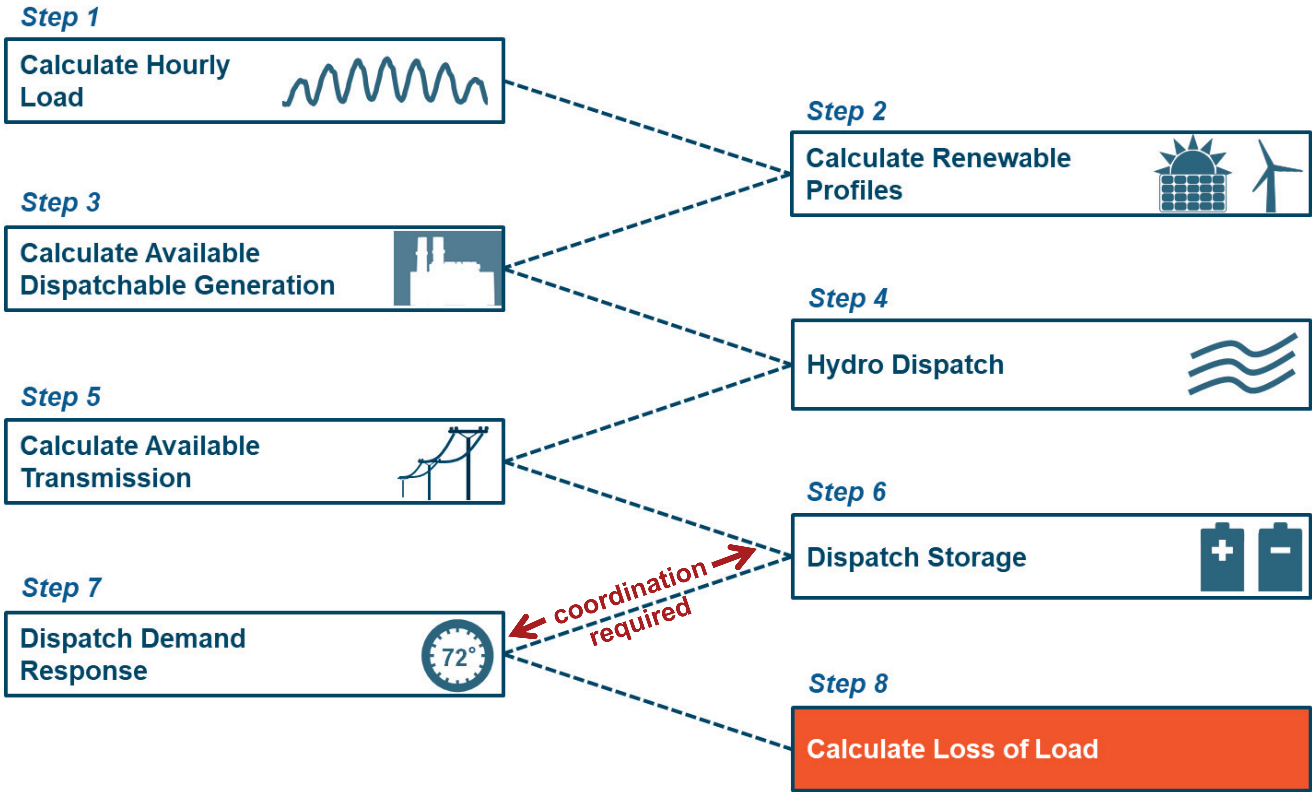
Step 7
Dispatch Demand Response

Step 8
Calculate Loss of Load

DR Interaction with Storage

- Historically, DR is dispatched as a resource of “last resort” which is how RECAP dispatched DR
- A system with high penetrations of storage require much more coordination in the dispatch of DR and storage in order to achieve maximum reliability

E3 RECAP Model Methodology



Step 1
Calculate Hourly Load

Step 2
Calculate Renewable Profiles

Step 3
Calculate Available Dispatchable Generation

Step 4
Hydro Dispatch

Step 5
Calculate Available Transmission

Step 6
Dispatch Storage

Step 7
Dispatch Demand Response

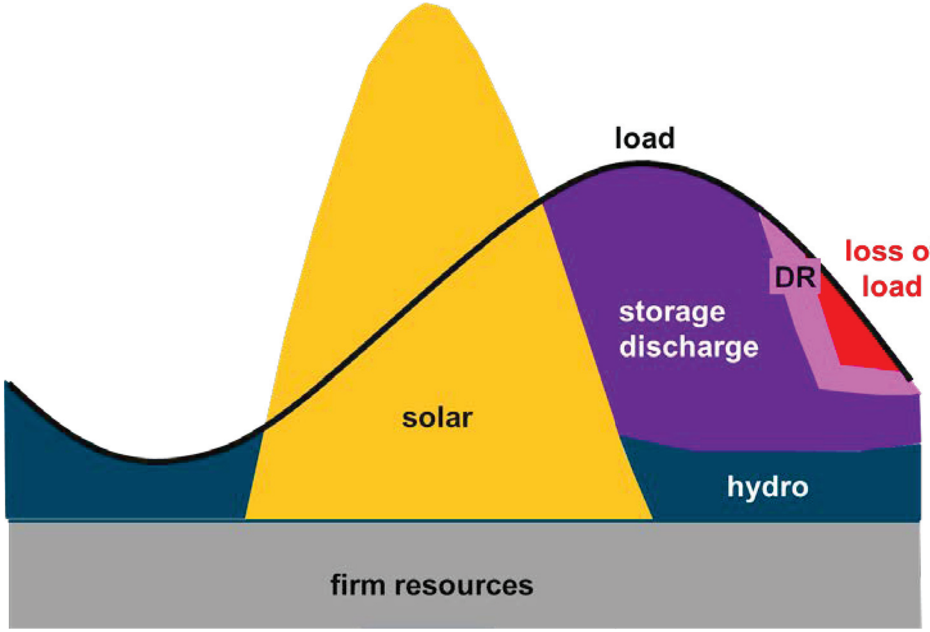
Step 8
Calculate Loss of Load

coordination required

Last Resort vs. Optimal Dispatch

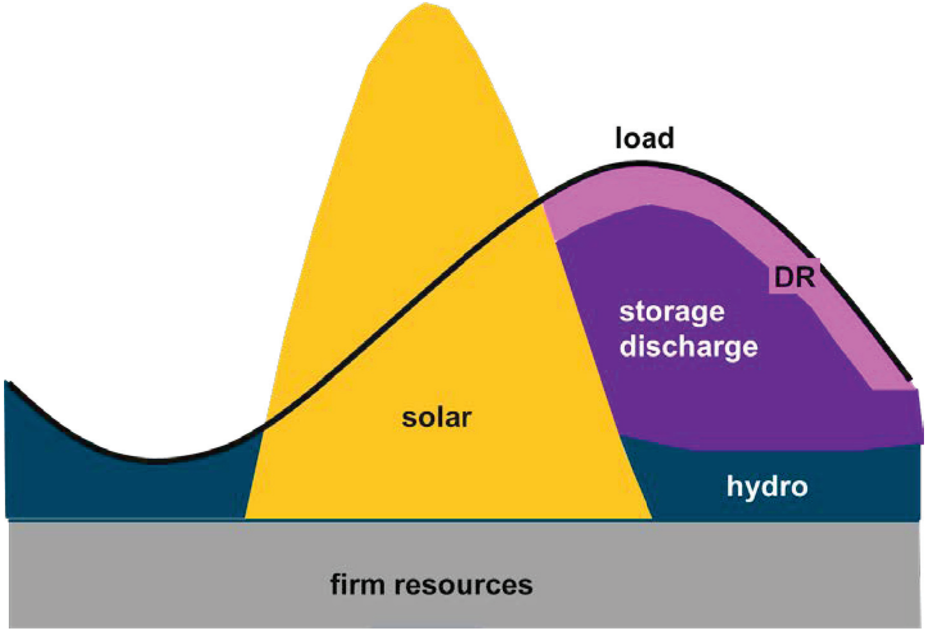
DR as Resource of Last Resort

When DR is dispatched as the resource of last resort, there is loss of load



DR Dispatch to Delay Storage Discharge

Preemptively dispatching DR to delay storage discharge eliminates loss of load event



Key takeaway: DR should be dispatched to delay storage discharge on days with potential loss of load

Call and Duration ELCC Results

First-in ELCC

Last-in ELCC

2019

First-in ELCC

ELCC (% of nameplate)		Max annual calls						
		1	2	4	5	10	15	20
Max call duration (hrs)	1	46%	50%	51%	51%	51%	51%	51%
	2	63%	73%	78%	78%	78%	78%	78%
	4	70%	81%	94%	95%	95%	95%	95%
	6	70%	81%	94%	95%	95%	95%	95%
	8	70%	81%	94%	95%	95%	95%	95%

Last-in ELCC

ELCC (% of nameplate)		Max annual calls						
		1	2	4	5	10	15	20
Max call duration (hrs)	1	59%	73%	73%	73%	73%	73%	73%
	2	74%	90%	94%	94%	94%	94%	94%
	4	77%	98%	100%	100%	100%	100%	100%
	6	77%	98%	100%	100%	100%	100%	100%
	8	77%	98%	100%	100%	100%	100%	100%

No interactions with storage – therefore no expected significant differences

Significant degradation in last-in ELCC in 2030 is driven by saturation of energy-limited resources, primarily storage

2030

First-in ELCC

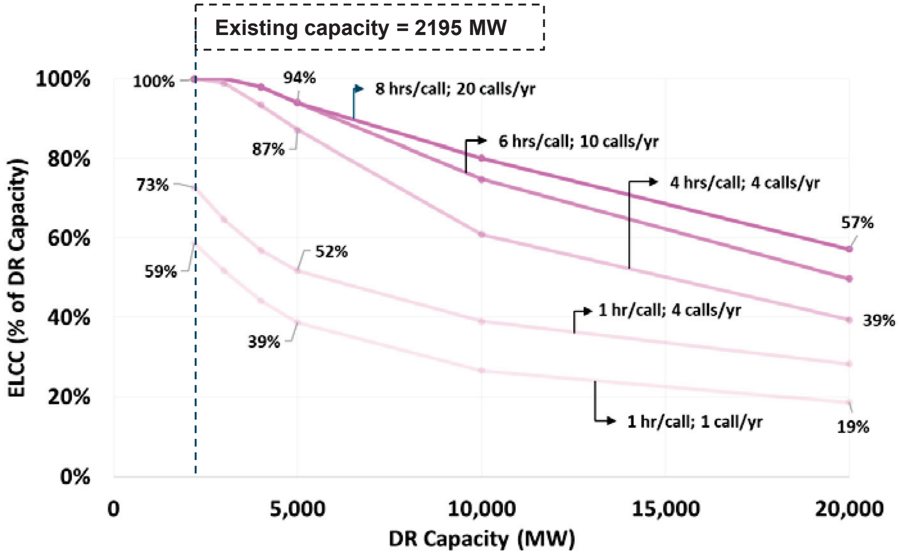
ELCC (% of nameplate)		Max annual calls						
		1	2	4	5	10	15	20
Max call duration (hrs)	1	41%	43%	43%	43%	43%	43%	43%
	2	60%	65%	65%	65%	65%	65%	65%
	4	72%	91%	95%	95%	95%	95%	95%
	6	73%	92%	98%	98%	98%	98%	98%
	8	73%	92%	98%	98%	98%	98%	98%

Last-in ELCC

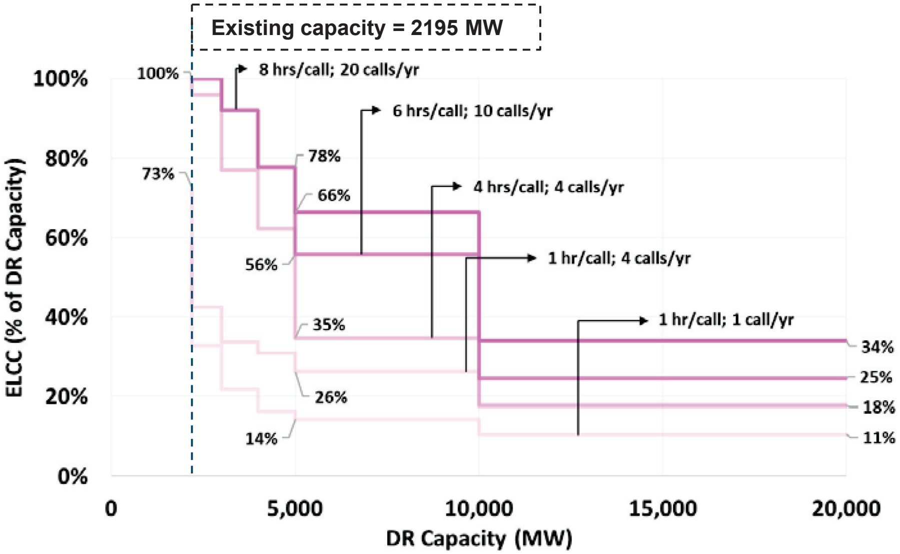
ELCC (% of nameplate)		Max annual calls						
		1	2	4	5	10	15	20
Max call duration (hrs)	1	35%	37%	37%	37%	37%	37%	37%
	2	44%	49%	49%	49%	49%	49%	49%
	4	52%	65%	69%	69%	69%	69%	69%
	6	56%	77%	77%	77%	77%	77%	77%
	8	75%	91%	93%	93%	93%	93%	93%

