Resource Adequacy Two-Slice Framework

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About Gridwell Consulting

- Women-owned economics and energy consulting firm – www.gridwell.com
  - Educate, model, advise, and advocate
  - Experts in energy and ancillary service markets, resource adequacy, interconnection, and storage optimization and modeling for RFOs, due diligence, and bid strategy
- Carrie Bentley, co-founder and CEO
  - Designed CAISO's Capacity Procurement Mechanism, portions of forced and planned outage rules, and RA Availability Incentive Mechanism
  - Has evaluated or negotiated over 10,000 MW of long- and short-term RA contracts in California over last 5 years
  - Represent WPTF at the CAISO, full client list on website

Recap Workshop Scope

- Motivation for proposal
- Review high-level framework
- Address prior questions on how framework meets CPUC Principles
- Pro/Con recap
- Not presenting, but included in deck
  - Framework details – subset of prior presentation
  - Appendix – support slides

Gridwell system RA framework motivation

- System RA framework should retain the separation between capacity and energy and yield a transactable product
  - Capacity value is based on the contribution to grid reliability over a long period of time
  - Energy value is based on day-to-day power deliveries to the grid
- Requirement should yield a loss of load expectation of not more than 1 day in 10 years
- Counting rules should accurately value a resources contribution to grid reliability
  - Efficient investment and retirement decisions depend on developers and planners being able to compare the reliability value and cost of different technology types
- Load and resource diversity benefits of ISO should be preserved

Two-Slice Framework Overview

Framework overview

Component	Gridwell proposal
Slice Structure	2 slices, gross load peak and net load peak
Showings	Seasonal or Monthly
Peak Requirement	1 in 10 LOLE
Peak Resource Counting*	Operationally-limited resources (solar, wind, battery, hydro): ELCC Hybrid and Hybrids with ITC: Like today, but battery portion has ELCC Use-limited thermal: ELCC or UCAP Thermal: UCAP or UCAP Light (ambient derate due to temperature) Dynamic Imports: Based on underlying resource type Non-dynamic Imports: Contracted amount
MCC Buckets	No, but cap on Demand Response
Peak Backstop	Same as today; CPUC penalty, CAISO CPM
Net Peak Showing	None in 2024, can be added later if needed
Net Peak Resource Counting	Shown wind and solar resources adjusted downward to historical minimum in net peak load hour to get net peak QC. Net Peak NQC list can be added later if needed
Net Peak Backstop	Same principles as peak backstop. Aggregate shown net peak QC compared to aggregate net load peak. Any system shortage assigned to short LSE same as system shortage.

* Exact ELCC methodology to be determined in subsequent process

Compliance with CPUC principles

CPUC principles

Principle 1: To balance ensuring a reliable electrical grid with minimizing costs to customers

Principle 2: To balance addressing hourly energy sufficiency for reliable operations with advancing California's environmental goals

Principle 3: To balance granularity and precision in meeting hourly RA needs with a reasonable level of simplicity and transactability

Principle 4: To be implementable in the near-term (e.g., 2024).

Principle 5: To be durable and adaptable to changing electric grid

NOTE: After review of relevant CPUC materials, Gridwell does not believe the Commission Decision supports reducing load and supplier diversity benefits by mandating each LSE procure to their own load shape in every hour

Principle 1: Balance reliability and costs

- The Commission states they are concerned, "the value of an RA resource does not necessarily align with a resource's energy bidding behavior, which could lead to additional reliability costs to ratepayers."
- The two-slice proposal focuses on discounting all operationally-limited resources' RA value. Thus, resources that cannot provide energy in all hours have their capacity value explicitly discounted. This has a two-fold effect:
  1. Consumers will pay less in RA costs for resources that are not available in all 24-hours
  2. There is assurance that regardless of the resource mix procured by individual LSEs, all 24-hours retain at least a 1 in 10 LOLE

Principle 1, additional explanation

- Consumers pay less in RA costs for resources that are not available in all 24-hours

The Two-Slice explicitly discounts all operationally–limited resources. These resources NQC will represent their reliability compared to a perfectly available generator. By discounting the resources value, in order to meet the requirement and maintain a 1 in 10, all LSEs will have to show the equivalent fleet to a perfect generator.

