Draft Proposed Qualifying Capacity and Effective Flexible Capacity Calculation Methodologies

Energy Storage and Supply-Side Demand Response

RA Workshop | October 15, 2013 | Joanna Gubman

California Public Utilities Commission

Agenda

- Scope
- Probabilistic Modeling
- Qualifying Capacity
- Effective Flexible Capacity
- Eligibility Criteria and Aggregation
- Testing and Certification
- Deterministic Alternatives
- Next Steps

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Only Supply-Side Demand Response and Energy Storage are in Scope

Demand Response (DR)

- May be supplied by any DR provider (DRP), whether IOU or third party
- Must participate in CAISO markets and be subject to a must-offer obligation (MOO)

Energy Storage (ES)

- Must participate in CAISO markets and be subject to a must-offer obligation (MOO)
  - Stand-alone
  - Distributed peakers
  - Customer-sited, with market participation
  - Co-located with DR or generation resources

Load-modifying & other ES/DR are not within the scope of this proceeding

Demand Response (DR)

- Customer-focused programs and rates
  - Example: Critical peak pricing
- Emergency reliability programs not bidding into CAISO markets
- Typically IOU-operated
- Need not participate in any markets

Energy Storage (ES)

- Voltage support applications
- Substation energy storage
- Community energy storage
- Customer-sited storage without full market participation

Deliverability, which yields net qualifying capacity, is also not in scope

- Deliverability calculations determine the impact of transmission constraints that could prevent a resource’s full QC from being deliverable to load
  - QC is an input to deliverability calculations
  - The deliverable capacity is called the net qualifying capacity (NQC)
- NQC is calculated by the CAISO and adopted by the CPUC

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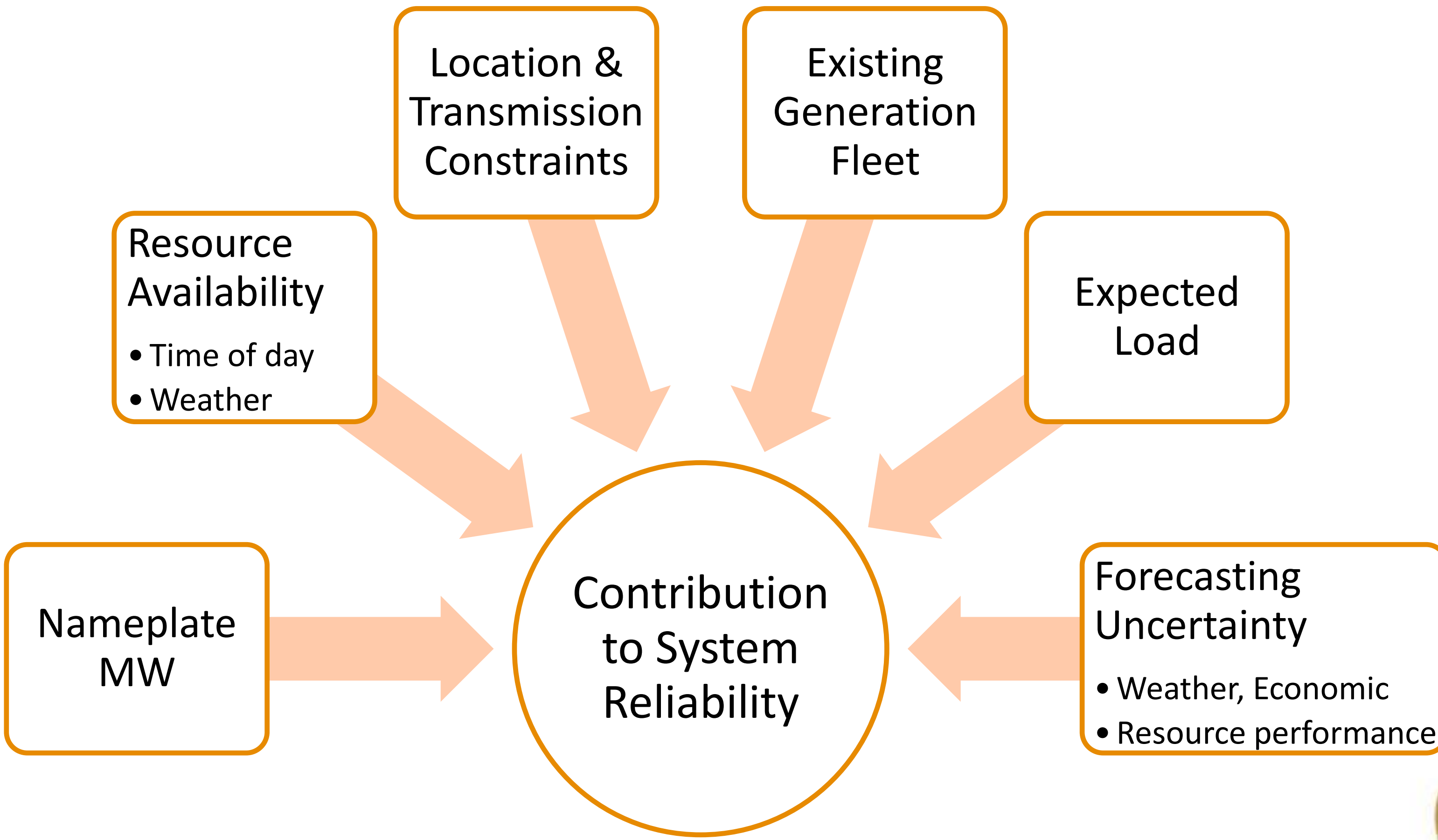
Probabilistic modeling enables a usefulness-based valuation of capacity



There are two usefulness categories: meeting *peak* and *ramping* needs

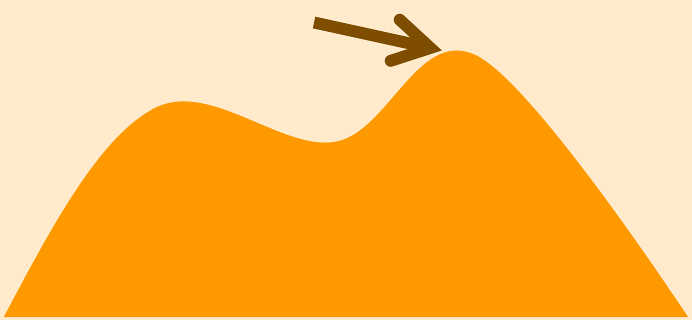
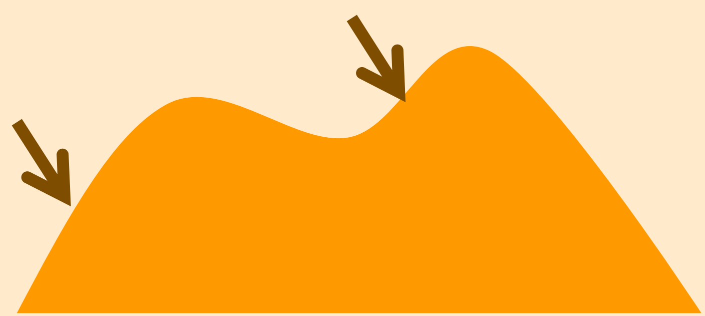
Effective Load Carrying Capability (ELCC)

- Derating factor indicating how much each resource MW contributes to meeting peak capacity needs