DR ELCC Performance at Increasing Penetrations (2019)

Average Last-in ELCC



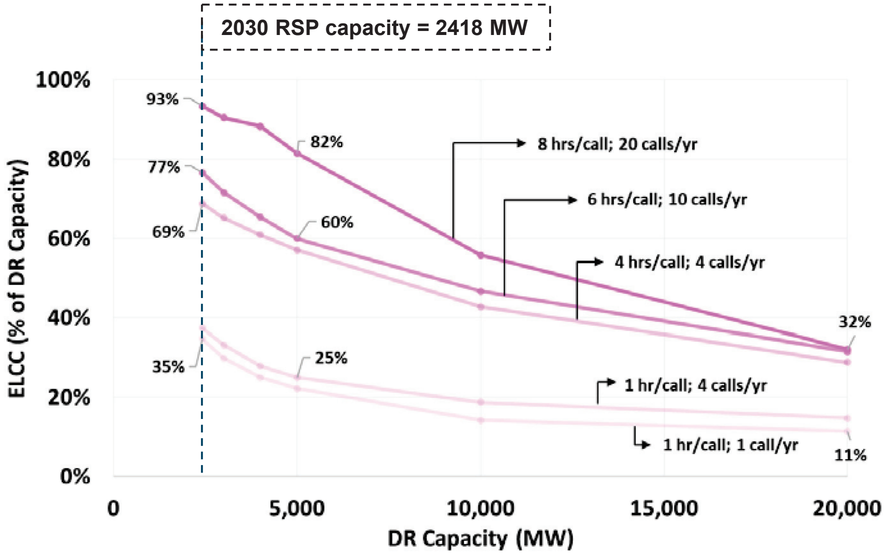
Incremental Last-in ELCC



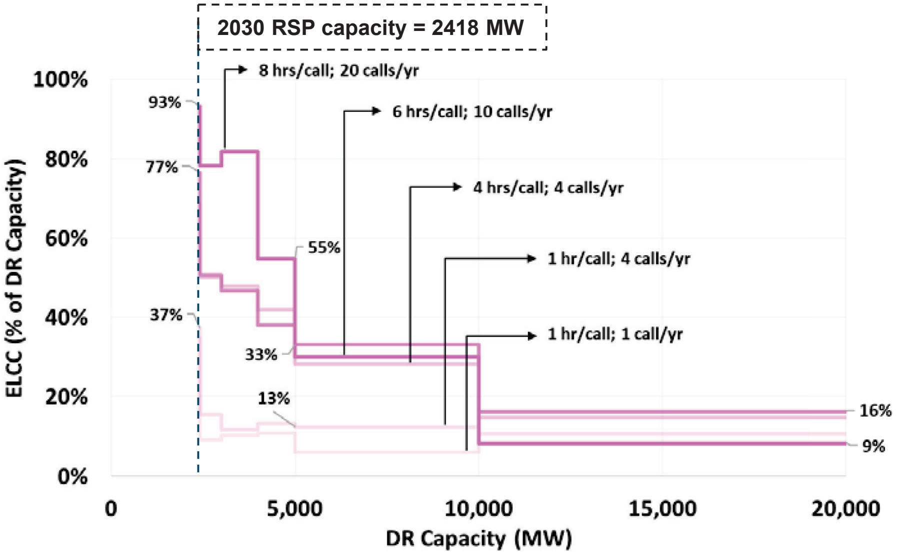
- **Average ELCC = Total Effective Capacity / Total Installed Capacity**
- **Incremental ELCC = ∆ Effective Capacity / ∆ Installed Capacity**
- **ELCC generally decreases as DR capacity on the system increases:**
  - Similarity in hours of operation and characteristics limits the incremental value that more of the exact same resource type can add to the system.
  - Degradation gets more severe as call constraints become more stringent.

DR ELCC Performance at Increasing Penetrations (2030)

Average Last-in ELCC



Incremental Last-in ELCC

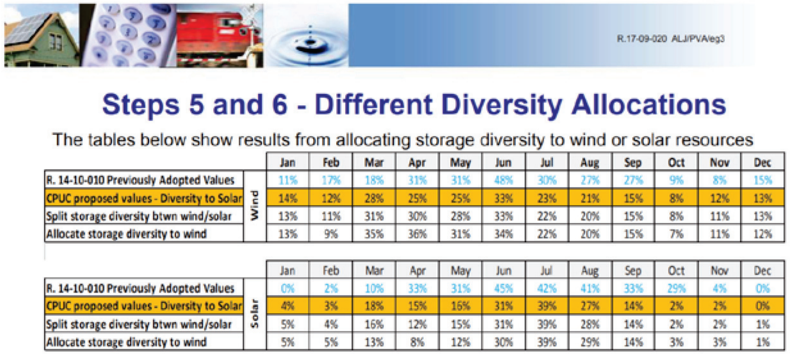


+ ELCC generally decreases as DR capacity on the system increases:

- Similarity in hours of operation and characteristics limits the incremental value that more of the exact same resource type can add to the system.
- For a given DR capacity on the system, ELCC in 2030 is lower than that in 2019 owing to saturation of energy-limited resources on the system in 2030, particularly storage.

CPUC Role in RA & ELCC Implementation

- **The CPUC has been a leader in North America through the incorporation of intermittent and energy-limited resources into RA frameworks**
  - One of the first to adopt and implement **ELCC** framework to value wind and solar
  - Currently the only jurisdiction that recognizes and accounts for **interactive effects** of resources through allocation of a "diversity benefit" to wind and solar
- **The CPUC has recognized that the concept of "interactive effects" applies not only to renewables but to storage and other resources, but has not yet established an approach for allocation that incorporates them all**



R.17-09-020 ALJ/PVA/eg3

Steps 5 and 6 - Different Diversity Allocations

The tables below show results from allocating storage diversity to wind or solar resources

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
R. 14-10-010 Previously Adopted Values	Wind	11%	17%	18%	31%	31%	48%	30%	27%	27%	9%	8%	15%
CPUC proposed values - Diversity to Solar		14%	12%	28%	25%	25%	33%	23%	21%	15%	8%	12%	13%
Split storage diversity btwn wind/solar		13%	11%	31%	30%	28%	33%	22%	20%	15%	8%	11%	13%
Allocate storage diversity to wind		13%	9%	35%	36%	31%	34%	22%	20%	15%	7%	11%	12%

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
R. 14-10-010 Previously Adopted Values	Solar	0%	2%	10%	33%	31%	45%	42%	41%	33%	29%	4%	0%
CPUC proposed values - Diversity to Solar		4%	3%	18%	15%	16%	31%	39%	27%	14%	2%	2%	0%
Split storage diversity btwn wind/solar		5%	4%	16%	12%	15%	31%	39%	28%	14%	2%	2%	1%
Allocate storage diversity to wind		5%	5%	13%	8%	12%	30%	39%	29%	14%	3%	3%	1%

- **Establishing a more generalized, durable framework for ELCC (capable of accounting for renewables, storage, and DR) will require a reexamination of the methods used to allocate ELCC and the "diversity benefit"**
- **This section examines alternative options for allocating ELCC among resources that could improve upon existing methods currently in use**

Allocating ELCC

- **Allocating Portfolio ELCC is necessary with a centralized or bilateral capacity market framework where individual resources must be assigned a capacity contribution for compensation purposes**
  - Directly impacts billions of dollars of market clearing transactions within California and other organized capacity markets
- **Allocating Portfolio ELCC can impact planning and procurement in California to the extent that entities procure based on the economic signal they receive in the RA program**
  - An allocation exercise is not necessary in vertically integrated jurisdictions or in systems with a centralized procurement process
- **There are an infinite number of methods to allocate Portfolio ELCC to individual resources and no single correct or scientific method, similar to rate design**

Sample ELCC Allocation Method Options

1. **Allocate proportionally to First-In ELCC**
2. **Allocate proportionally to Last-In ELCC**
3. **Allocate adjustment to First-In ELCC proportionally to differences between First-in and Last-In ELCC**
4. **Vintaging approach where each resource permanently receives Last-In ELCC at the time it was constructed**
5. **More**

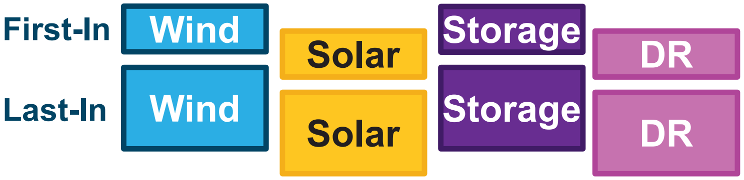
Framework to Incorporate DR ELCC Into CPUC RA Framework

- **This section presents a framework as one option for attributing capacity value to DR *within the current resource adequacy framework* administered by the CPUC**
- **This framework relies on several key principles:**
  1) **Reliability:** The ELCC allocated to each project/program should sum to the portfolio ELCC for all resources
  2) **Fairness:** ELCC calculations should be technology neutral, properly reward resources for the capacity characteristics they provide, and not unduly differentiate among similar resources
  3) **Efficiency:** ELCC values should send accurate signals to encourage an economically efficient outcome to maximize societal resources
  4) **Customer Acceptability:** ELCC calculations should be transparent, tractable understandable, and implementable

Overview of Framework

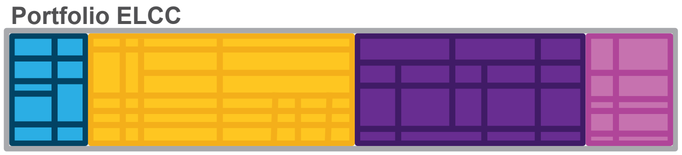
1. **Calculate portfolio ELCC**

2. **Calculate "first-in" and "last-in" ELCC for each resource category**



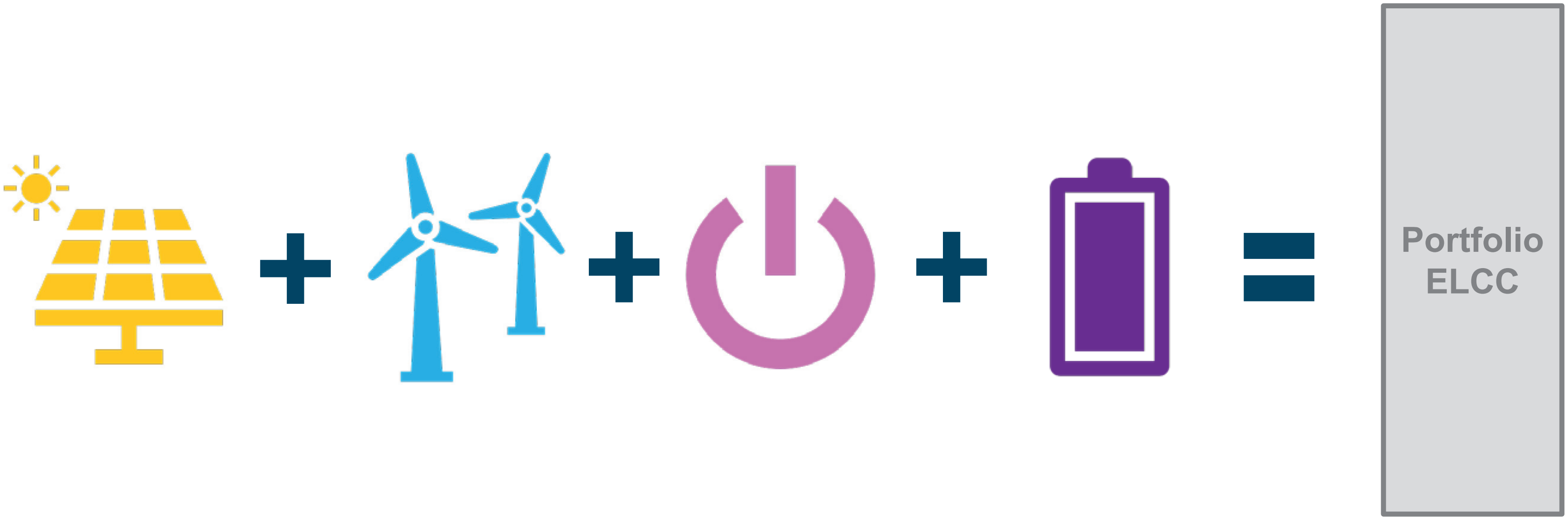
3. **Allocate portfolio ELCC to each resource category**

