Energy Storage and Distributed Energy Resources Phase 4

Lauren Carr, Gabe Murtaugh, Jill Powers, Bridget Sparks
Infrastructure & Regulatory Policy

Market Surveillance Committee Meeting
General Session
July 30, 2020

ESDER 4 includes proposals enhancing energy storage and demand response resource market participation

1. Vetting application of an ELCC valuation for variable-output demand response resources *
2. End-of-hour State-of-charge parameter for the non-generator resource model *
3. Applying market power mitigation to energy storage resources *
4. Streamlining market participation agreements for non-generator resource participants
5. Establishing parameters to better reflect demand response resource operational characteristics

*Three proposal elements will be discussed today

ESDER4 proposals emphasize developing tools to enhance energy storage provisions in the market

- CPUC call for procurement of 3,300 MW of additional resource adequacy resources by 2023 to make up for gas retirements
- Most of the resources in the interconnection queue are energy storage
  - Lithium-ion 4-hour batteries
  - There will be hundreds of MW of interconnected storage capacity this year, and several thousand MW of capacity added in the next few years
- Markets were designed around gas resources, and may not have features that best accommodate the unique attributes of storage
- The ISO currently does not apply market power mitigation to storage

ESDER4 also explores qualifying capacity counting of demand response using an ELCC methodology

- 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
- The ELCC quantifies resources' contribution to resource adequacy by assessing their ability to avoid a loss of load event
- Study performed by E3 demonstrates an ELCC methodology can be used to inform DR's contribution to system reliability, and therefore, its capacity value

VETTING APPLICATION OF AN ELCC METHODOLOGY IN VALUING VARIABLE OUTPUT DEMAND RESPONSE

Lauren Carr

The RA program must evolve to ensure the RA fleet meets capacity *and energy* needs all hours of the year

- California will rely more heavily on both variable and availability-limited resources as we move to decarbonize the grid
- It is critical to assess the ability of preferred resources to displace traditional thermal generation while maintaining system reliability and serving energy needs every hour of the year
  - Decarbonizing energy supply requires replacing both the capacity AND energy provided by the gas-fired fleet; not just capacity substitution that is only focused on the gross peak demand hour
  - Must rethink how to properly value energy and availability-limited preferred resources as California pursues a GHG free energy sector

Most DR resources have variable output and energy limitations that must be considered when setting DR's qualifying capacity value

- Demand response resources' maximum output (load reduction capability) can vary over the course of a day, month, or season due to production schedules, seasonality, temperature, occupancy, etc.
- Demand response also has limits on availability
  - e.g., hours of operability, duration, and number of event calls
- Capacity valuation should consider both variability and availability
  - These factors impact a resource's ability to provide energy/load reduction over the course of the RA month and year
  - Variability and availability can differ by DR program leading to differing contributions to reliability