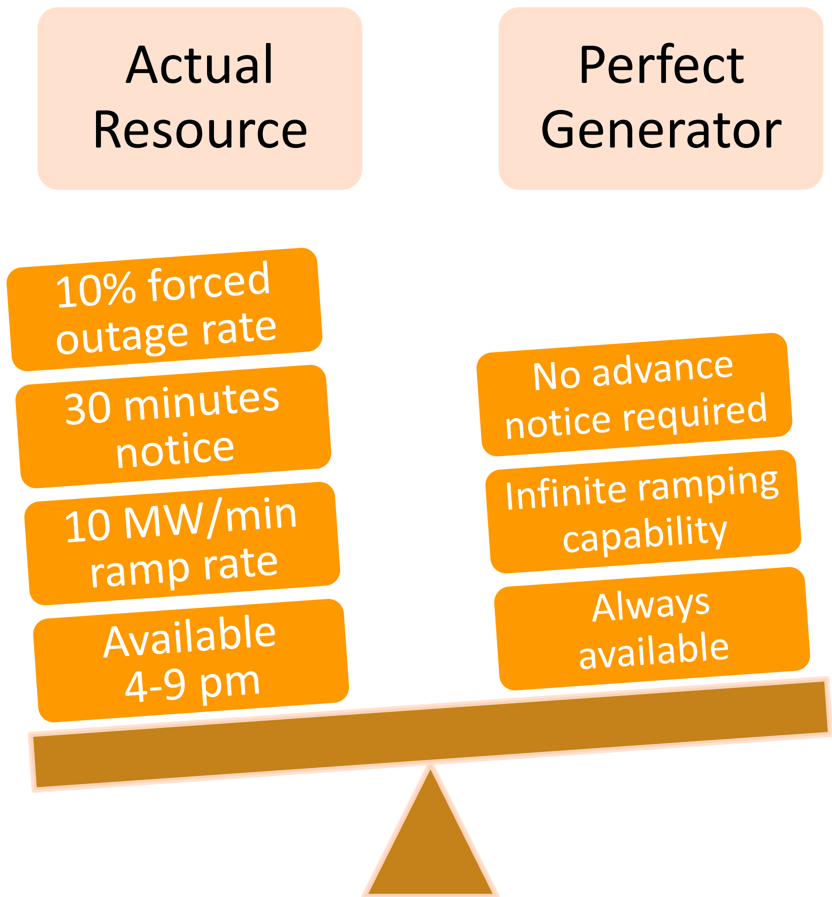
Effective Ramping Capability (ERC)

- Derating factor indicating how much each resource MW contributes to meeting system ramping needs

Usefulness is measured by a resource's contribution to preventing blackouts

Metric: Loss of Load Expectancy (LOLE)	Metric: Loss of Ramping Expectancy (LORE)
For a given electricity system and year, LOLE is the chance of load shedding due to insufficient capacity	For a given electricity system and year, LORE is the chance of load shedding due to insufficient ramping capability
	

A resource's ELCC and ERC express its usefulness relative to a perfect generator



Why use probabilistic modeling for Energy Storage and Supply-Side DR?

- Already mandated for wind and solar (SB 1x2)
- More accurately represents likely conditions than deterministic modeling
- Reflective of ES and DR value to the system as a whole
- Will enable ED staff to provide guidance going forward as to what types of resources & design choices may be most useful

Probabilistic modeling is harder than deterministic, but still worth pursuing

New resource performance uncertainty can be addressed

- For Supply-Side DR, we can draw on performance data from existing Retail DR programs
- For ES, extensive performance testing can be conducted
- Performance forecasting uncertainty can also be built into the model

Because ES and Supply-Side DR are emerging resources, we can start small and learn from experience

Rules have not yet been fully developed for these resources; let's start as we intend to proceed

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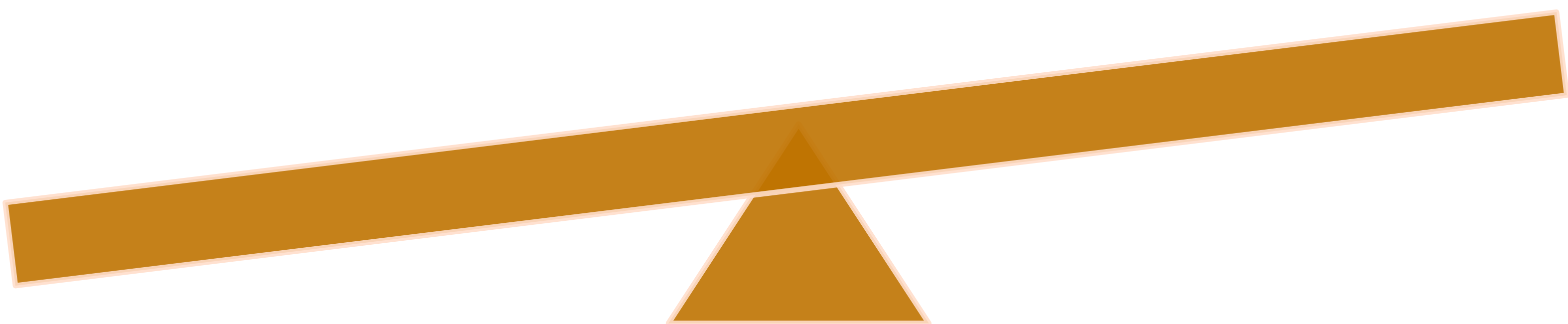
Qualifying Capacity (QC) is a resource's contribution towards meeting peak

- Based on an ES or DR resource's demonstrated maximum output, P_{max}
- Derated by the resource's ELCC (usefulness factor) to take into account resource performance and use limitations, considering:
  - P_{max}
  - Availability by hour of day and season
  - Location
  - Temperature impacts
  - Forced outage rate
  - Startup, ramping, and shutdown profiles
  - Energy storage: Efficiency, available energy, charge/discharge duration
  - DR: Fatigue (consecutive hours and days), maximum calls, dispatch triggers
  - Historical performance of similar resources
  - Forecasting uncertainty
  - Other considerations?

Please share with us what inputs you think are needed,
and how you feel we should address historical performance.