4. **Allocate resource category ELCC to each project/program using tractable heuristic**



1) Calculate Portfolio ELCC

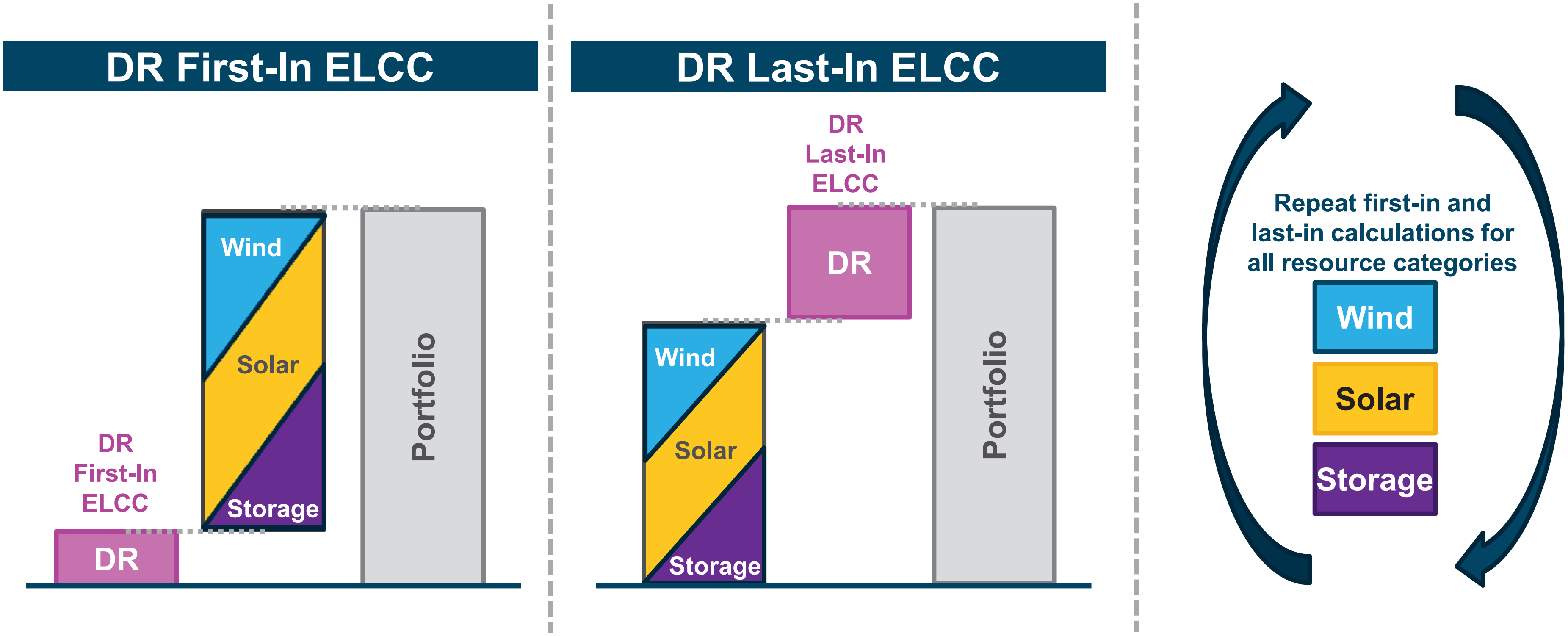
+ **The first step should calculate the portfolio ELCC of all variable and energy-limited resources**
  - Wind
  - Solar
  - Storage
  - Demand Response



Portfolio ELCC

2) Calculation First-In and Last-In Resource Category ELCCs

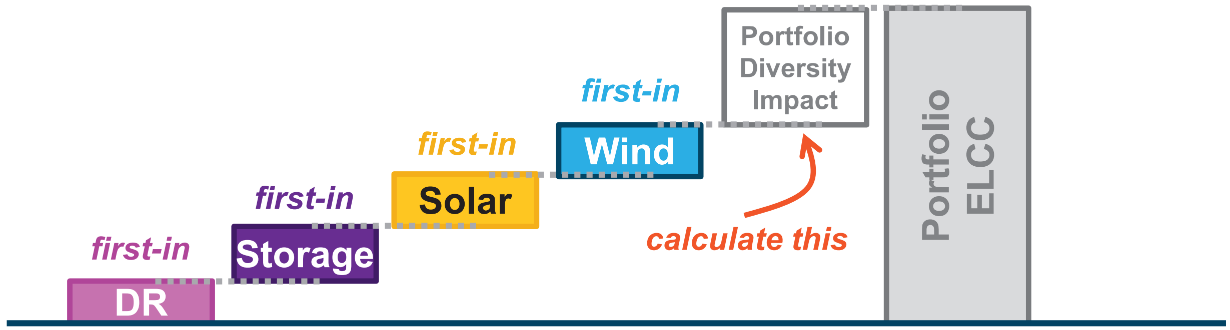
- The second step calculates the "first-in" and "last-in" ELCC for each resource category as a necessary input for allocation of the portfolio ELCC



3) Allocate Portfolio ELCC to Each Resource Category

Calculate diversity impact as the difference between portfolio ELCC and sum of first-in ELCCs

1



first-in DR

first-in Storage

first-in Solar

first-in Wind

Portfolio Diversity Impact

calculate this

Portfolio ELCC

2

Calculate diversity impact for each resource category

calculate this

first-in DR

DR Diversity Impact

last-in DR

Repeat calculation of positive or negative allocator for each resource category

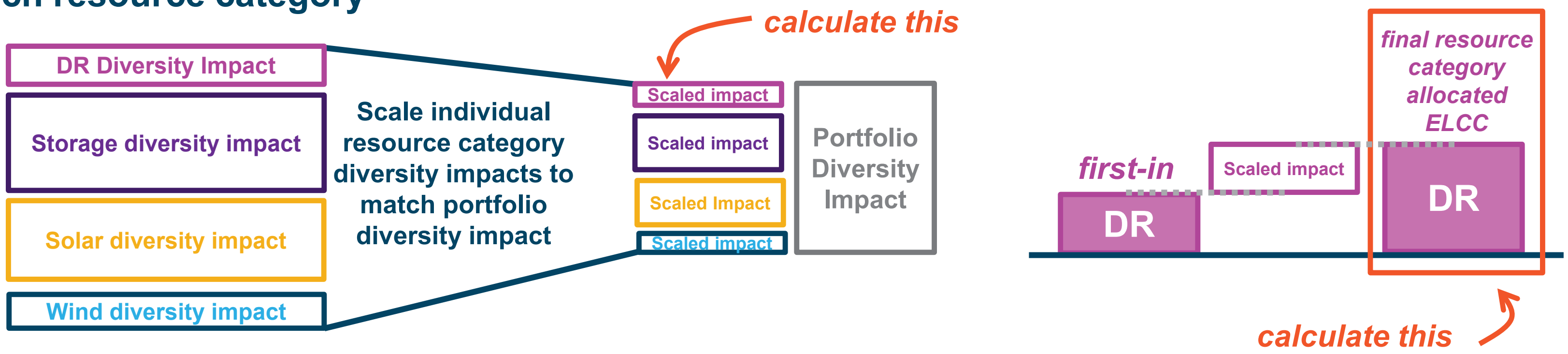
Wind diversity impact

Solar diversity impact

Storage diversity impact

3

Allocate diversity impact in proportion to the difference between first-in and last-in ELCC for each resource category



DR Diversity Impact

Storage diversity impact

Solar diversity impact

Wind diversity impact

Scale individual resource category diversity impacts to match portfolio diversity impact

calculate this

Scaled impact

Scaled impact

Scaled Impact

Scaled impact

Portfolio Diversity Impact

first-in DR

Scaled impact

final resource category allocated ELCC

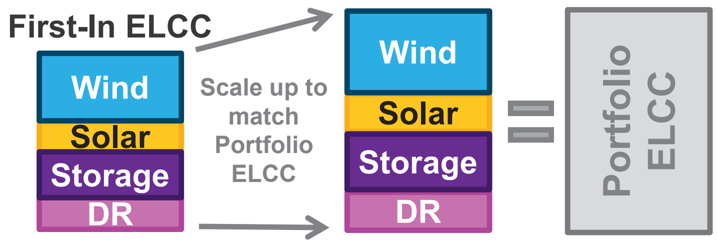
DR

calculate this

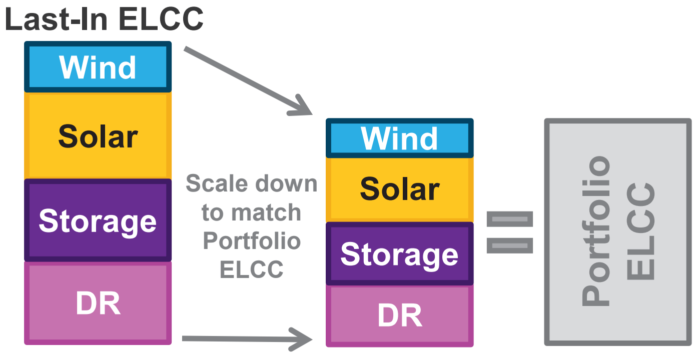
Benefits of this Approach

- There are several options to allocate Portfolio ELCC to each technology category, two examples of which are shown below

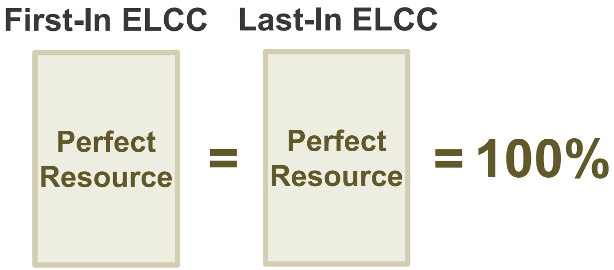
First-In ELCC Allocation Option



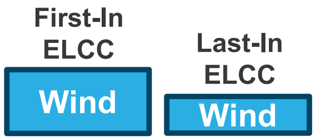
Last-In ELCC Allocation Option



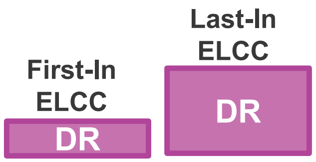
- Both of these options can lead to final ELCC allocations that fall outside the bounds of the first-in or last-in ELCC
  - For example, in the case of a "perfect" resource (e.g. ultra-long duration storage, always available DR, baseload renewables, etc.), this should be counted at 100% ELCC and should not be unduly scaled up or down based on the synergistic or antagonistic impacts of other resource interactions
  - Scaling the first-in or last-in ELCC in any way would result in an ELCC of either >100% or <100% for this perfect resource



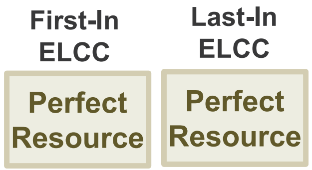
- The method presented in this deck scales resources based on the difference of their first-in and last-in ELCC in order to reflect their synergistic or antagonistic contributions to Portfolio ELCC



Negative diversity impact leads to first-in ELCC being scaled up to match Portfolio ELCC



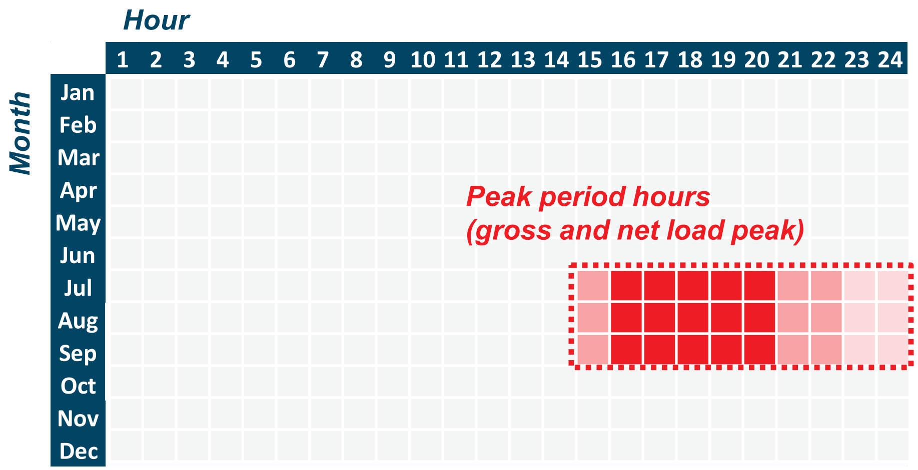
Positive diversity impact leads to first-in ELCC being scaled down to match Portfolio ELCC