- There is assurance that regardless of the resource mix procured by LSEs, all 24-hours have sufficient energy capacity

Hourly energy sufficiency is sustained by discounting resources compared to a perfect resource. For example, in 2040 a very reliable 24-hour geothermal plant may be 98% of deliverable nameplate, whereas as 4-hour battery maybe be 15% of deliverable nameplate. Thus, an LSE would have to procure ~six 4-hour batteries to meet the equivalent reliability of one geothermal plant. There is no need to have an hourly requirement, because the generator itself is discounted. This ultimately reduces costs to consumers and ensures reliability.

Principle 2: Balance energy sufficiency and green goals

- The Commission here is concerned with the balance between hourly energy sufficiency and advancing California's green goals. They also note the MCC buckets specifically are to limit overreliance on use-limited resources and have a gap of not ensuring battery charging sufficiency.
- Finally, the Commission notes a concern with other hours of the day when "load may still be high" and variable resource provide little or no value.
- The Two-Slice proposal addresses each of these:

1. Energy sufficiency is sustained as described in the prior slides and in particular focuses on when "load may still be high and variable resources provide little to no value" via the peak net load requirement as discussed as a need in Principle 2
2. The proposal addresses battery charging sufficiency accounting for charging needs both the peak requirement and ELCC studies which ensures batteries have sufficient charging energy
3. None of the slice-of-day options initially eliminate the need for MCC buckets demand response limitation. However, Gridwell's proposal reduces the RA value of bucket 2 and 3 MCC bucket resources. These buckets will no longer be needed because the resources in these buckets have their NQC value reduced. The MCC buckets may still be needed for demand response or other non-modeled limits.

Principle 3: Balance granularity and transactability

- The Commission reviews the current MCC buckets and states, "A less complex framework will inherently result in ease of transactability and contracting, as comprehensible rules regarding need determination and resource counting will facilitate bilateral trading and contracting of RA products and provide better certainty to allow for long-term contracting."
- Gridwell's framework only has two-slices and expands the current ELCC paradigm that is already used in wind and solar contracts. It also uses the UCAP methodology which has been a well-discussed paradigm at the CAISO over the last three years
- The framework maintains a single transactable product for foreseeable future
- Eventually a second, net load product may emerge in the market

Principle 4: To be implementable in the near-term

- The Commission seeks a framework that can be implemented in late 2023 for the 2024 RA year
- Gridwell's proposal aligns with CAISO's capabilities and uses ELCC as a groundwork for enhancements
- It yields a transactable product in terms of a single MW value per month that will not cause trigger significant renegotiations on existing and in-progress contracts
- The proposal prioritizes reliability today and can be enhanced over time as additional batteries and renewables enter the system

Principle 5: To be durable and adaptable

- The Gridwell proposal relies on modern capacity theory and ensures reliability and efficiency across resource mixes
- As the grid evolves, Gridwell's proposal continually yields a transactable product that provides a measure of reliability and cost from each resource and resource technology type
- This information will be vital to the market and planners as decisions around gas retention, retirement, and new technology investment are considered
- All CPUC-jurisdictional resources participate in the California ISO, and the only way to ensure reliability in the long-run is for a coordinated system RA framework

Pros and Cons

- **Pros**
  - ✓ Removes need for MCC buckets, except demand response
  - ✓ Resolves immediate reliability need to better evaluate resource supply during peak net load hours
  - ✓ Aligned with IRP and CAISO local RA framework
  - ✓ Yields a simple, transactable RA product
  - ✓ Preserves load and resource diversity benefits
  - ✓ Preserves commonly understood peak RA framework across west and does not require significant transition time or contract renegotiations
- **Cons**
  - ✓ ELCC not globally well-understood even by knowledgeable industry professionals
  - ✓ Requires consultant or internal CPUC resources to develop complex LOLE and ELCC studies every other year
  - ✓ Requires effort to convince CPUC Commission that meets slice-of-day direction