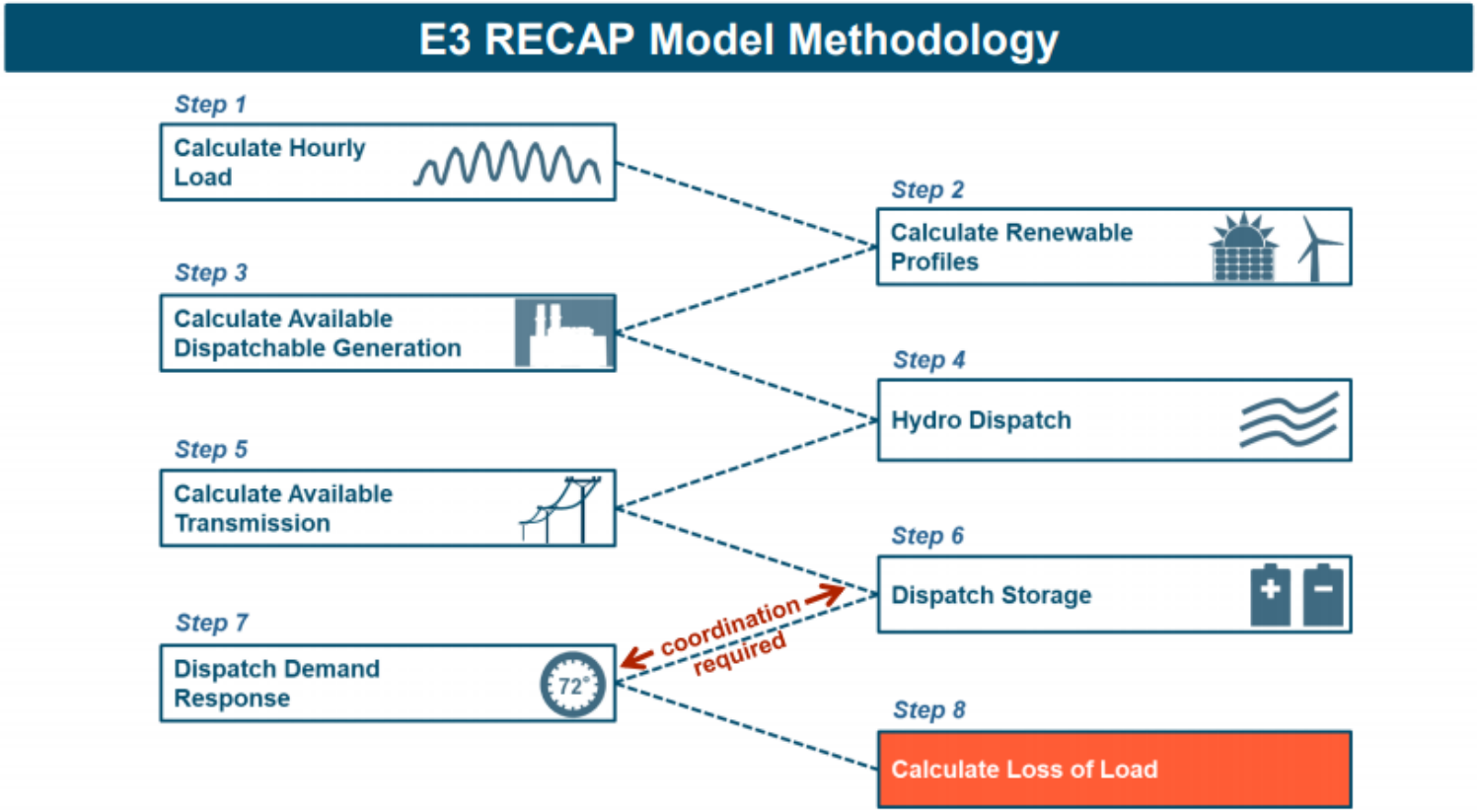
Current RA qualifying capacity methodology does not appropriately consider variability and energy limitations

- Current RA qualifying capacity methodology, *i.e.* Load Impact Protocols (LIPs), use a combination of ex-post and ex-ante assessments of demand response programs to estimate load reduction capability for each month during 1-in-2 system peak conditions
  - Considers a resource's own load reduction capability in the availability assessment hours of the monthly peak day
  - This approach does not:
    - Address variability and use- and availability-limitations, or
    - Interactive effects of growing dependency on variable and energy-limited resources over an RA month

CAISO contracted with E3 to develop an alternative qualifying capacity methodology for DR using 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
  - An ELCC methodology informs DR's contribution to system reliability, considering its load reduction profile, availability, and use-limitations
  - This assessment helps inform program design features and overall investment decisions to ensure procuring best resources at lowest cost