No diversity impact leads to no scaling of first-in ELCC to match Portfolio ELCC

4) Allocate Resource Category ELCC to Individual Resource/Programs Using Heuristics

- **Each DR program submits the following information**
  - Expected output during peak period hours
  - Maximum number of calls per year
  - Maximum duration of call
- **Step 1) Calculate average MW availability during peak period hours (gross and net load)**
- **Step 2) Multiple MW availability from step (1) by lookup table de-rating factor to account for call and duration limitations**
  - DR category ELCC to individual program ELCC using first-in and last-in ELCC would work similarly to the allocation process of portfolio ELCC to resource category ELCC



First-In ELCC

ELCC (% of nameplate)		Max annual calls						
		1	2	4	5	10	15	20
Max call duration (hrs)	1	41%	43%	43%	43%	43%	43%	43%
	2	60%	65%	65%	65%	65%	65%	65%
	4	72%	91%	95%	95%	95%	95%	95%
	6	73%	92%	98%	98%	98%	98%	98%
	8	73%	92%	98%	98%	98%	98%	98%

Last-In ELCC

ELCC (% of nameplate)		Max annual calls						
		1	2	4	5	10	15	20
Max call duration (hrs)	1	35%	37%	37%	37%	37%	37%	37%
	2	44%	49%	49%	49%	49%	49%	49%
	4	52%	65%	69%	69%	69%	69%	69%
	6	56%	77%	77%	77%	77%	77%	77%
	8	75%	91%	93%	93%	93%	93%	93%

Questions?

Questions

Energy+Environmental Economics

Thank You

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Zach Ming, (zachary.ming@ethree.com)

Vignesh Venugopal (vignesh.venugopal@ethree.com)

Energy+Environmental Economics

Updated Demand Response ELCC Study

CAISO

December 2020

Zach Ming, Director
Vignesh Venugopal, Consultant

Overview of DR ELCC Study Update

- **The DR ELCC study has been updated to reflect two primary changes**

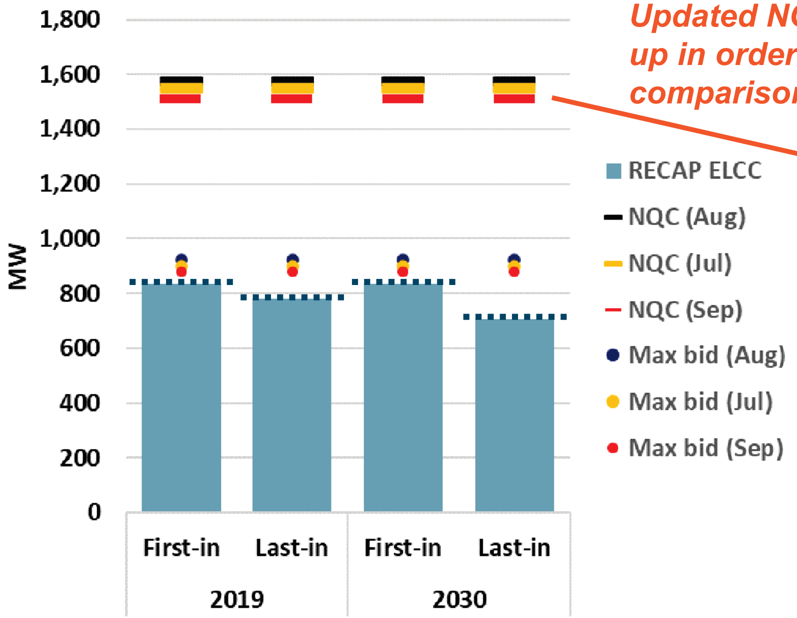
1) SCE BIP Bid Values
    - The original DR bid data submitted to E3 from SCE reflected the actual BIP bid values but not the full capability of these resources
    - Due to discrete dispatch limitations and registration restrictions, SCE had been underbidding the full capability of its DR resources into the CAISO market
    - SCE has now modified its bidding procedures to reflect the full capability of these resources and has retroactively modified 2019 bid values to reflect its new bidding strategy
2) T&D Loss and PRM Gross Up
    - DR ELCC values are now compared to the DR NQC values net of T&D loss factors and PRM
    - Originally, both SCE and PG&E indicated to E3 that the demand response bid data was grossed up for T&D losses but after the May release of the study indicated it was not

Average Increase in SCE Hourly DR Bid Data

Avg Difference (MW)																								
Month/Hour (PST)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
1	127	126	125	125	130	137	142	147	148	151	158	148	146	144	140	137	127	125	125	124	124	141	143	139
2	122	121	121	121	125	132	137	140	140	140	143	144	140	136	134	132	129	128	127	125	125	134	135	131
3	113	113	113	116	122	128	132	131	132	141	138	133	129	126	125	123	123	122	121	120	124	126	124	118
4	207	289	456	187	205	193	210	220	230	219	260	202	192	188	186	179	177	187	179	180	185	199	204	186
5	137	137	134	137	144	150	153	157	152	153	157	156	149	148	145	140	133	142	141	145	147	140	138	131
6	108	107	105	108	115	119	123	125	120	123	125	124	119	119	115	111	103	112	110	114	115	109	107	106
7	92	92	89	91	98	103	109	110	101	105	107	106	103	101	99	95	88	96	95	98	98	93	91	90
8	99	99	95	97	104	109	117	119	112	115	116	115	117	117	115	111	105	103	101	105	106	101	97	96
9	86	88	85	87	93	98	102	105	99	102	103	102	99	98	94	90	84	91	89	94	95	90	86	86
10	101	102	98	101	105	108	111	117	115	119	121	117	112	112	109	106	98	107	104	109	110	104	99	98
11	88	89	89	90	92	97	102	108	104	110	111	153	105	103	101	101	101	101	97	87	84	91	97	93
12	72	68	67	66	69	75	77	80	79	77	95	78	79	79	77	76	74	71	76	76	75	80	79	77

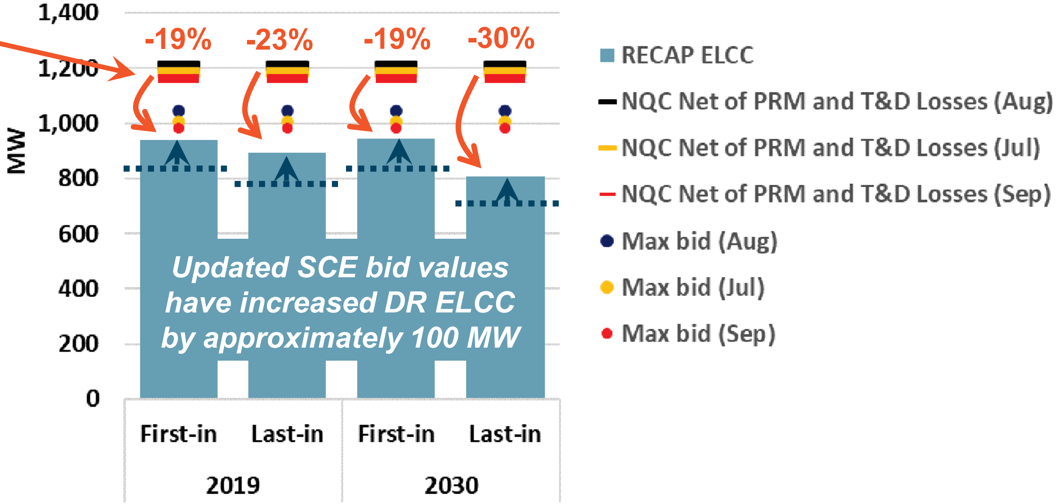
Updated November 2020 Results

Original May 2020 Results



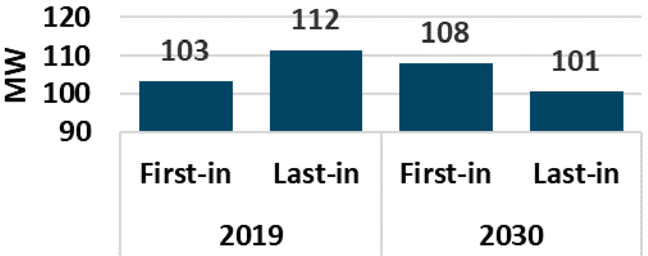
Updated November 2020 Results

Updated NQC values remove PRM and T&D gross up in order to ensure apples-to-apples comparison with DR bids



Updated SCE bid values have increased DR ELCC by approximately 100 MW

Nov – May Difference in Results



Key Finding

- **DR ELCC is approximately 20 to 30% less than apples-to-apples NQC comparison**

Factors Affecting Gap Between NQC* and ELCC

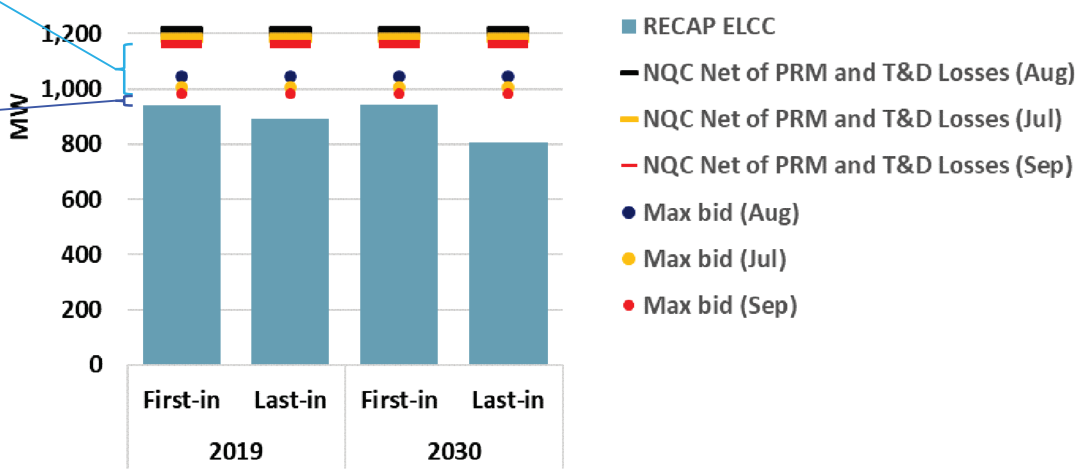
- **The gap between NQC* and ELCC is driven by two primary factors**
  - NQC* implies NQC net of T&D losses and PRM

① **Maximum aggregate bids are lower than NQC* in all hours**

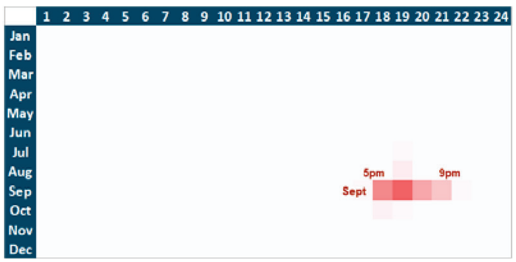
② **ELCC is lower than maximum aggregate bid because resources do not produce at this level in all loss of load hours**

- As more storage is added to the system, it flattens the peak which **elongates** the period of loss of load hours beyond 4-9pm which further decreases the "Last-In ELCC" of DR
- This issue is expected to grow in the future as evidenced by declining Last-In ELCC in 2030