Framework Details

Two-slice proposal details

1. System aggregate peak load requirement allocated based on coincident load ratio share
2. Enhanced counting rules – replace MCC buckets to all extent possible by derating operationally limited resources
   a) Incremental ELCC or other ELCC methodology to-be-determined in an annual study process for all operationally-limited resources
   b) Thermal resources derated by UCAP or UCAP-light
3. Backstop process includes a system peak net load (non-solar hour) assessment

Peak Load Requirement

Probabilistic LOLE sets monthly peak load requirement

- Probabilistically determine Loss of Load Expectation capturing hourly needs
- Use Hourly Forecast Update – CAISO Mid-Mid Case in the most recent CEC full or updated IEPR as basis for projected load
- For target year model generation capacity online (Baseline Resources) plus potentially any projects with executed contracts for that year expected to achieve COD
- Perform Loss of Load Hourly calculation
  - Calculate Loss of Load Hours (LOLH) = sum of all hourly LOLP's in a year $(\frac{h}{y})$
  - Uses 8,760 hourly probabilities setting each ρ between 0 to 1
- Use probabilistic approach for uncertainties to produce distribution of outcomes (X_i)

Demand Variations	Forced outage risk	Substitution risk for planned outages	VER Availability Risks	Operational Uncertainty

- To ensure reliability threshold is met set the LOLE common LOLE reliability target to 0.1 event/year, or 1 outage event per 10 years (i.e., a 1-in-10 planning standard)

Methodology Options

Option A: Set monthly requirement using LOLE capacity requirement output

- Use LOLE modeling to determine total generation capacity needed for each month to meet 1 in 10
  - Note, PRM method needs to be updated depending on whether resource capacity valuation will include outage risks, substitution risk, operational risk, availability risk directly in the NQC or not
- Set slice 1 requirement for each month as the monthly total capacity needed to meet 1 in 10 identified in the LOLE modeling
- Allocate to each LSE same as today

Both Option A and Option B arrive to the same monthly requirement, they are just different ways if there is a strong preference to “set” a PRM. Alternatively, in Option A the PRM can be calculated more as a reliability metric too.

Option B: Set monthly requirement using reserve margin on top of CEC monthly forecasts

- Calculate Planning Reserve Margin for each month
- Use LOLE modeling output for total generation capacity needed for each month
- Use Managed 1-in-2 Monthly Peak Load CAISO Coincident System Peak Load for each month
  - From recent CEC full or updated IEPR
- Apply the percent difference to the monthly CAISO coincident peak to set monthly need

$$PRM = \frac{LOLE\ Capacity\ to\ Meet\ 0.1}{Managed\ 1in2\ Monthly\ CAISO\ Coincident\ Peak}$$