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 impact value



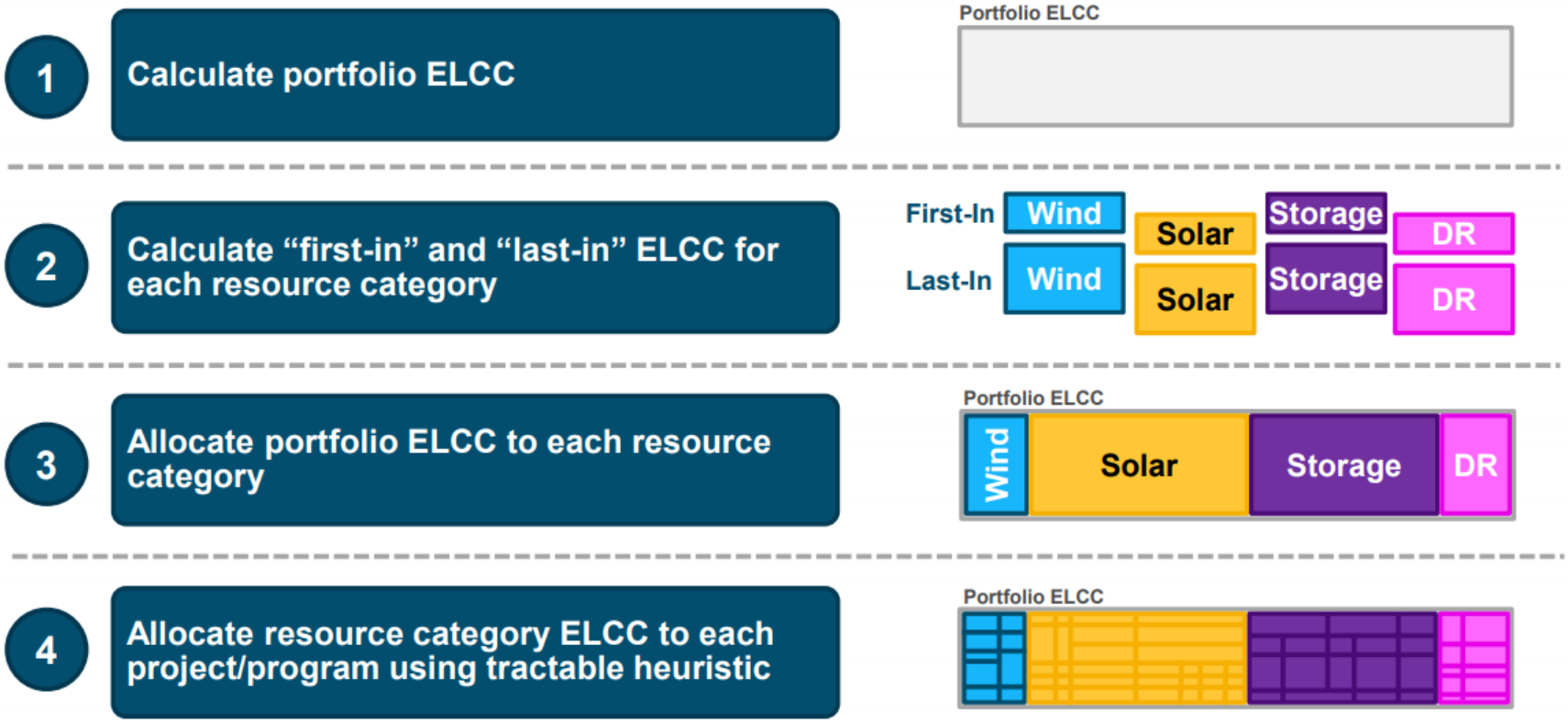
Source: Demand Response ELCC, E3: http://www.caiso.com/InitiativeDocuments/E3Presentation-EnergyStorage-DistributedEnergyResourcesPhase4-May27-2020.pdf

Summary of E3's study results

- E3's analysis suggests ELCC value of DR is less than the capacity value derived from the LIPs for two reasons:
  - DR does not bid into the CAISO market, in aggregate, at levels equal to its NQC value
  - The times when DR is bid are either not at optimal times or not for long enough to earn full ELCC value
- 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 4-hour storage

Source: Demand Response ELCC, E3: http://www.caiso.com/InitiativeDocuments/E3Presentation-EnergyStorage-DistributedEnergyResourcesPhase4-May27-2020.pdf

E3 also provided a methodology for allocating individual DR program types using ELCC



Source: Demand Response ELCC, E3: http://www.caiso.com/InitiativeDocuments/E3Presentation-EnergyStorage-DistributedEnergyResourcesPhase4-May27-2020.pdf

End-of-Hour State of Charge Parameter

Bridget Sparks

End-Of-Hour State-of-Charge (EOH SOC) Biddable Parameter

Optional parameter for storage using the non-generator resource (NGR) model to manage its state-of-charge in real-time