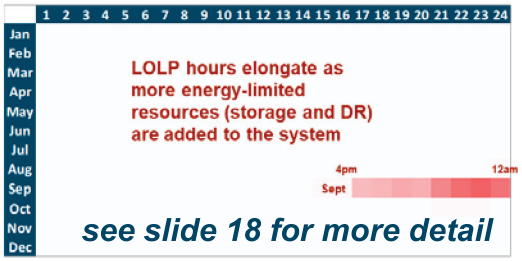
Updated November 2020 Results



LOLP in 2019



LOLP in 2030



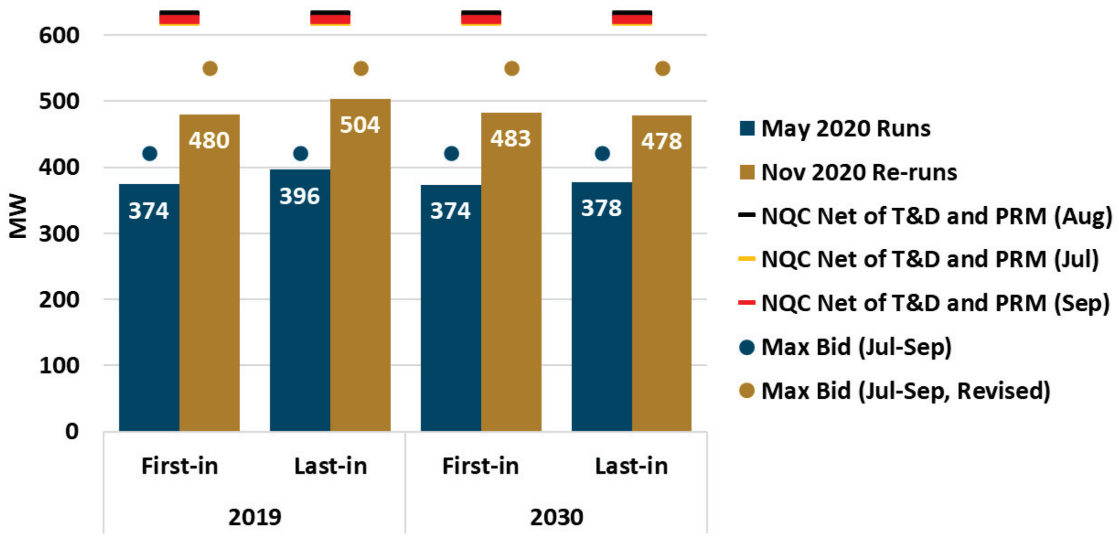
LOLP hours elongate as more energy-limited resources (storage and DR) are added to the system

see slide 18 for more detail

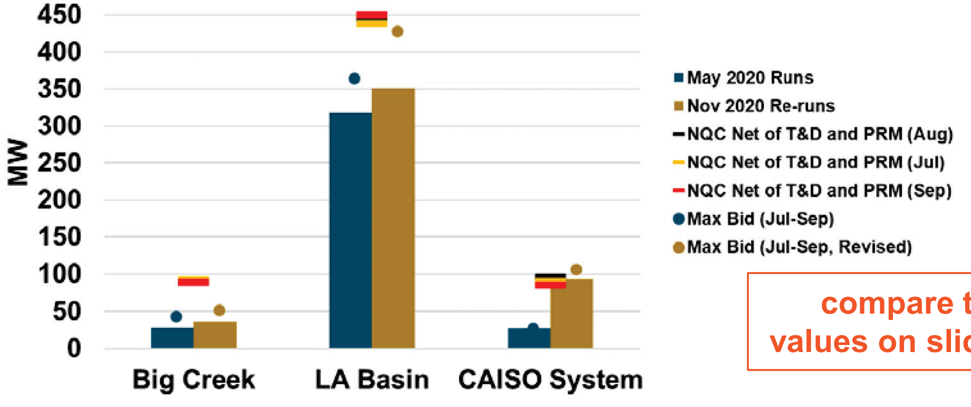
SCE-Specific Updated Results

- The update in the overall DR ELCC results are driven by updated bid data from the SCE BIP program
- SCE BIP ELCC has increased by approximately 100 MW across all cases
- First-in ELCC for BIP program in each LCA has increased

SCE BIP ELCC



First-In ELCC for SCE BIP Programs by LCA

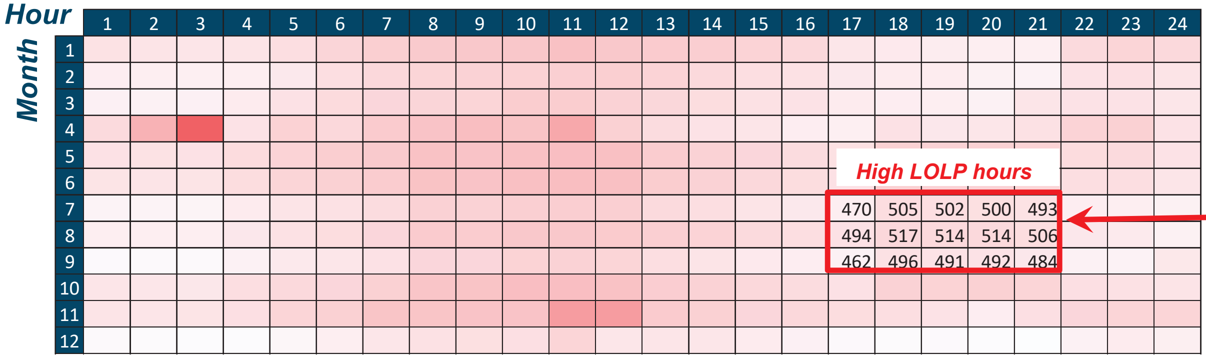


compare to values on slide 15

Comparing SCE BIP NQC to Nominations

- The primary reason SCE BIP ELCC values are lower than NQC values (adjusted for T&D and PRM factors) is due to nomination values that are lower than the NQC values
- September SCE BIP NQC (net of T&D and PRM) is 624 MW

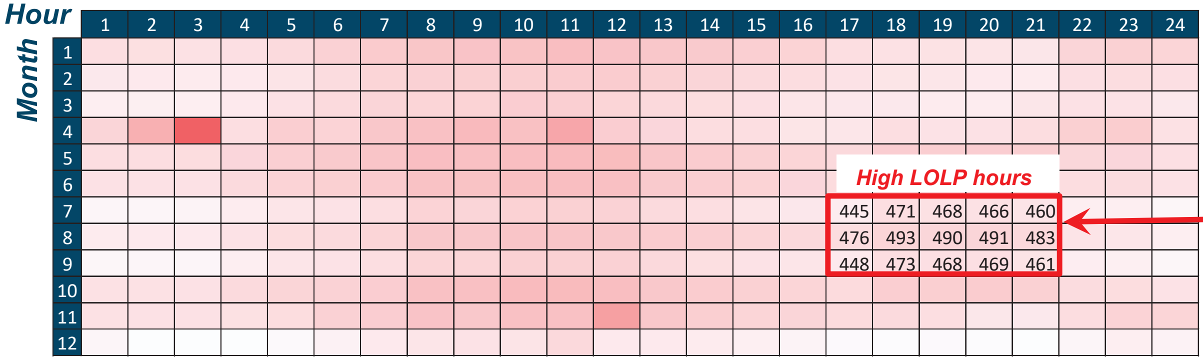
Maximum Nomination MW (2019 SCE BIP)



Month	17	18	19	20	21
7	470	505	502	500	493
8	494	517	514	514	506
9	462	496	491	492	484

Maximum SCE BIP nomination during high LOLP hours is 517 MW

Average Nomination MW (2019 SCE BIP)



Month	17	18	19	20	21
7	445	471	468	466	460
8	476	493	490	491	483
9	448	473	468	469	461

Average SCE BIP nomination during high LOLP hours is 471 MW

Energy+Environmental Economics

Appendix

NQCs as a Basis for Comparison with ELCCs

- NQCs are calculated using load impacts (LI) , i.e. load reductions expected during peak conditions, calculated in line with the Load Impact Protocols.
- Load impacts are grossed up for transmission and distribution losses, as also the 15% PRM, owing to demand response being a demand reduction measure.

$$NQC = LI * 1.15\ (PRM) * T\&D\ loss\ factor$$[1]

- Load impacts for the year 2019 are referenced from the CPUC's RA Compliance documents[2]
- Load impacts were defined on an LCA level from 1 pm to 6 pm, Apr to Oct, and from 4 pm to 9 pm in the rest of the year, both with and without line losses
- The timing has since been revised to 4 pm to 9 pm year-round[3]

[1] CPUC 2019 RA Guide
[2] CPUC 2019 IoU DR Program Totals
[3] CPUC 2020 IOU LIP Workshop

Key Question: What Call and Duration Characteristics are Needed to Maximize DR ELCC?

+ **E3 tested how two primary constraints impact the ELCC of demand response resources**
  - Max # of calls per year
    - How many times can a system operator dispatch a demand response resource?
  - Max duration of each call
    - How long does the demand response resource respond when called by the system operator?

+ **Key Assumptions:**
  - DR portfolio is divided into 100 MW units, each of which can be dispatched independently of the other
    - In other words, 2-hour-100 MW units can be dispatched in sequence to avoid an unserved energy event 100 MW deep and 4 hours long
  - Each 100 MW unit is available 24/7, at full capacity of 100 MW, subject to call constraints defined above to establish a clear baseline for ELCC %’s
  - Pure Shed DR; No shifting of load; No snap-backs

Average ELCC as a function of DR Capacity on the System

2019

First-in ELCC

Call constraints

ELCC (% of DR capacity) DR capacity (MW)	1 hour/call 1 call/year	1 hour/call 4 calls/year	4 hours/call 1 call/year	4 hours/call 4 calls/year	4 hours/call 20 calls/year	6 hours/call 10 calls/year	8 hours/call 4 calls/year	8 hours/call 20 calls/year
2,195	46%	51%	70%	94%	95%	95%	94%	95%
3,000	40%	47%	61%	92%	94%	96%	93%	96%
4,000	36%	42%	52%	78%	80%	86%	80%	86%
5,000	32%	39%	46%	73%	75%	83%	74%	84%
10,000	21%	30%	31%	51%	60%	65%	53%	70%
20,000	14%	21%	20%	33%	46%	44%	35%	52%

Last-in ELCC

Call constraints

ELCC (% of DR capacity) DR capacity (MW)	1 hour/call 1 call/year	1 hour/call 4 calls/year	4 hours/call 1 call/year	4 hours/call 4 calls/year	4 hours/call 20 calls/year	6 hours/call 10 calls/year	8 hours/call 4 calls/year	8 hours/call 20 calls/year
2,195	59%	73%	77%	100%	100%	100%	100%	100%
3,000	52%	65%	67%	99%	100%	100%	99%	100%
4,000	44%	57%	63%	93%	98%	98%	93%	98%
5,000	39%	52%	59%	87%	94%	94%	88%	94%
10,000	27%	39%	38%	61%	75%	75%	61%	80%
20,000	19%	28%	25%	39%	53%	50%	40%	57%

2030

First-in ELCC

Call constraints

ELCC (% of DR capacity) DR capacity (MW)	1 hour/call 1 call/year	1 hour/call 4 calls/year	4 hours/call 1 call/year	4 hours/call 4 calls/year	4 hours/call 20 calls/year	6 hours/call 10 calls/year	8 hours/call 4 calls/year	8 hours/call 20 calls/year
2,195	41%	43%	72%	95%	95%	98%	98%	98%
3,000	38%	40%	66%	92%	93%	98%	97%	98%
4,000	35%	37%	56%	83%	88%	91%	85%	91%
5,000	32%	35%	50%	74%	80%	86%	77%	88%
10,000	23%	30%	33%	52%	62%	67%	55%	71%
20,000	15%	22%	22%	35%	47%	46%	37%	53%

Last-in ELCC

Call constraints

ELCC (% of DR capacity) DR capacity (MW)	1 hour/call 1 call/year	1 hour/call 4 calls/year	4 hours/call 1 call/year	4 hours/call 4 calls/year	4 hours/call 20 calls/year	6 hours/call 10 calls/year	8 hours/call 4 calls/year	8 hours/call 20 calls/year
2,195	35%	37%	52%	69%	69%	77%	93%	93%
3,000	30%	33%	48%	65%	65%	72%	90%	90%
4,000	25%	28%	43%	61%	61%	65%	88%	88%
5,000	22%	25%	41%	57%	57%	60%	80%	82%
10,000	14%	19%	30%	43%	43%	47%	54%	56%
20,000	11%	15%	22%	29%	30%	31%	32%	32%

Incremental ELCC as a function of DR Capacity on the System

First-in ELCC

Last-in ELCC

2019

First-in ELCC

ELCC (% of DR capacity)	Call constraints							
DR capacity (MW)	1 hour/call 1 call/year	1 hour/call 4 calls/year	4 hours/call 1 call/year	4 hours/call 4 calls/year	4 hours/call 20 calls/year	6 hours/call 10 calls/year	8 hours/call 4 calls/year	8 hours/call 20 calls/year
2,195	46%	51%	70%	94%	95%	95%	94%	95%
3,000	25%	36%	37%	86%	93%	99%	90%	99%
4,000	22%	29%	26%	34%	39%	57%	40%	58%
5,000	15%	23%	22%	52%	56%	69%	51%	73%
10,000	11%	22%	16%	30%	45%	47%	32%	57%
20,000	7%	11%	10%	16%	31%	23%	17%	33%