$$Requirement = Monthly\ CAISO\ Coincident\ Forecast * PRM$$

- Allocate to each LSE same as today

Methodology Considerations

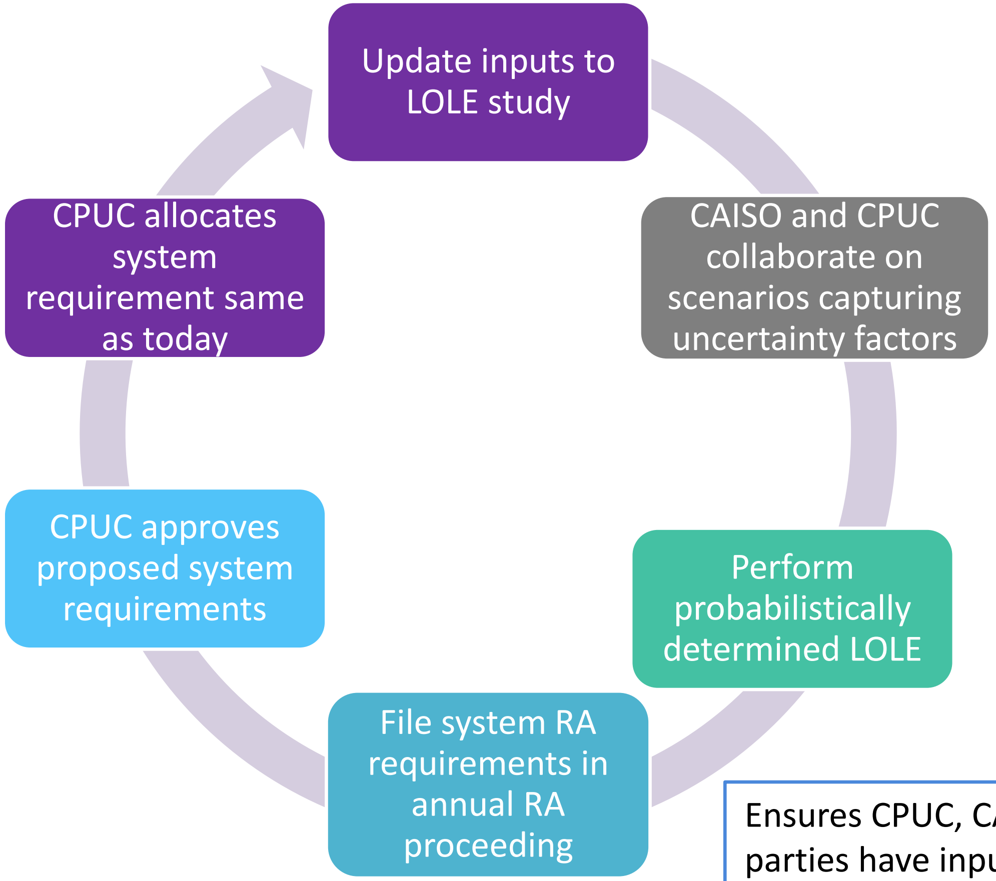
- Energy Division discussed California's approach to LOLE at November 23, 2021 workshop and some considerations for potentially using LOLE studies to determine system RA needs
- LOLE modeling being done by the CPUC Energy Division generally accomplishes the goals of this proposal, with the need for incremental modeling improvements rather than wholesale redesign
  - Models 8,760 hours capturing hourly probabilities and expected output scenarios. The dispatch scenarios may need to be reviewed, especially for storage or use limited resources.
  - Uses a probabilistic approach to assess range of conditions. The range of conditions and uncertainties need to be reviewed and updated as appropriate.
  - Uses CEC forecast. It may warrant reviewing the specific CEC forecast in more detail but at a minimum ensuring that the most recent CEC forecast is being used for each hour.
  - Sets the reliability threshold to 1 in 10. Counting rules need to be updated to boost confidence.
- Greater involvement from CAISO is needed to ensure there is a shared view of the reliability need
  - CAISO and CPUC should coordinate more closely in the LOLE modeling
  - CAISO needs at a minimum to have more agency in informing the uncertainties as these are observed in the operational time frame that CAISO has best information and experience with.
- LOLE studies must be updated regularly, ideally annually but no more than every two years, to update the system RA need for slice 1 – gross peak
- ELCC for each bucket should be updated after each LOLE study for use in next LOLE study

Benefits of regularly updated requirements

Requiring annual filings ensures the system RA requirement reflects current need increasing market confidence

Increases market certainty that CPUC and CAISO share same view of need, which better supports forward procurement by reducing regulatory risks

Provide CAISO greater engagement to inform/provide uncertainty scenarios to increase CAISO confidence in the results



Uses understood LOLE/EUE metrics that address hourly energy sufficiency while also balancing complexity and costs