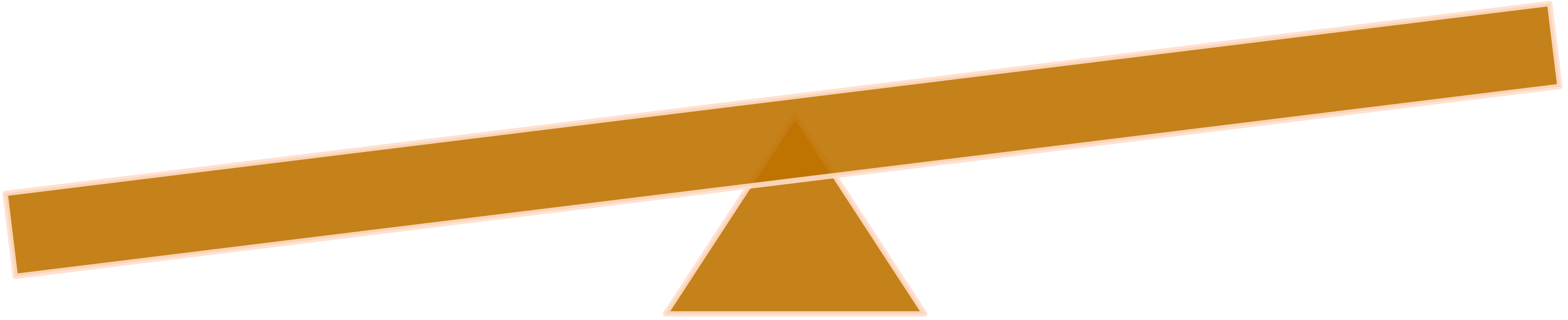
ELCC = Perfect MW / Resource MW



ELCC = Perfect MW / Resource MW

Model the electrical system…

including the ES/DR resource



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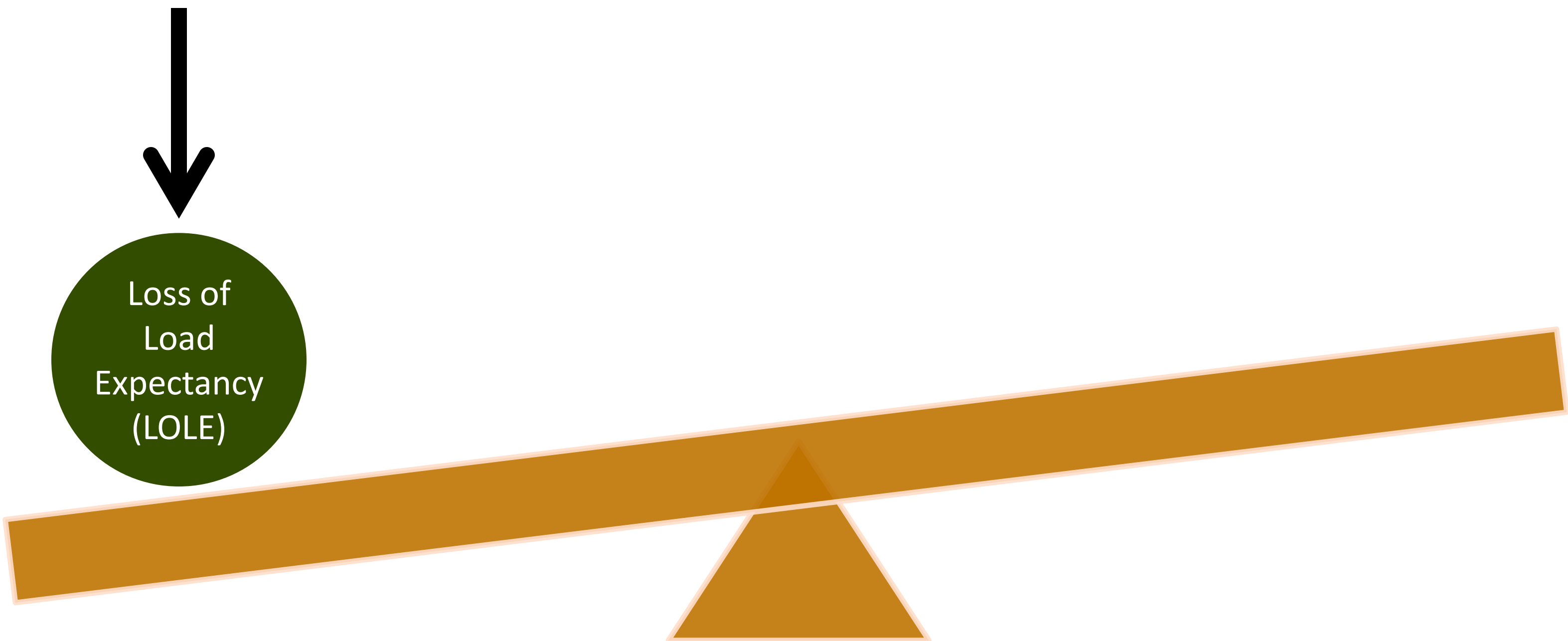

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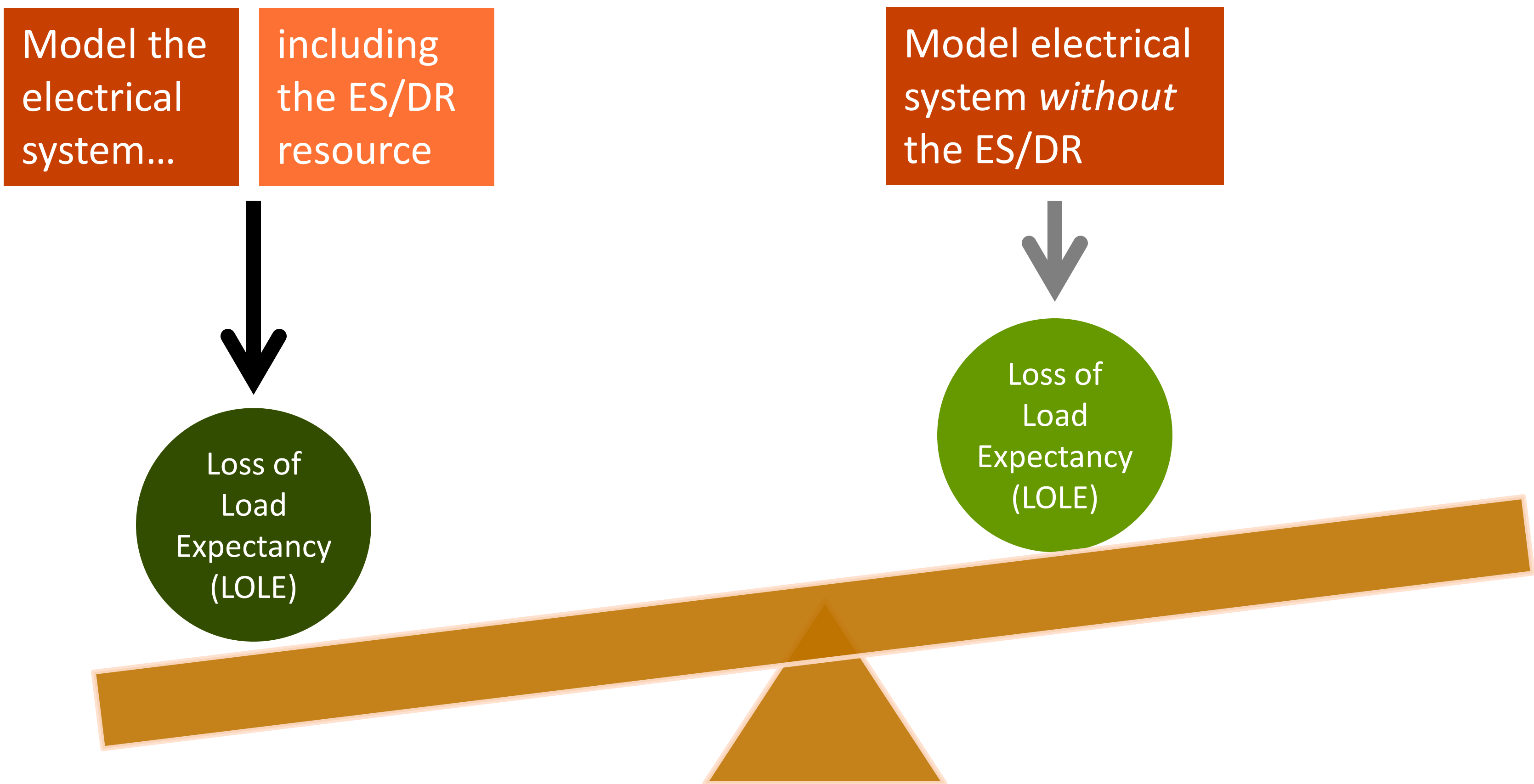