Last-in ELCC

ELCC (% of DR capacity)	Call constraints							
DR capacity (MW)	1 hour/call 1 call/year	1 hour/call 4 calls/year	4 hours/call 1 call/year	4 hours/call 4 calls/year	4 hours/call 20 calls/year	6 hours/call 10 calls/year	8 hours/call 4 calls/year	8 hours/call 20 calls/year
2,195	59%	73%	77%	100%	100%	100%	100%	100%
3,000	33%	42%	37%	96%	100%	100%	96%	100%
4,000	22%	34%	53%	77%	92%	92%	77%	92%
5,000	16%	31%	40%	62%	77%	78%	67%	78%
10,000	14%	26%	18%	35%	56%	56%	34%	66%
20,000	11%	18%	12%	18%	30%	25%	18%	34%

2030

First-in ELCC

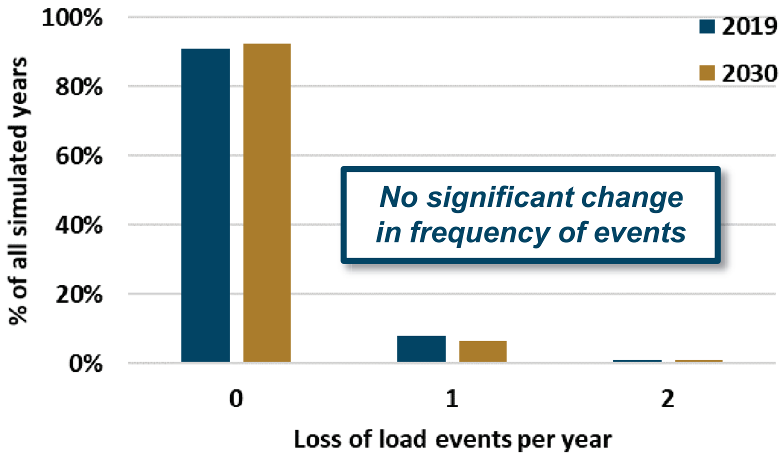
ELCC (% of DR capacity)	Call constraints							
DR capacity (MW)	1 hour/call 1 call/year	1 hour/call 4 calls/year	4 hours/call 1 call/year	4 hours/call 4 calls/year	4 hours/call 20 calls/year	6 hours/call 10 calls/year	8 hours/call 4 calls/year	8 hours/call 20 calls/year
2,195	41%	43%	72%	95%	95%	98%	98%	98%
3,000	26%	28%	42%	81%	84%	96%	94%	96%
4,000	25%	28%	25%	53%	71%	72%	48%	72%
5,000	19%	25%	24%	39%	48%	65%	45%	76%
10,000	15%	26%	17%	31%	45%	49%	33%	53%
20,000	8%	13%	11%	17%	32%	25%	19%	36%

Last-in ELCC

ELCC (% of DR capacity)	Call constraints							
DR capacity (MW)	1 hour/call 1 call/year	1 hour/call 4 calls/year	4 hours/call 1 call/year	4 hours/call 4 calls/year	4 hours/call 20 calls/year	6 hours/call 10 calls/year	8 hours/call 4 calls/year	8 hours/call 20 calls/year
2,195	35%	37%	52%	69%	69%	77%	93%	93%
3,000	9%	16%	29%	50%	50%	51%	78%	78%
4,000	10%	12%	29%	48%	48%	47%	82%	82%
5,000	11%	13%	34%	42%	42%	38%	46%	55%
10,000	6%	13%	20%	28%	28%	33%	29%	30%
20,000	9%	11%	13%	15%	18%	16%	9%	8%

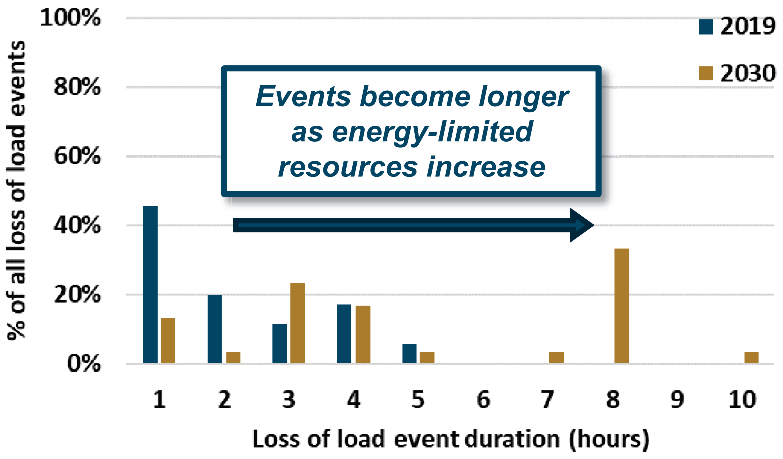
2019 vs 2030 Loss of Load Events

Frequency of Event Occurrence



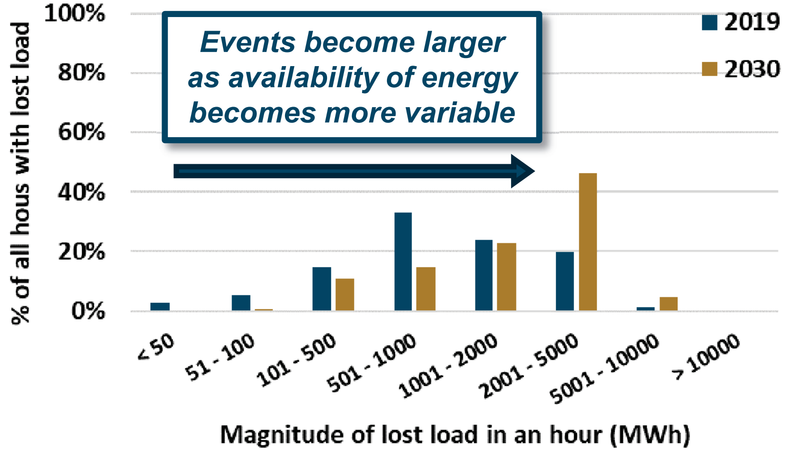
No significant change in frequency of events

Distribution of Event Duration



Events become longer as energy-limited resources increase

Distribution of Event Magnitude



Events become larger as availability of energy becomes more variable

Overview of Data

- **The 2019 PG&E and SCE DR ELCC results focus on “event-based” DR programs, as opposed to passive measures like dynamic pricing applicable throughout a season/year**
  - Does not consider SDG&E or Demand Response Auction Mechanism (DRAM) resources which are a significant portion of the data DR portfolio, due to data limitations
- **Data sources for RECAP ELCC calculations**

1. Hourly PG&E DR bid data for 2019
   - BIP, CBP, and SAC
   - PSPS outage logs were provided by PG&E and used by E3 to identify and then fill gaps in DR bid data
2. Hourly SCE DR bid data for 2019
   - API, BIP, CBP, and SDP

Data Benchmarking

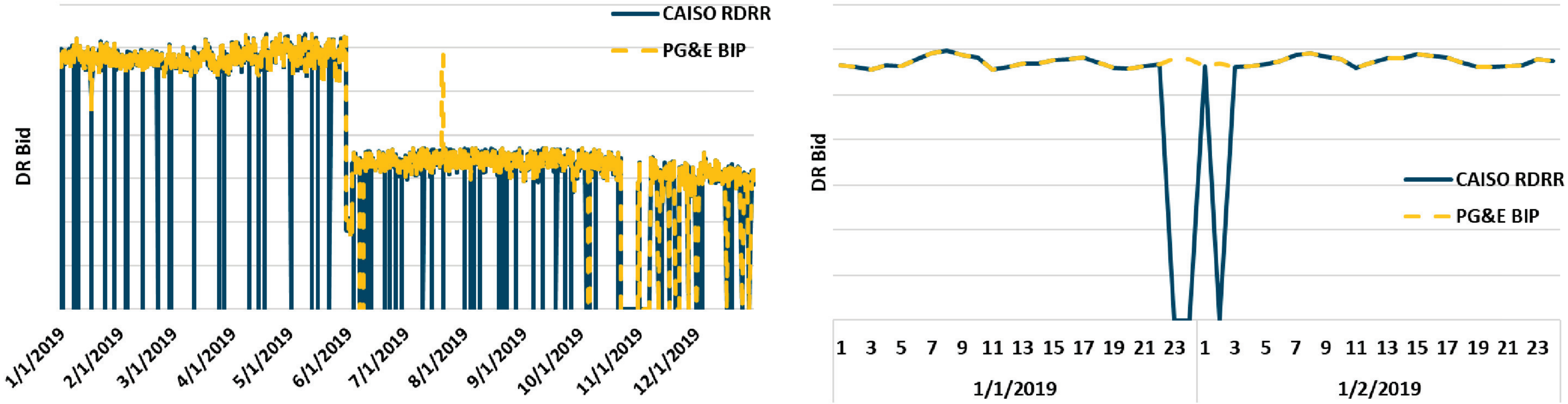
- **E3 used utility data directly from PG&E and SCE for two reasons**
  - CAISO does not have data by utility program
  - Wanted to ensure results were not predicated on CAISO data
- **E3 benchmarked utility data to CAISO data to ensure the veracity of the data**
  - Data generally benchmarked well
  - A few inconsistencies were spotted in the RDRR data:
    - In ~1.3% of hours in the year, DR bids present in PG&E's data are missing in CAISO's data. Technical glitches in transmitting/recording systems may explain this.
    - DR bids in SCE data were slightly lower than bids recorded in CAISO data across significant portions of the year.

      Underlying reason is currently not known.

Benchmarking of 2019 Bid Data from PG&E and CAISO

- **PDR data from the two sources are identical**
- **There are a few hours (114 out of 8760) where RDRR data is inconsistent:**
  - Several instances across each of the 24 hours of the day
  - These are hours where data is <u>missing</u> in the CAISO dataset
  - Unclear if a bid was not placed, or if it was placed but not recorded due to technical glitches

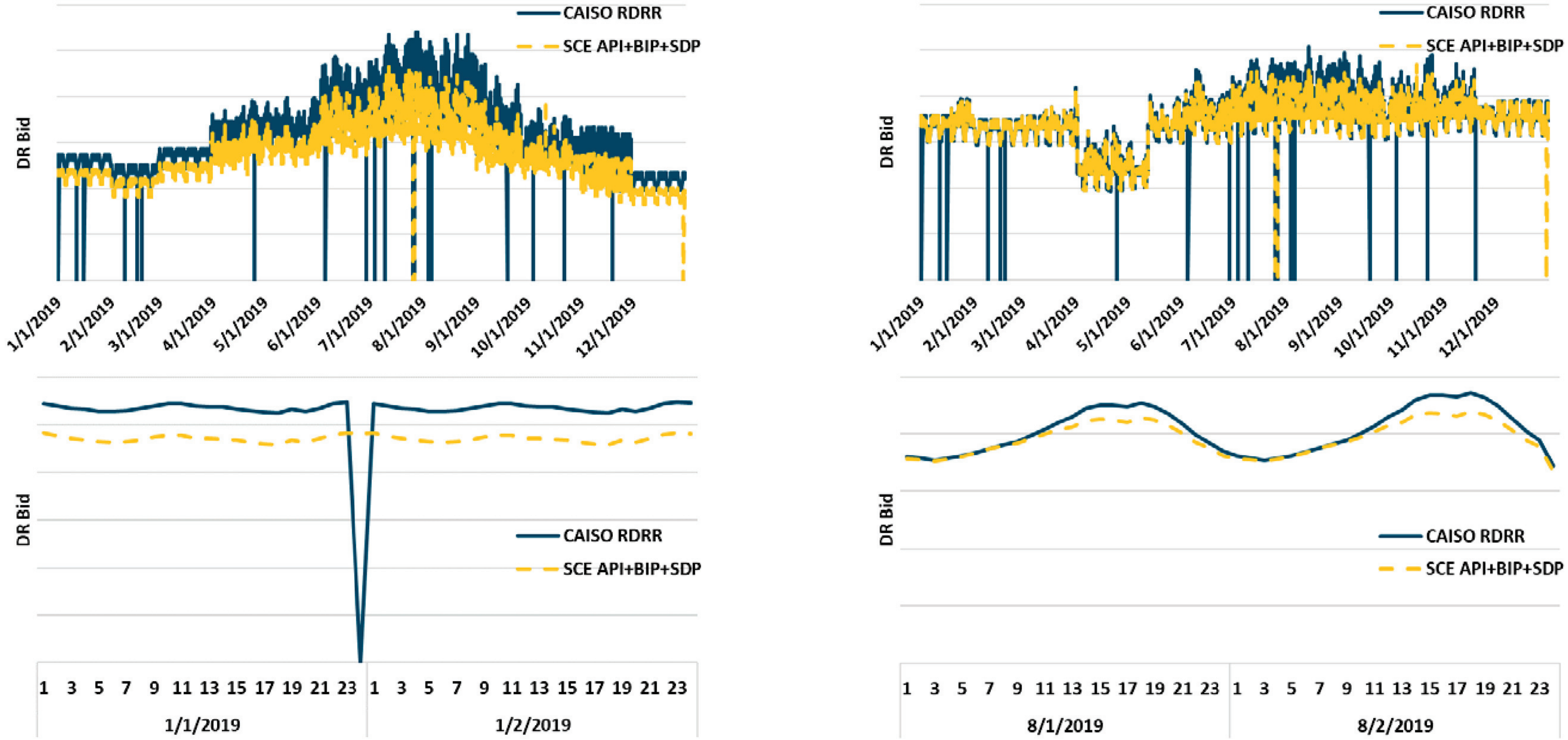
Example comparison for one of the subLAPs over the entire year and a couple of days in specific