CPUC is the final decision maker on requirements vetting that they meet the CPUC standards

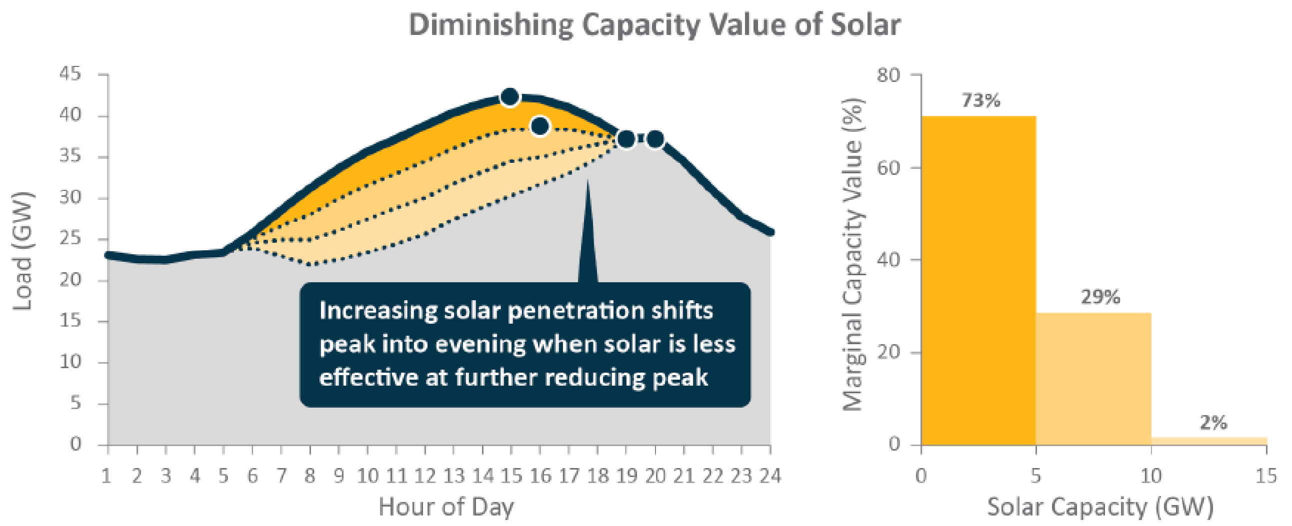
Ensures CPUC, CAISO, and RA parties have input into the proposed system requirements