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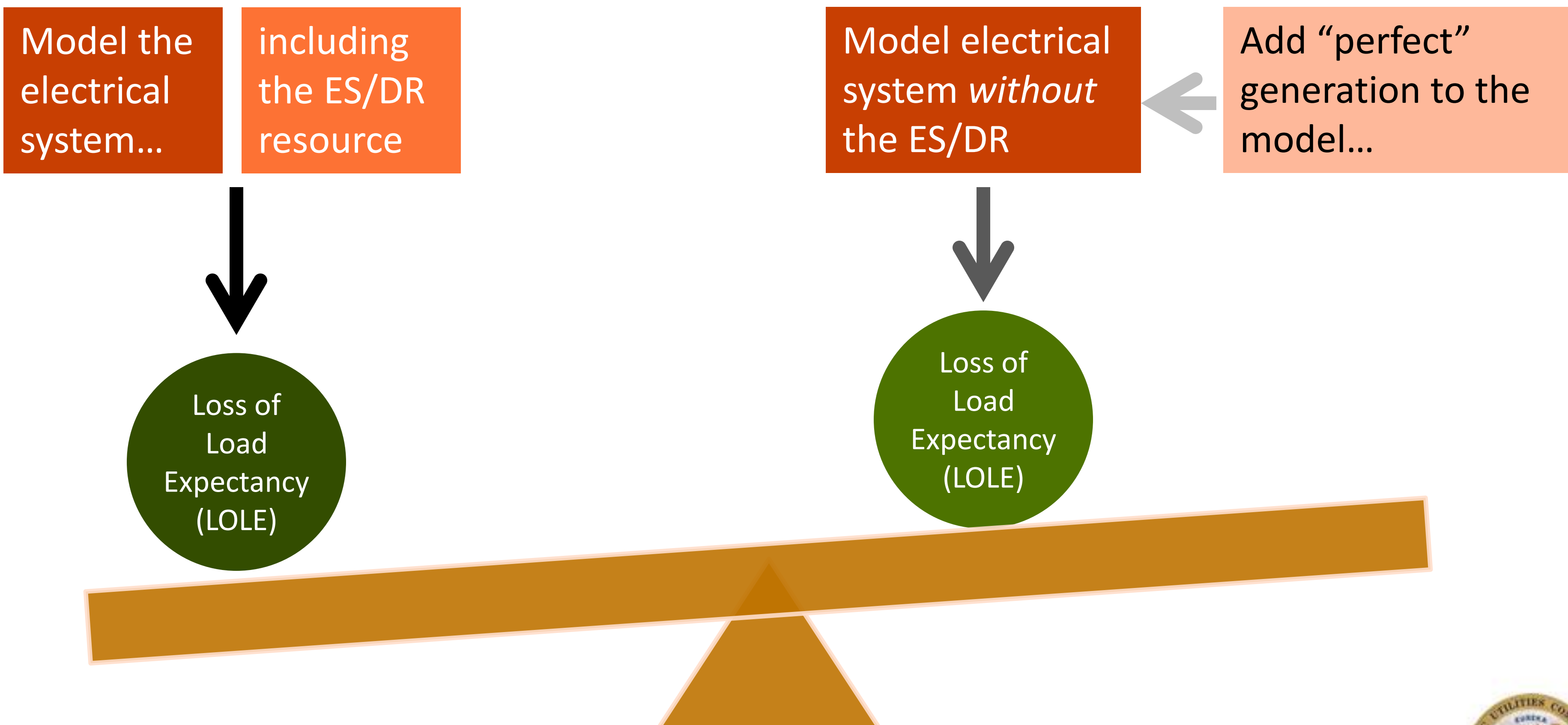
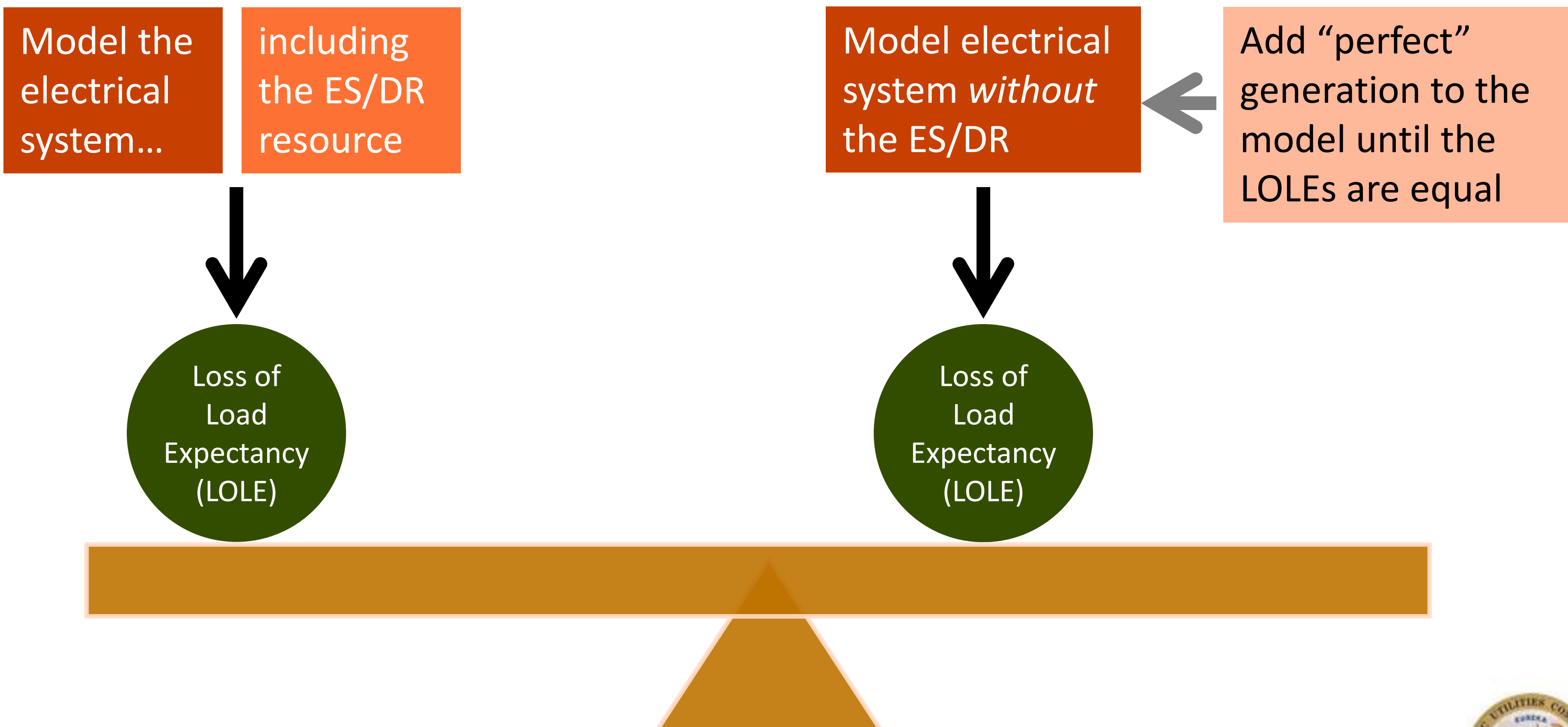
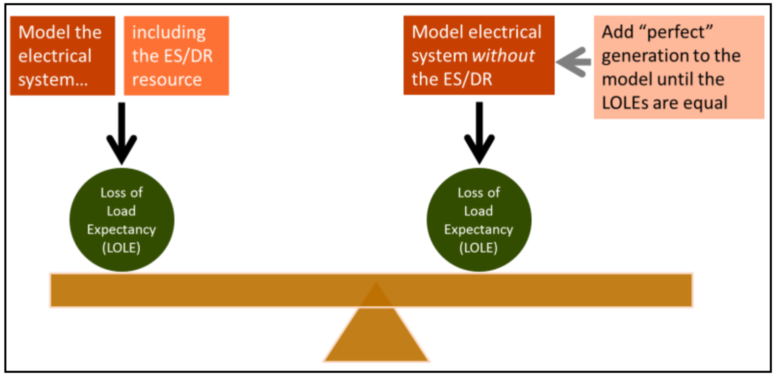


ELCC = Perfect MW / Resource MW



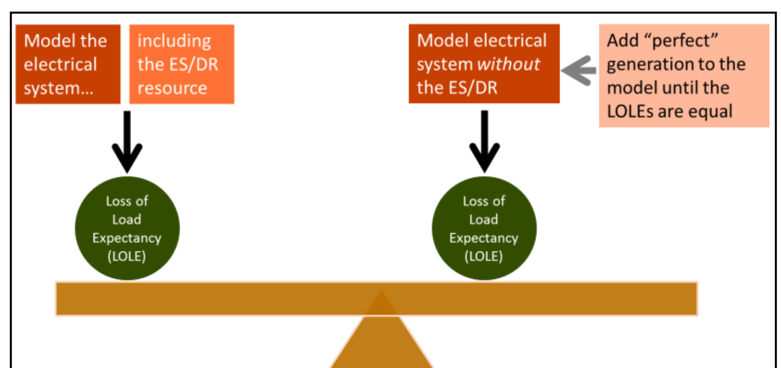
ELCC = Perfect MW / Resource MW

$$ELCC = \frac{\text{Perfect MW Added}}{\text{Resource } P_{max} \text{ (MW)}}$$



QC is equal to the resource MW, derated by its ELCC ("usefulness")

$$QC = \text{Resource } P_{max} \text{ (MW)} \times \text{ELCC (\%)}$$



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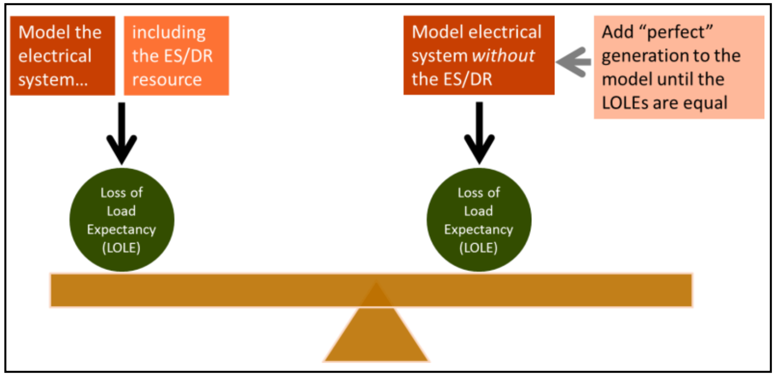