Benchmarking of 2019 Bid Data from SCE and CAISO data

- PDR data from the two sources are identical
- Inconsistencies exist in RDRR data – unclear if the difference is systematic and attributable to a single factor, like treatment of line-losses

Example comparisons for 2 subLAPs- across the entire year and across a couple of days in specific



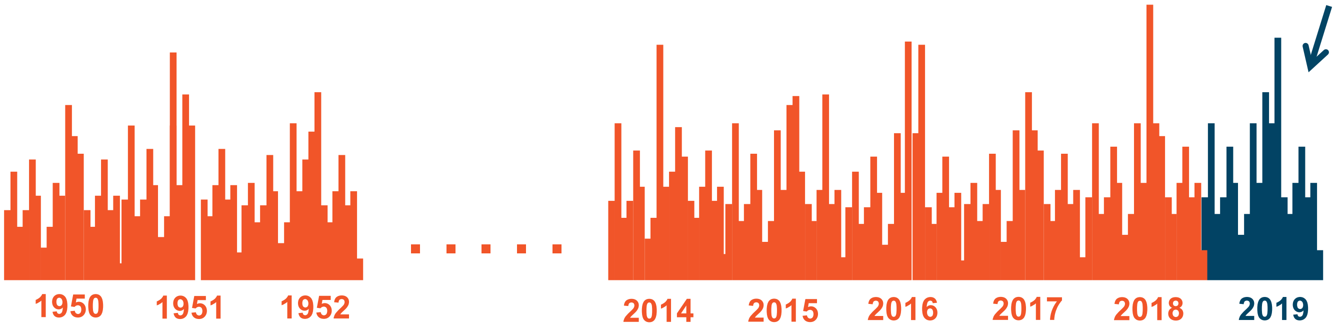
Extrapolation of DR Bid Data

- In order to calculate the ELCC of a DR program or portfolio, RECAP must predict how these programs will perform over many different conditions and weather years

- Therefore, E3 must extend actual 2019 data over the entire historical temperature record as a data requirement for the E3 RECAP model

backcasted CAISO bid data based on historical weather

actual CAISO bid data



historical weather years

complete time-series of DR bids is needed as an input into the E3 RECAP model

- In response to stakeholder feedback from the May 3 CAISO ESDER meeting, E3 modified the backcasting approach to include temperature for temperature-dependent air conditioner DR programs
  - More details on this process and methodology can be found in the appendix

Process of Extrapolating Actual DR Bid Data to Entire Weather Record

Get daily max, min and average temperature data (1950-2019) from NOAA for every climate zone that DR program bids come from

⇩

Use weather-informed day-matching to match every day from Jan 1, 1950 - Dec 31, 2018 to the “most similar” day from Jan 1, 2019 – Dec 31, 2019

⇩

Use day-matching results to extrapolate hourly DR bids from just 2019 to 1950-2019

⇩

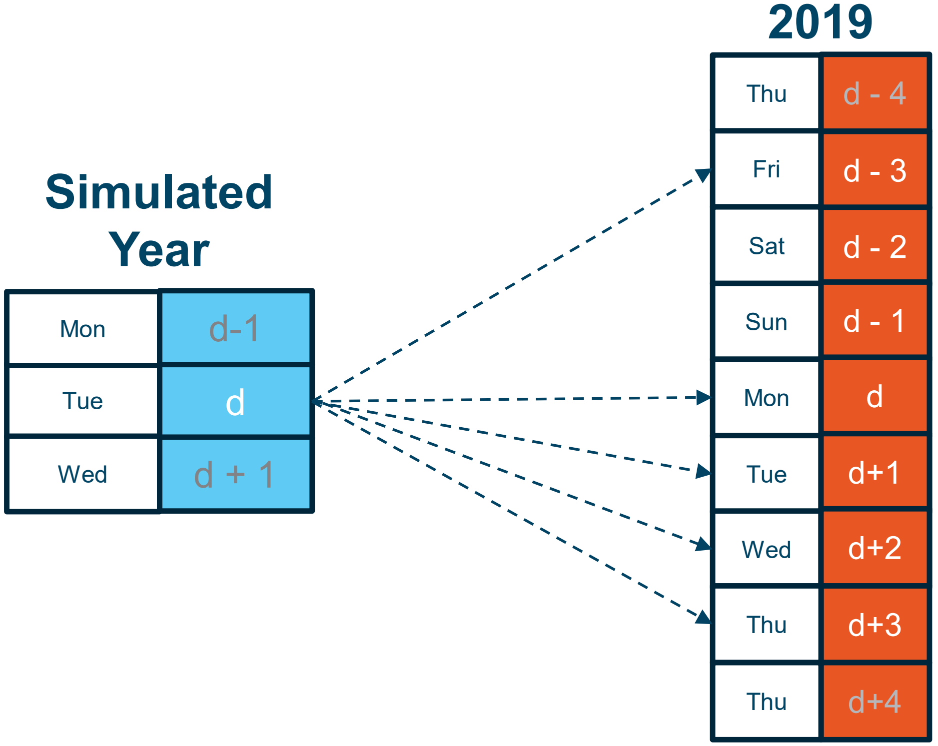
Aggregate extrapolated DR bids by program-LCA to allow for comparison with respective NQCs

⇩

Each aggregated shape dictates the hourly availability of the corresponding DR program-LCA combination in RECAP

Simple Day-Matching Algorithm for CBP, BIP and API DR Programs

- As in the previous phase of this project, E3 used a simple day-matching approach for CBP, BIP and API programs
- DR bid forecasts for these programs were not as strong a function of the temperature as Smart AC
- For an individual DR program and a particular day, ‘d’ in a simulated year, pick one day out of +/- 3 calendar days, ‘d+3’ to ‘d-3’ of the same type (workday/holiday) from the actual 2019 data at random



Simulated Year

Mon	d-1
Tue	d
Wed	d + 1

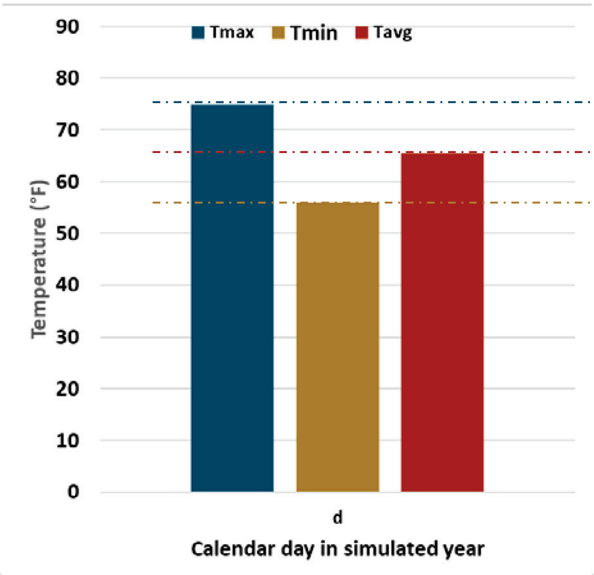
2019

Thu	d - 4
Fri	d - 3
Sat	d - 2
Sun	d - 1
Mon	d
Tue	d+1
Wed	d+2
Thu	d+3
Thu	d+4

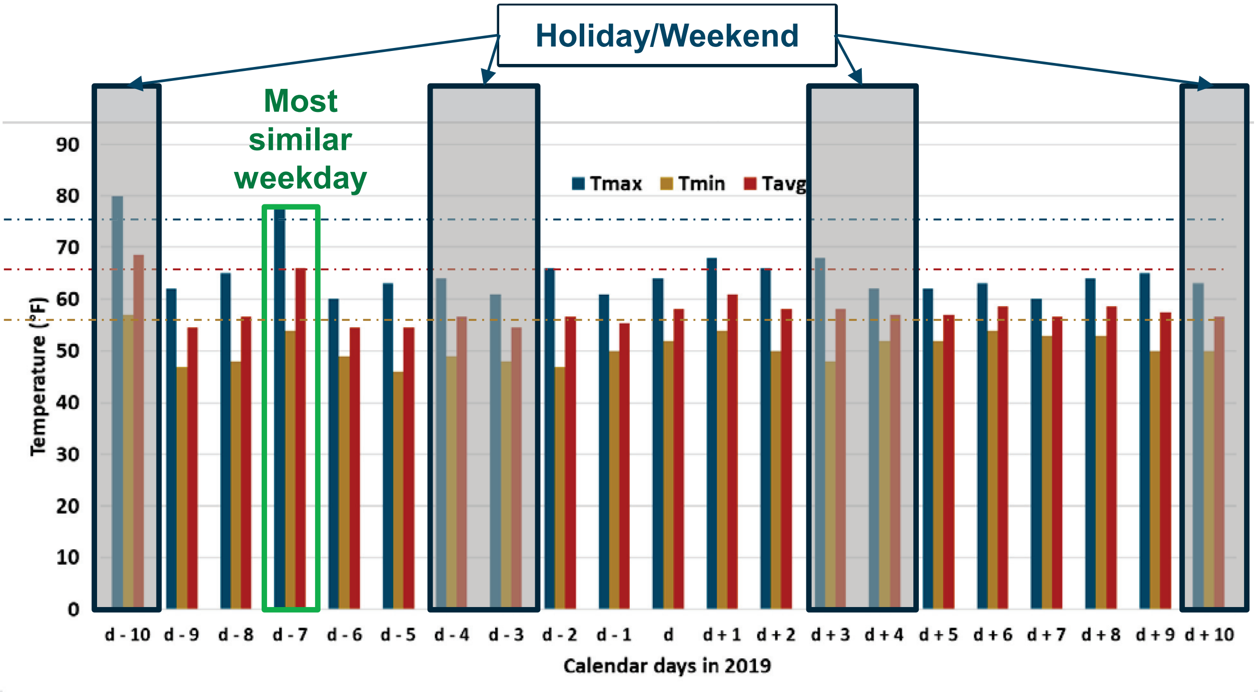
Weather-informed Day-Matching Algorithm for AC cycling DR Programs

- Inclusion of weather for air conditioner DR is in direct feedback to stakeholder comments from the May 3, 2020 CAISO ESDER meeting
- For an individual DR program and a particular day in a simulated year, pick one day out of +/- 10 calendar days of the same type (workday/holiday) from actual 2019 data with the closest T_{max}, T_{min} and T_{avg}
- Applied to PG&E's Smart AC program and SCE's Summer Discount Plan program data to account for influence of temperature on DR availability