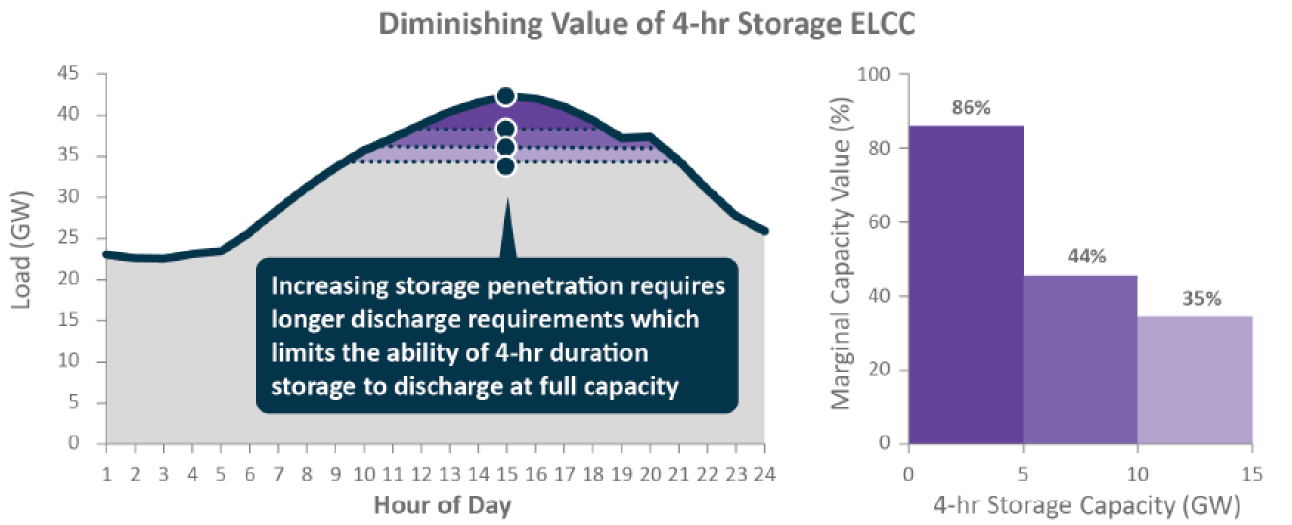
Resource Counting

Resource counting overview

- Counting rules should be coordinated across proceedings and products
  - System RA counting should coordinate with IRP
  - System RA counting should coordinate with local RA counting
- Resource limitations can be reflected primarily in RA requirement OR in counting rules, propose to reflect limitations primarily in counting rules
- ELCC methodology establishes QC based on equivalent reliability to a perfect resource considering all hours and captures resource diversity
- An accurate ELCC for any operationally-limited resource (due to fuel, use-limitations, or energy) will discount the RA sufficiently to ensure grid reliability in all hours

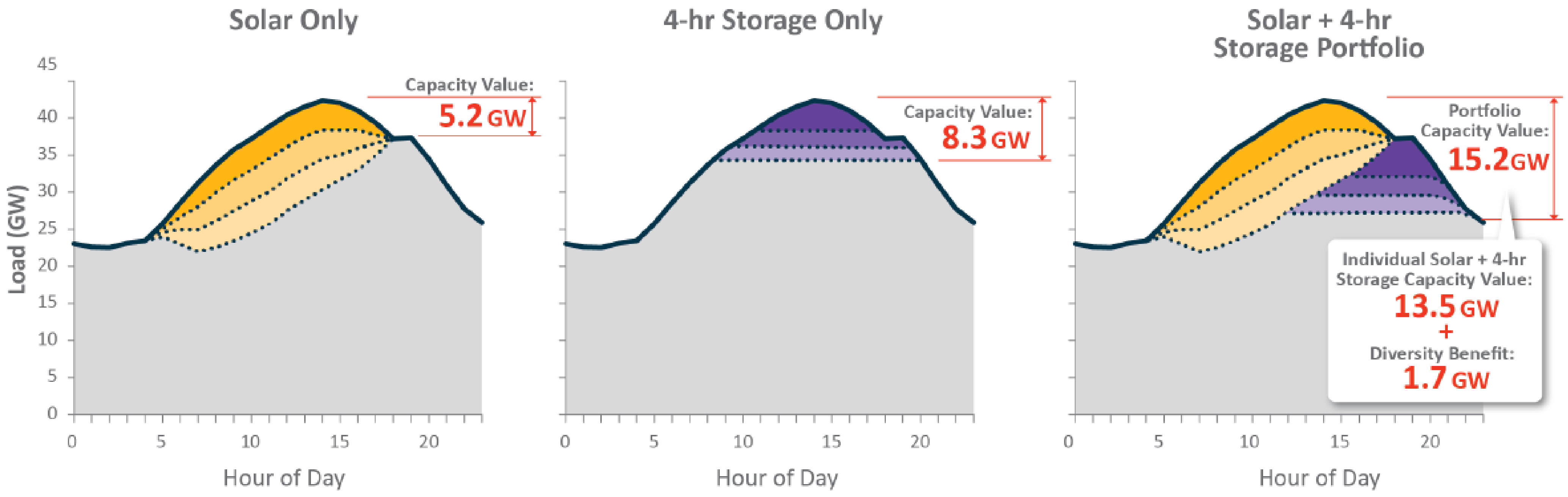
Diminishing value of operationally-limited resources