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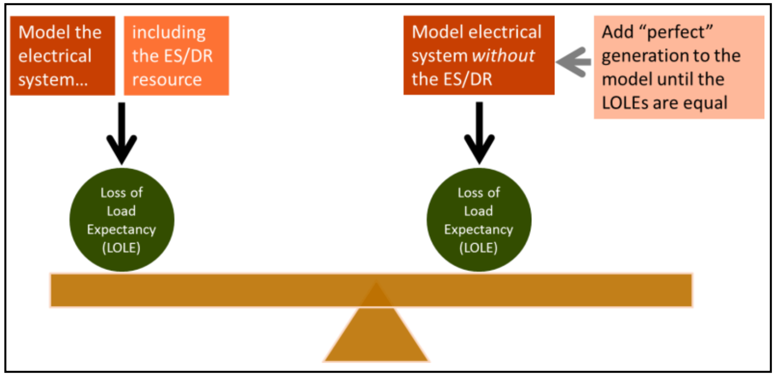


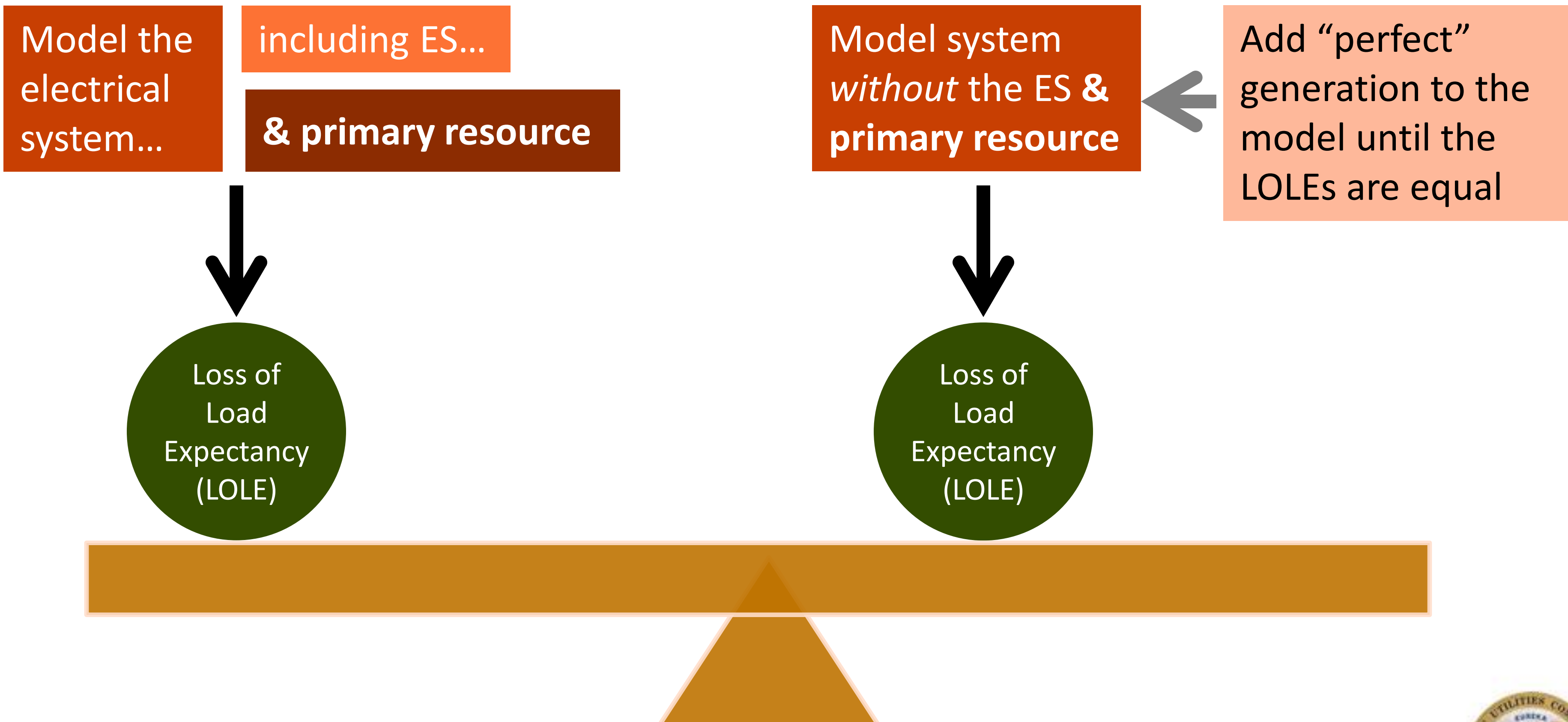
QC is equal to the resource MW, derated by its ELCC ("usefulness")

$$QC = ELCC * P_{max}$$

Special Case: Co-Located Storage

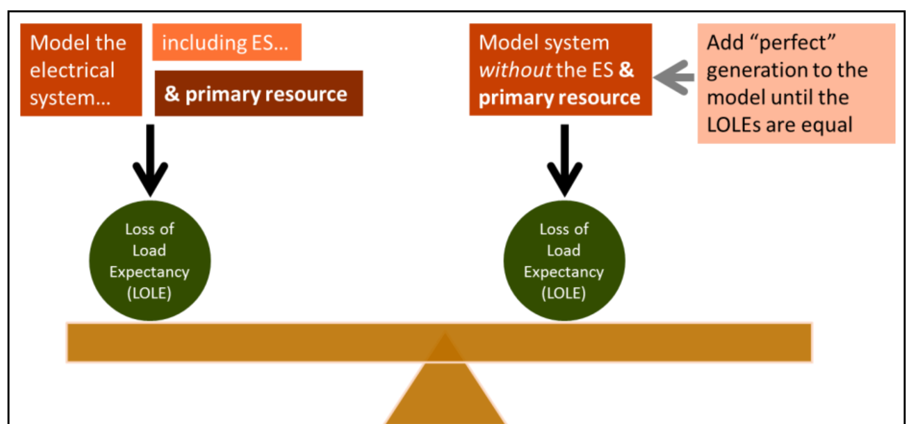
- Co-located ES supplements a larger, primary generator (intermittent or conventional)
- Given its supplementary role, co-located ES does not receive its own QC, but rather modifies that of the primary generator

Special Case: Co-Located Storage



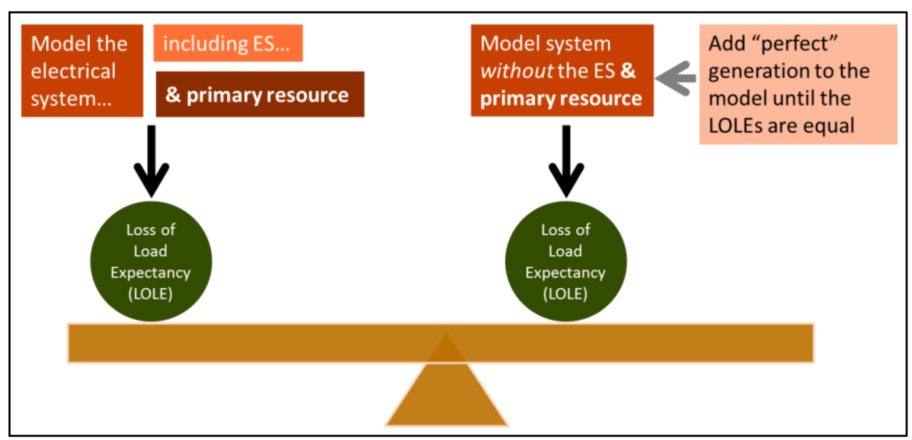
Special Case: Co-Located Storage

$$\text{ELCC} = \frac{\text{Perfect MW Added}}{\text{Primary Resource } P_{max} \text{ (MW)}}$$