Example weekday in simulated year



Candidate (2019) days for matching

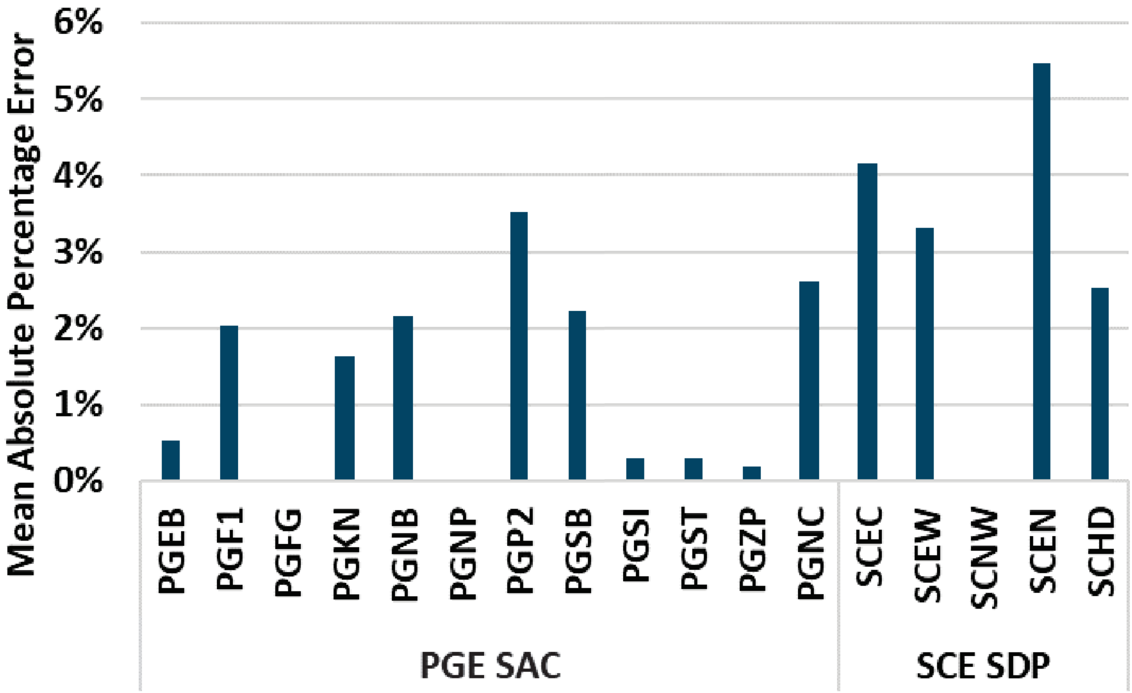


Comparison of day matched and real values

- The Mean Absolute Percentage Error (MAPE) is defined as:

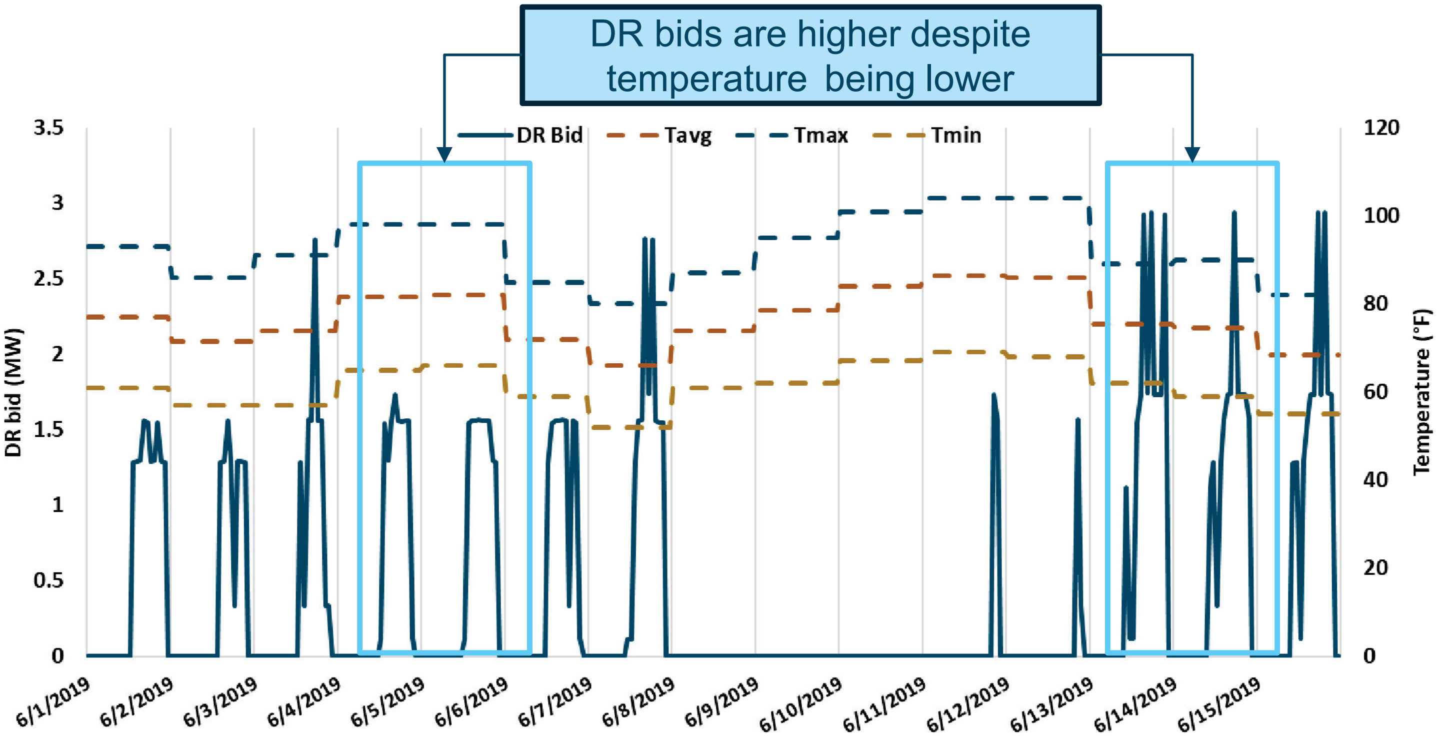
$$\frac{\text{Abs(Day–matched value – Actual Value) x 100}}{\text{Actual Value}}$$

- MAPE is calculated and shown below for July-September, 4 pm to 10 pm



Why Day Matching and not Regression?

- **Regression based on temperature, month and day-type couldn't explain movement in DR bids. Potential reasons could be:**
  - Mismatch in temperature data used by E3 and IoUs.
  - Not accounting for other explanatory variables that IoUs use in their forecasts.
- **Absence of reliable hourly temperature records going back to 1950 meant only regression for daily DR bids was doable.**

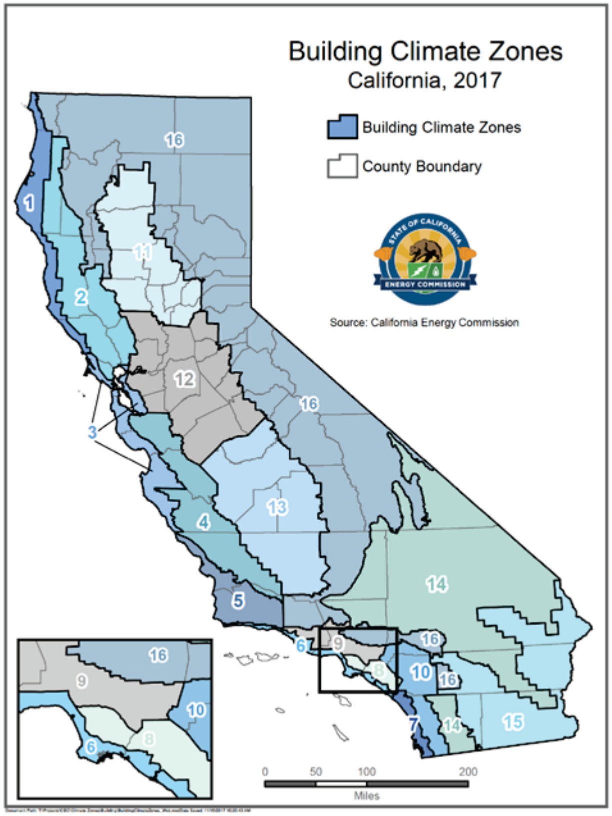


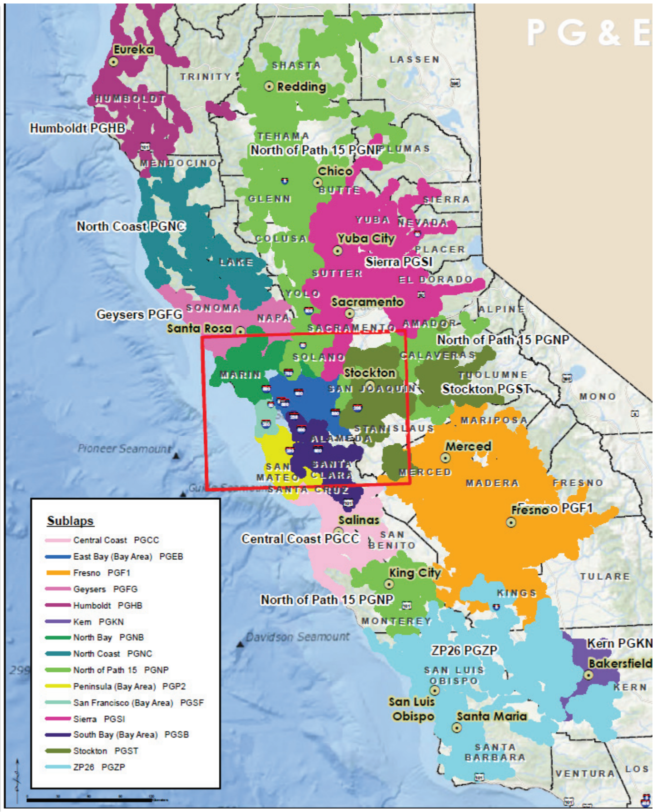
DR bids are higher despite temperature being lower

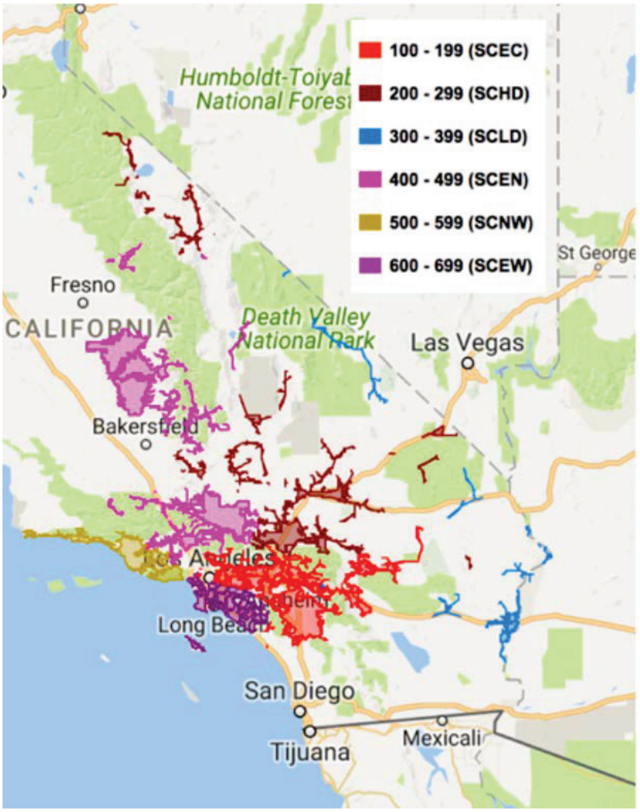
Assumptions on DR Program Characteristics

Utility	DR Program	Event Duration (hours/call)	Max. Events per Month	Max. Events per Year	Comments on RECAP Implementation
PG&E	**BIP**	6	10		
	CBP	6	5		30 hrs/month is interpreted as 5 events/month
	SAC	6		17	100 hrs/year is interpreted as 17 events/year
SCE	**API**	6	7		40 hours/month is interpreted as 7 events/month
	BIP	6	10		60 hours/month is interpreted as 10 calls/month
	CBP	6	5		30 hours/month is interpreted as 5 calls/month
	SDP	6		30	180 hours/year is interpreted as 30 events/year

Climate zones and sub-LAPs for reference







Sub-LAPs vs. Local Capacity Areas

Sub-LAP	Sub-LAP (long form)	Local Capacity Area
PGCC	PG&E Central Coast	Bay Area
PGEB	PG&E East Bay	Bay Area
PGF1	PG&E Fresno	Greater Fresno
PGFG	PG&E Fulton-Geysers	North Coast/North Bay
PGHB	PG&E Humboldt	Humboldt
PGKN	PG&E Kern	Kern
PGNB	PG&E North Bay	North Coast/North Bay
PGNC	PG&E North Coast	North Coast/North Bay
PGNP	PG&E North of Path 15 - non local	CAISO System
PGP2	PG&E Peninsula	Bay Area
PGSB	PG&E South Bay	Bay Area
PGSF	PG&E San Francisco	Bay Area
PGSI	PG&E Sierra	Sierra
PGST	PG&E Stockton	Stockton
PGZP	PG&E ZP26 (between Path 15 and 26) -non local	CAISO System
SCEC	SCE Central	LA Basin
SCEN	SCE North (Big Creek)	Big Creek/Ventura
SCEW	SCE West	LA Basin
SCHD	SCE High Desert	CAISO System
SCLD	SCE Low Desert	CAISO System
SCNW	SCE North-West (Ventura)	Big Creek/Ventura
SDG1	SDG&E	San Diego/Imperial Valley
VEA	VEA	CAISO System