- Enhance real-time market to accept state-of-charge values for future hours and constrain the storage output to meet those values
  - Submitted as a MWh range with min and max SOC
  - Targeted SOC accommodated with min = max
- Allow EOH SOC parameter to take precedence over economic outcomes in the market optimization
- Allow the market to dispatch storage economically or uneconomically to achieve a preferred hourly EOH SOC
- Provide more flexibility than the use of self-schedules to manage SOC
- Resource will be ineligible for BCR for the EOH SOC applicable operating hour and the hour prior

Resource Constraints Prioritized Above EOH SOC

- Certain constraints will be respected before respecting the EOH SOC constraint
  - The max/min continuous energy limits in the Masterfile or upper/lower charge limit that are bid in
  - A state-of-charge needed to meet an ancillary service award
  - A state-of-charge needed to meet an exceptional dispatch, if the resource is exceptionally dispatched, the resource will be eligible for BCR

Figure 1: End-of- hour state-of-charge constrained by upper and lower charge limits

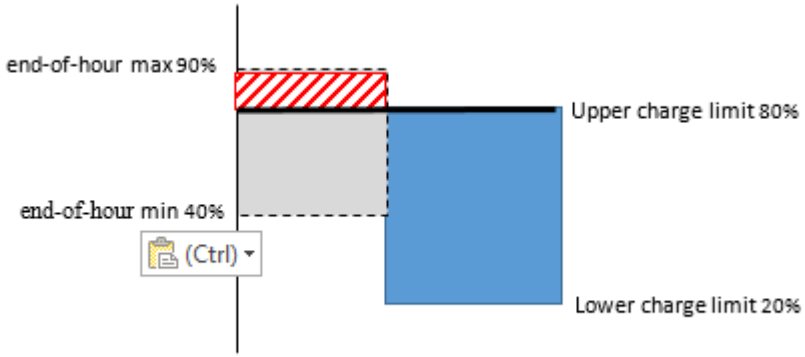
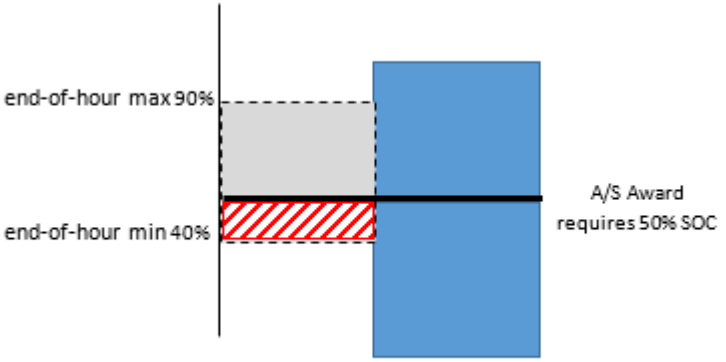


Figure 2: End-of- hour state-of-charge constrained by ancillary service award



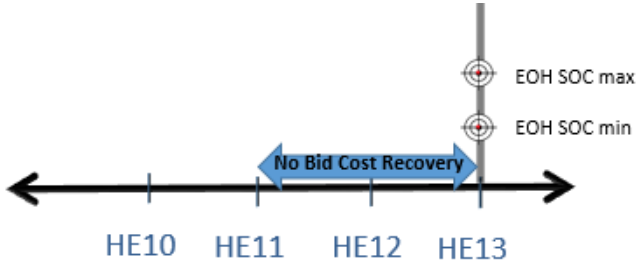
Market Application of the end-of-hour SOC bid

- EOH SOC will be submitted into the market 75-minutes prior to the start of the hour
  - Informs dispatch instructions in the successive 15-minute market (RTPD) interval and the corresponding 5-minute interval (RTD)
- Due to the different time horizons across the two real-time markets, the CAISO proposes to align visibility of the EOH SOC bid constraint to the same binding intervals for both the 5-minute (RTD) and 15-minute real-time (RTPD) markets.
  - An implied end of hour constraint will be applied at the end of the time horizon for 5-minute (RTD) runs.
  - The end of horizon constraint will be set to the end of hour constraint, adjusted for the resources full charging capability between the end of horizon and end of hour.