The QC is the primary resource MW, derated by its ES-supplemented ELCC

$$QC = \text{Primary } P_{max} \text{ (MW)} \times \text{ELCC (\%)}$$



The QC is the primary resource MW, derated by its ES-supplemented ELCC

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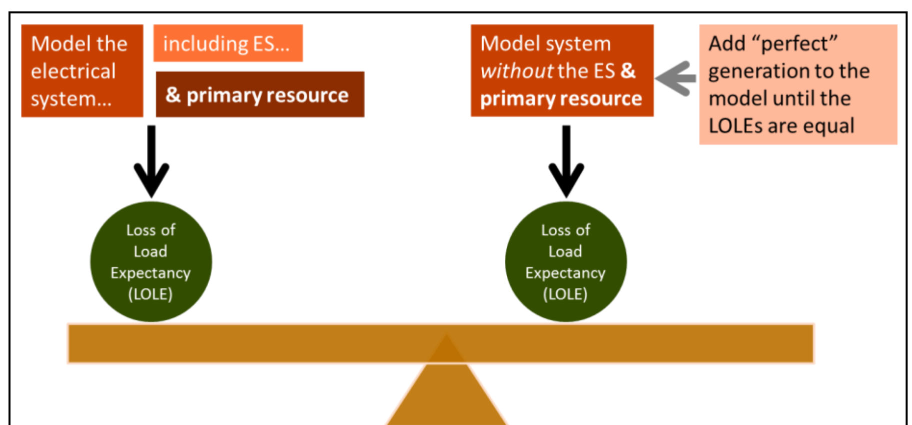
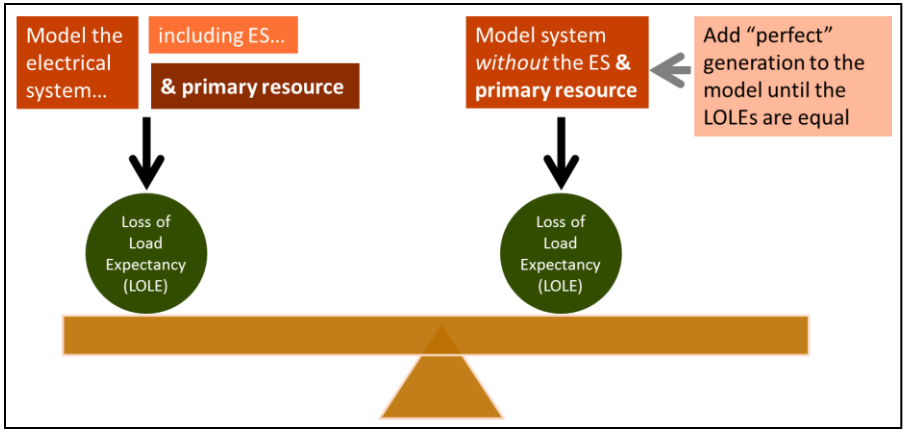


The QC is the primary resource MW, derated by its ES-supplemented ELCC

QC = Perfect MW Added



The QC is the primary resource MW, derated by its ES-supplemented ELCC

$$QC = ELCC * P_{max,primary}$$

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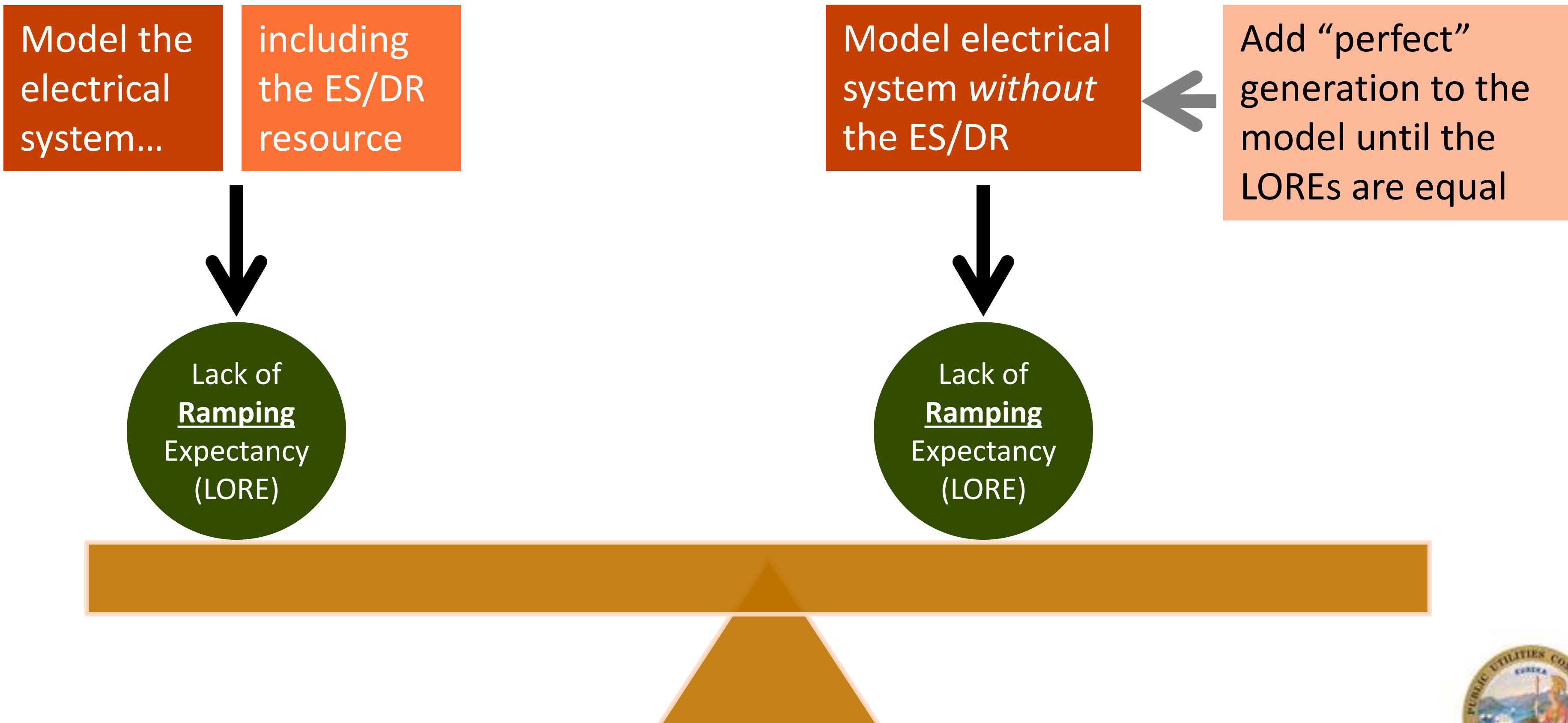
Effective Flexible Capacity (EFC) reflects meeting of ramping needs

- Quantifies the effective MW a resource contributes towards avoiding reliability events caused by inability to meet short term/intra-hour ramping needs
- Based on an ES or DR resource's demonstrated maximum output, P_{max}, and minimum output, P_{min}
- Derated by the resource's effective ramping capability, ERC (usefulness factor), to take into account resource performance and use limitations

ERC is similar to ELCC, but based on ramping-related reliability events

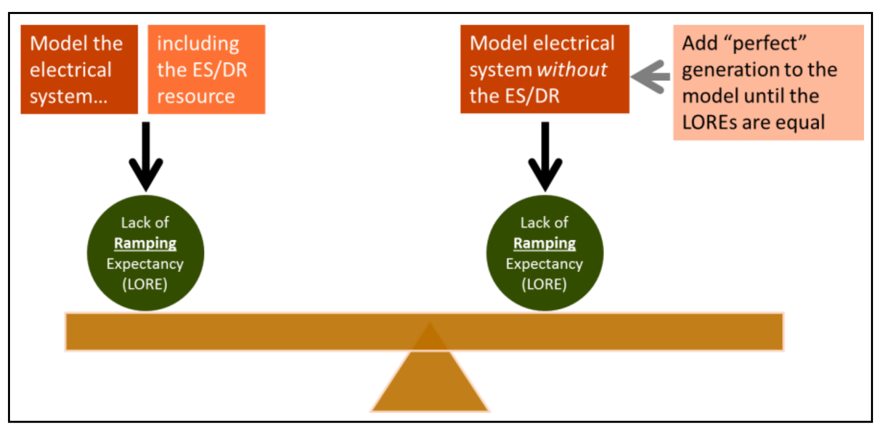


ERC is similar to ELCC, but may include dispatchable load/charging ($P_{min} < 0$)

$$ERC = \frac{\text{Perfect MW Added}}{\text{Resource } P_{max} - P_{min} \text{ (MW)}}$$

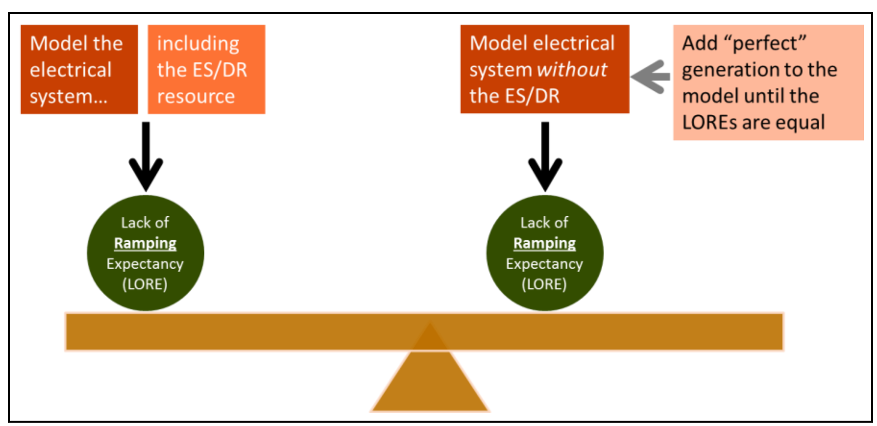
Notes:

1. P_{min} is only included if it is negative. Otherwise, a minimum output of zero MW (i.e., not dispatched) is used.
2. The perfect generator is positive only.