Source: E3 report on ELCC https://www.pjm.com/-/media/committees-groups/task-forces/ccstf/2020/20200807/20200807-item-04-e3-allocating-elccmw-from-portfolio-to-classes.ashx

Resource diversity benefits (i.e., portfolio benefits)



Source: E3 report on ELCC
https://www.pjm.com/-/media/committees-groups/task-forces/ccstf/2020/20200807/20200807-item-04-e3-allocating-elccmw-from-portfolio-to-classes.ashx

Counting rules proposal

- Incremental ELCC or other ELCC methodology to-be-determined in an annual study process for all operationally-limited resources
  - Solar, wind, batteries by location and technology
  - Hydro resources that are not run-of-river
  - Landfill gas, duration limited thermal resources
- Non-use-limited thermal QC derated seasonally by ambient derates due to temperature OR UCAP, depending on CAISO's January analysis
- Updated rules needed or MCC buckets retained for demand response
- ELCC (and UCAP) studies done at a minimum every two-years and updated based on effectiveness and lessons learned in CAISO and other ISOs

ELCC ratings in most recent PJM study

ELCC Class	ELCC Class Rating for 2023/2024 BRA
Onshore Wind	15%
Offshore Wind	40%
Solar Fixed Panel	38%
Solar Tracking Panel	54%
4-hr Storage	83%
6-hr Storage	98%
8-hr Storage	100%
10-hr Storage	100%
Solar Hybrid Open Loop - Storage Component	82%
Solar Hybrid Closed Loop - Storage Component	82%
Hydro Intermittent	42%
Landfill Gas Intermittent	59%
Hydro with Non-Pumped Storage*	96%

* PJM performs an ELCC analysis for each individual unit in this class. The value shown in the table is a representative value provided for informational purposes