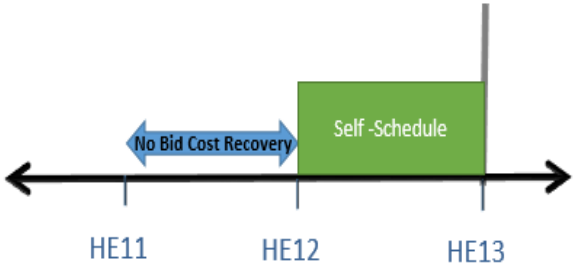
Modifications to Bid Cost Recovery

Proposal modifies a non-generator resource's bid cost recovery settlement in hours when EOH SOC bid parameter or self-schedule has the potential to create an uneconomic dispatch. Net costs will not be counted towards the daily BCR settlement during ineligible hours, but net revenues in these hour(s) will be counted towards offsetting shortfalls accrued during other intervals during the day.

- Ineligible to receive bid-cost recovery for shortfalls in both the hour preceding AND for the hour in which an end-of-hour state-of-charge is bid



- Ineligible to receive bid-cost recovery for shortfalls in the hour preceding the self-scheduled hour



BCR Modification Proposal

- The two hour BCR ineligibility flag will cover the entire two hours.
- A secondary indicator will evaluate bid cost and revenue on a 5-minute interval basis:
  - If bid cost > revenue, then interval will be set to 0
  - If bid cost < revenue, then no change to interval
  - This will essentially exclude intervals with an uneconomic dispatch by setting it equal to zero, but will allow any additional revenues to flow through to the daily BCR calculation and could be use to cover BCR shortfall in other periods not effected by the EOH SOC parameter

BCR Modification Example

- Resource A is a 25 MW four-hour duration battery (100 MWhs)
- A scheduling coordinator submits the following parameters:
  - EOH SOC target= 50MWh at HE 14
  - EOH SOC target= 20MWh at HE 20
  - Bids $0 to charge, and $10 to discharge energy

BCR Modification Example cont.

5M Interval	164	165	166	167	168	~	235	236	237	238	239	240
EOH SOC target					50							20
SOC	46	48	49	49	50	~	25	24	23	22	21	20
Dispatch (MWh)	-1	-1	-1	0	-1	~	1	1	0	1	1	1
Bid (Chg)	0	0	0	0	0	~	-	-	-	-	-	-
Bid (Gen)	-	-	-	-	-	~	10	10	10	10	10	10
Price	6	-1	0	1	5	~	5	5	5	15	15	15
BCR Eligibility	N	N	N	N	N	~	N	N	N	N	N	N
Cost	6	0	0	-	5	~	10	10	-	10	10	10
Revenue	0	1	0	-	0	~	5	5	-	15	15	15
Included in BCR settlement	0	1	0	-	0	~	0	0	-	5	5	5
BCR Impacted	Y	N	N	N	Y	~	Y	Y	N	N	N	N

Battery would not get BCR when Bid Cost > Revenue

- If we assume revenue neutrality in subsequent intervals, the resource had Daily Bid Cost of $61 > Revenue of $56
- Resource would normally be eligible for $5 BCR payment
- Under new proposal, intervals 164,168,235,236 would be set to $0, new Daily Bid Cost of $40< Revenue of $56
- Resource would not have a BCR shortfall, and would not receive a payment
  - It is assumed that the Battery performs as expected, therefore Persistent Deviation and Performance Metrics do not apply

DEFAULT ENERGY BIDS FOR STORAGE RESOURCES

Gabe Murtaugh

Market power mitigation for energy storage resources

- The proposed default energy bid for energy storage resources estimates marginal costs based on four primary cost categories:
  - Energy
  - Losses
  - Cycling costs
  - Opportunity costs

Formulation:

$$Storage\ DEB = Max[En + VO, OC] * 1.1$$

Where:

- En – Energy cost, for the charge duration of the battery
- VO – Variable operating costs, including cycling costs
- OC – Opportunity cost, for the discharge duration of the battery

The proposed DEB framework may not be perfect, but a first step to preventing the exercise of market power

- Market power mitigation will not decrease schedules and will not mitigate hours when ‘downward’ market power may be exerted
- Market power mitigation does not mitigate to a “spread”
  - Actual energy purchase prices are not considered
- Additional output in the day-ahead market may imply additional charging earlier in the day