EFC is equal to the resource MW range derated by its ERC ("usefulness")

$$EFC = \text{Resource } P_{max} - P_{min} \text{ (MW)} \times ERC\ (\%)$$



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EFC is equal to the resource MW range derated by its ERC ("usefulness")

$$EFC = \text{Resource } P_{max} - P_{min} \text{ (MW)} \times \frac{\text{Perfect MW Added}}{\text{Resource } P_{max} - P_{min} \text{ (MW)}}$$

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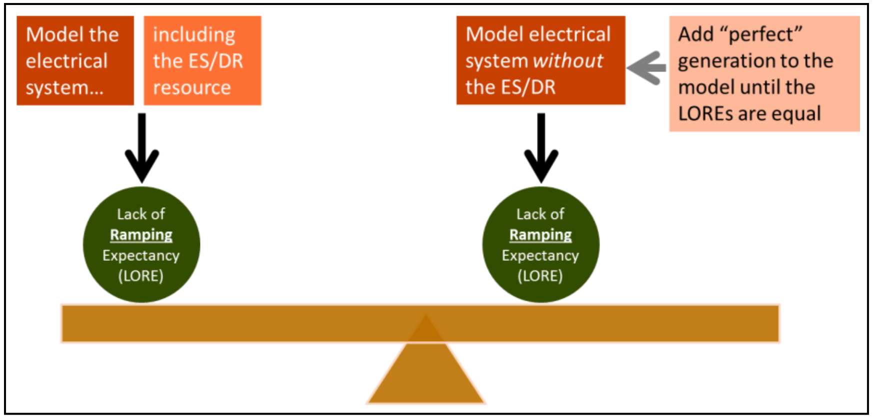

EFC is equal to the resource MW range derated by its ERC ("usefulness")

EFC = Perfect MW Added

Notes:

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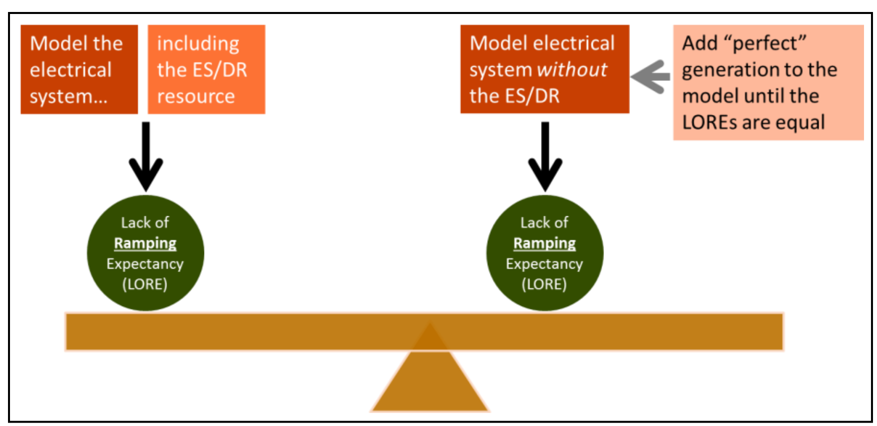

EFC is equal to the resource MW range derated by its ERC ("usefulness")

$$EFC = ERC * (P_{max} - P_{min}), \qquad P_{min} < 0$$

$$EFC = ERC * P_{max}, \qquad P_{min} \geq 0$$

Co-located ES is not given an EFC; it modifies that of the primary generator

$$EFC = ERC * P_{max,primary}$$

Note:

1. P_{min} is excluded because it is assumed that the primary generator does not have negative P_{min}.

Negative P_{min} Wrinkle: ERC may be greater than one, and EFC > QC

What is the impact of including negative P_{min} in EFC but not in QC?

- QC is proportional to P_{max}, while EFC is proportional to $P_{max} – P_{min}$, for $P_{min} < 0$
- It is very likely that EFC > QC for ES and for DR with dispatchable load
  - Depends on the ELCC and ERC deratings and the magnitude of P_{min}
  - This makes intuitive sense: a greater operational range is able to contribute to meeting ramping needs than to meeting peak needs
- Currently, EFC > QC is not permitted; this would need to be addressed in a decision

What if negative generation is more useful than positive generation?

- Perfect generation is positive only, while ES and DR can be < 0
- If negative generation is inherently more “useful” than positive generation in meeting ramping needs, then ERC could be > 1
- This is very unlikely to occur; if it does, we will explore further

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ES and DR should meet existing and planned RA & CAISO eligibility criteria

System RA

- At least 4-hour duration for P_{max} and P_{min} (in aggregate)
- Ability to operate over three consecutive days
- Must-offer obligation (MOO): may either bid into CAISO or self-schedule

Local RA

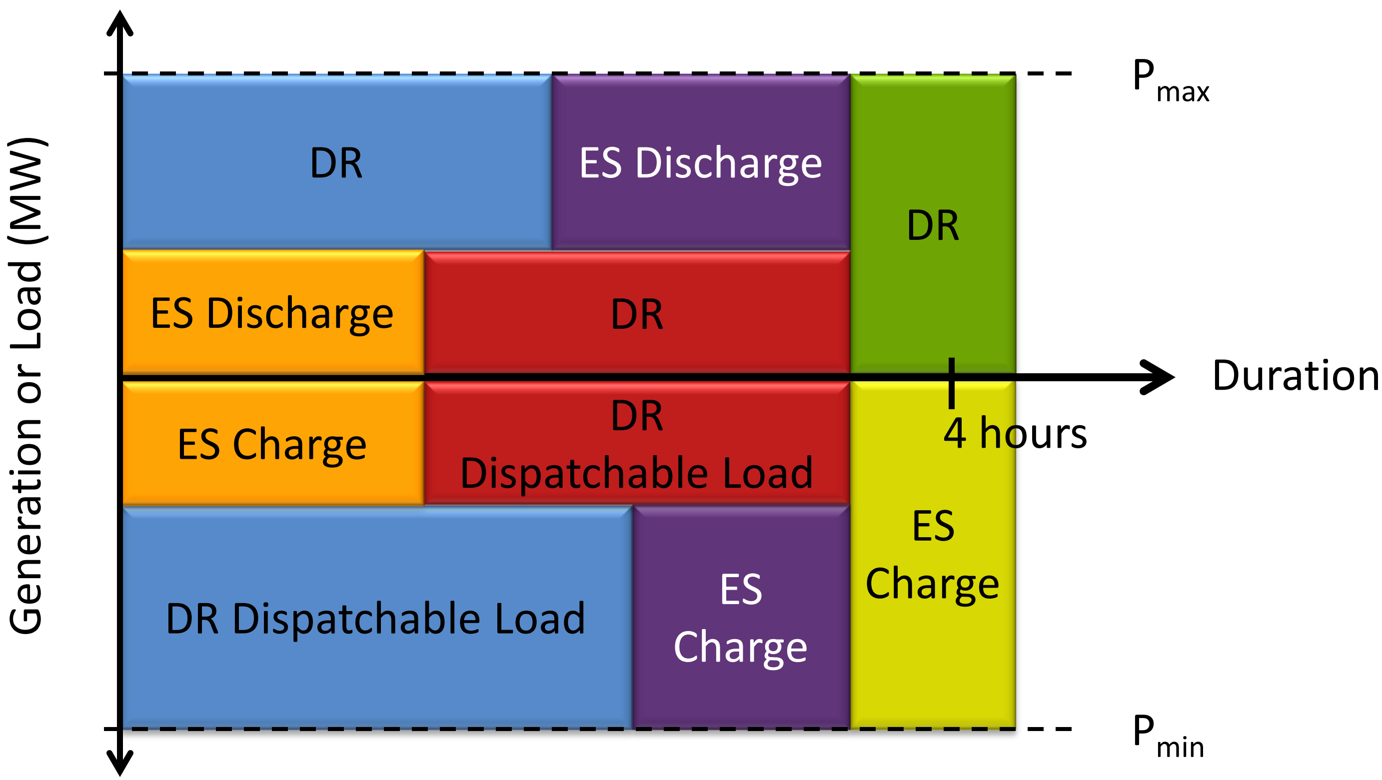
- At least 4-hour duration for P_{max} and P_{min} (in aggregate)
- Ability to operate over three consecutive days
- Must-offer obligation (MOO): may either bid into CAISO or self-schedule

Flexible RA

- Ability to ramp or sustain output for at least three hours (in aggregate)
- Must-offer obligation (MOO): must bid into CAISO markets during one of two intervals
  - 6:00-11:00 am
  - 4:00-9:00 pm

Co-located storage need only meet the MOO independently; the primary generator must be independently RA-eligible & at the same transmission node

ES and DR programs may be aggregated to meet RA requirements



Rules should be flexible yet still aligned with RA and CAISO goals & constraints

- Resources located in the same service territory may be aggregated for System and Flexible RA
- Local RA resources can only be aggregated if at the same transmission node and dispatchable by Local Capacity Area
- Aggregated resources will receive a single Resource ID
  - The resources can nevertheless be modeled separately in the reliability calculator
  - If one element is charging or rebounding while another is discharging or curtailing, the impacts cancel one another out
- Aggregation must take into account use limitations such as hours of non-availability

Please share the regional granularity you consider appropriate for aggregation and provide feedback on Resource ID aggregation

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Energy Storage must be tested to fully demonstrate RA eligibility

- ES operators must submit test data to the CAISO showing output at P_{max} and P_{min} over the full four-hour duration required for RA eligibility
  - Co-located storage need not meet the four-hour duration requirement
  - Individual units may be aggregated to meet the eligibility criteria
- It is assumed that ES is capable of operating over three consecutive days by recharging at times that do not increase LOLE
- Other physical/operating characteristics must also be submitted (similar to master file data for conventional resources), such as efficiency and available energy

We look forward to parties' input on:

- Other characteristics (manufacturer, test, or historical data) that should be submitted
- Whether and how it would be appropriate to apply a performance uncertainty when modeling less-proven technologies and/or newer units
- What type of ramping capability testing is appropriate, particularly considering the transition from charge to discharge

ES Wrinkle: ELCC, ERC may be above 1; results in QC > P_{max}, EFC > (P_{max} – P_{min})

P_{max} may be significantly lower than the short-term maximum power output; likewise, P_{min} may be significantly below maximum possible charging

- Occurs if short-term max/min cannot be sustained over the four hours needed for RA eligibility
- Other resources have short-term "emergency" ratings above P_{max}, but with ES this mode is more likely to be economically dispatched

The model may frequently dispatch the unit for intervals under four hours

- If so, dispatch may be significantly above P_{max} or below P_{min}

More than P_{max} MW of perfect generation may be needed to achieve the same LOLE as with the ES, if ES dispatch is usually above P_{max}

- This also depends on how useful the resource is, in light of other operating characteristics
- This would result in ELCC > 1, because ELCC = Perfect MW / Resource P_{max}
- Similar logic applies to LORE and ERC, except that the range is P_{max} - P_{min}

If ELCC > 1, then QC > P_{max}; if ERC > 1, then EFC > (P_{max} – P_{min})

DR P_{max} and P_{min} will be based on testing and Load Impact Protocols

Test Duration	Two hours
Test Participants	A representative sample, or all participants
Initial Processing and Adjustment	Simplified Load Impact Protocols (LIPs) will continue to be used to determine P_{max}, the maximum resource potential (1 in 10); they will also be used to determine P_{min}. Adjustments will consider temperature, time of year, and other relevant factors.
Submission and Certification	Test data and LIPs will be submitted to the CAISO and the CPUC; adjustments will be conducted by the CPUC in approving the resource's P_{max} and P_{min}
Ongoing Adjustment (due to participant turnover and commitment modifications)	If the contracted MW changes from one year to the next, the DRP must inform the CAISO; P_{max} and P_{min} will be revised by the CPUC, utilizing the LIPs
Ongoing Testing	If a resource is not called for an entire year, it must be retested

Please provide input on what type of ramping capability testing is appropriate, particularly considering dispatchable load → curtailment transition (when applicable)

Other parameters based on program design and DR historical performance

- Modeling will incorporate program design parameters such as hours of availability and dispatch triggers
- Performance of similar programs will be taken into account in estimating likely resource performance, in the absence of program-specific historical data
- As historical data accumulates, it will be incorporated into the modeling (going back 3 years)
  - Historical data will also be processed using simplified LIPs
  - To ensure a reasonable sample size, this data will only be included after ten dispatches

We look forward to parties' input on:

- What guidelines are appropriate in applying similar program performance to the modeling of new programs
- Whether and how it would be appropriate to apply a performance uncertainty when modeling less-proven program types, newer resources, and/or participant turnover
- How DR can/should be held accountable for performance given that Standard (Flexible) Capacity Product rules (SCP and SFCP) do not currently apply to DR
- Test duration (different rules for different applications?)
- The continuing use of simplified load impact protocols

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Deterministic QC and EFC could utilize a similar framework to that proposed

Many of the proposed regulations could be implemented without probabilistic modeling:

- RA eligibility and CAISO market participation
- Testing and certification
- Aggregation
- QC based on P_{max}
- EFC incorporating operation at negative P_{min} (dispatchable load/charging)
  - Would require removing the current limit of EFC < NQC

Storage QC could be calculated in the same manner as for fossil plants

Starting Point: P_{max}

- Maximum four-hour output

Modified by the CAISO

- Adjusted downward to reflect expected performance

SCP Accountability

- CAISO Standard Capacity Product (SCP) penalties for non-performance

Storage EFC calculations could be similar to those for fossil plants

Proposed ES EFC rules

- EFC = Minimum of (NQC – P_{min}) and (180 minutes * Average Ramp Rate)
- Negative P_{min} assumed
- EFC > NQC permitted
- CAISO Standard Flexible Capacity Product non-performance penalties

Conventional formula, for start-up time SUT > 90 min

- Assume facility begins at P_{min}
- EFC = Minimum of (NQC-P_{min}) and (180 minutes * Average Ramp Rate)

Conventional formula, for start-up time SUT < 90 min

- Assume facility begins off
- EFC = Minimum of (NQC) and (P_{min} + (180 minutes – SUT) * Average Ramp Rate)

Co-located ES: independent or modifying the performance of the primary unit

Independently RA-Eligible ES

- Co-located ES would be separately qualified for RA as stand-alone storage
- The co-located ES would receive its own Resource ID, QC, and EFC

Not Independently Eligible ES

- ES would not receive its own Resource ID, QC, or EFC
- ES would modify performance of the primary facility
- The QC and EFC of the primary facility would change as historical data (including the ES unit) accumulated

Existing Retail DR QC methodologies could be applied to Supply-Side DR

- The QC for current Retail DR programs is calculated using the Load Impact Protocols (LIPs)
- These LIPs could continue to be used (including CPUC adjustments)
- Non-performance would be reflected in future years' QC allocations

Existing conventional EFC methodologies could be adapted to DR

- P_{min} < 0 and EFC > NQC permitted
- Start-up time > 90 min or $P_{min} \leq 0$:
  - EFC = Minimum of (NQC-P_{min}) and (180 minutes * Average Ramp Rate)
- Start-up time SUT < 90 min, and P_{min} > 0:
  - EFC = Minimum of (NQC) and (P_{min} + (180 minutes – SUT) * Average Ramp Rate)
- CAISO Standard Flexible Capacity Product non-performance penalties (under development)

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Next Steps: Comments and Iteration

- Informal comments are due October 22, 2013
  - joanna.gubman@cpuc.ca.gov
- A formal proposal will be published in December, with workshop to follow in January
- The broader ELCC initiative will be proceeding in parallel, including:
  - Workshop on modeling assumptions in November
  - Study with preliminary results in December
  - Workshop and formal comments in January

Thank you!

For Additional Information:

www.cpuc.ca.gov

(Search: Resource Adequacy History)