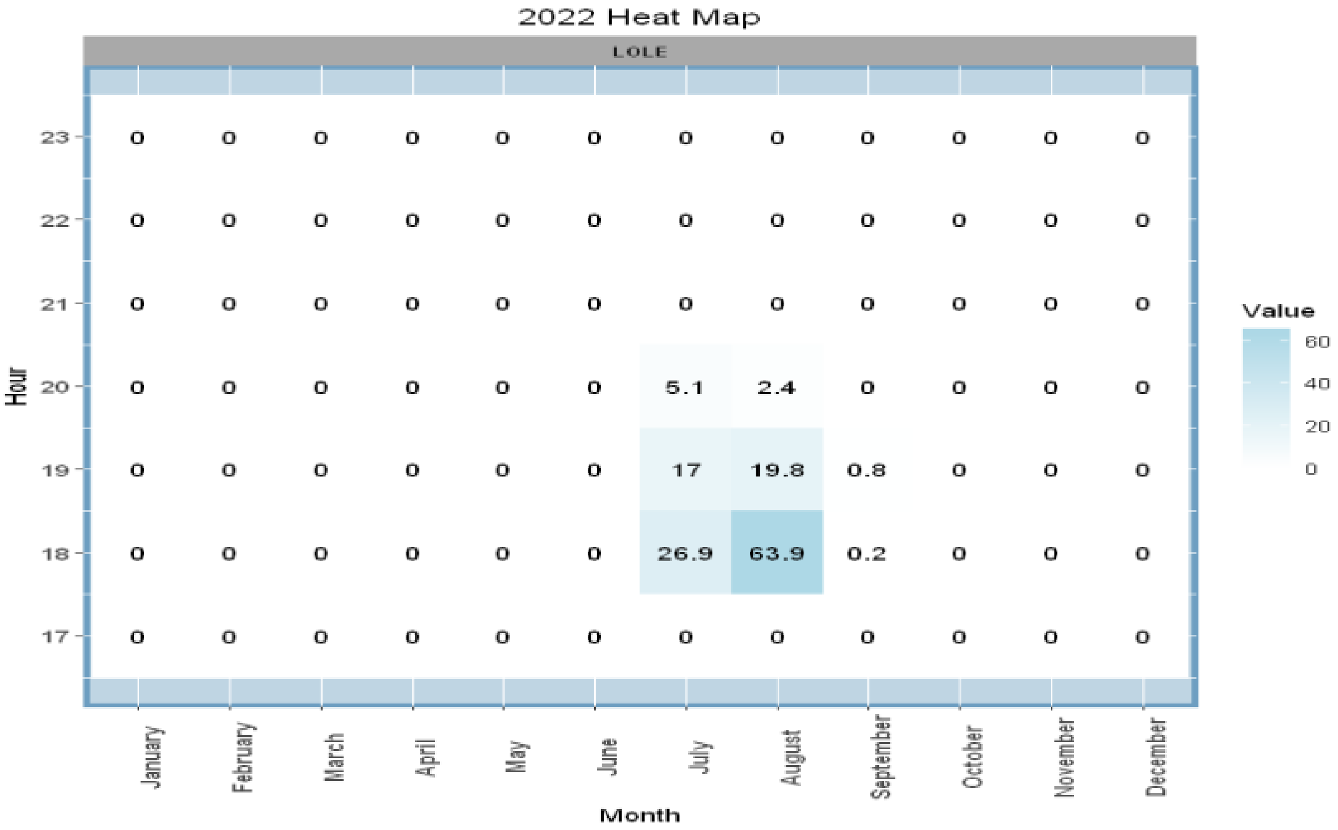
ELCC Background

- Presentation for PJM by E3 on ELCC options
- California ELCC topics
  - Incremental ELCC
  - SCE advocating for marginal ELCC in RA space with additional granularity
  - E3 Study on ELCC and Demand Response

Peak Net Load Requirement

CPUC ED LOLE analysis highlighted that there is increased net peak need

- CPUC November 23, 2020, presentation
- Maps showing amounts of Expected Unserved Energy identified under its LOLE modeling for target year 2022 for each hour and month
  - Show when loss-of-load risks are expected to occur and show expectations of magnitude
  - CPUC Energy Division saw that LOLP periods are likely during HB18-HB20 for now
- Consistent with CAISO 2020 blackout period



Source: Track 3.B Workshops: Day 2, https://www.cpuc.ca.gov/-/media/cpuc-website/files/uploadedfiles/cpuc_public_website/content/utilities_and_industries/energy/energy_programs/electric_power_procurement_and_generation/procurement_and_ra/ra/track-3b-day-2-presentation.pdf

Peak net load requirement captures non-solar hour reliability needs

- Currently the CAISO has the most trouble with reliability during peak net load hours due to the shift from relying on solar to relying on other resource types
- While ELCC and exceedance measure solar availability, any amount cannot capture that solar simply isn't available at night
- Thus, there needs to be an explicit check that during peak demand after sunset can be served by non-solar resources
- Multiple ways to do this check, but we propose to retain consistency with local RA program

Peak Net Load Requirement

- Use NQC, but solar, wind, and QF capacity ability to meet peak net load requirement restricted to historical minimum values
- Local RA incorporates net peak load check, where CAISO[2]:
  - Uses the CEC managed peak demand in the CEDU 2020-2030 Baseline Forecast
  - Incorporates the Peak Shift so that the actual peak hour is later in the day
  - Caps the capacity value of variable energy resources cannot exceed historical/projected output values at time of managed shifted peak load ($\min(NQC, Output_{shifted\ peak})$)
    - CEC provided solar output shapes for managed peak hour (ISO creates if CEC does not provide shapes)
    - Wind and QF capacity are also limit based on similar assumptions used in Transmission Planning Process

1 http://www.caiso.com/InitiativeDocuments/Presentation-2022FlexibleCapacityNeedsAssessment-Jan272021.pdf
2 http://www.caiso.com/InitiativeDocuments/Presentation-2023LocalCapacityTechnicalStudyCriteriaMethodologyandAssumptions.pdf

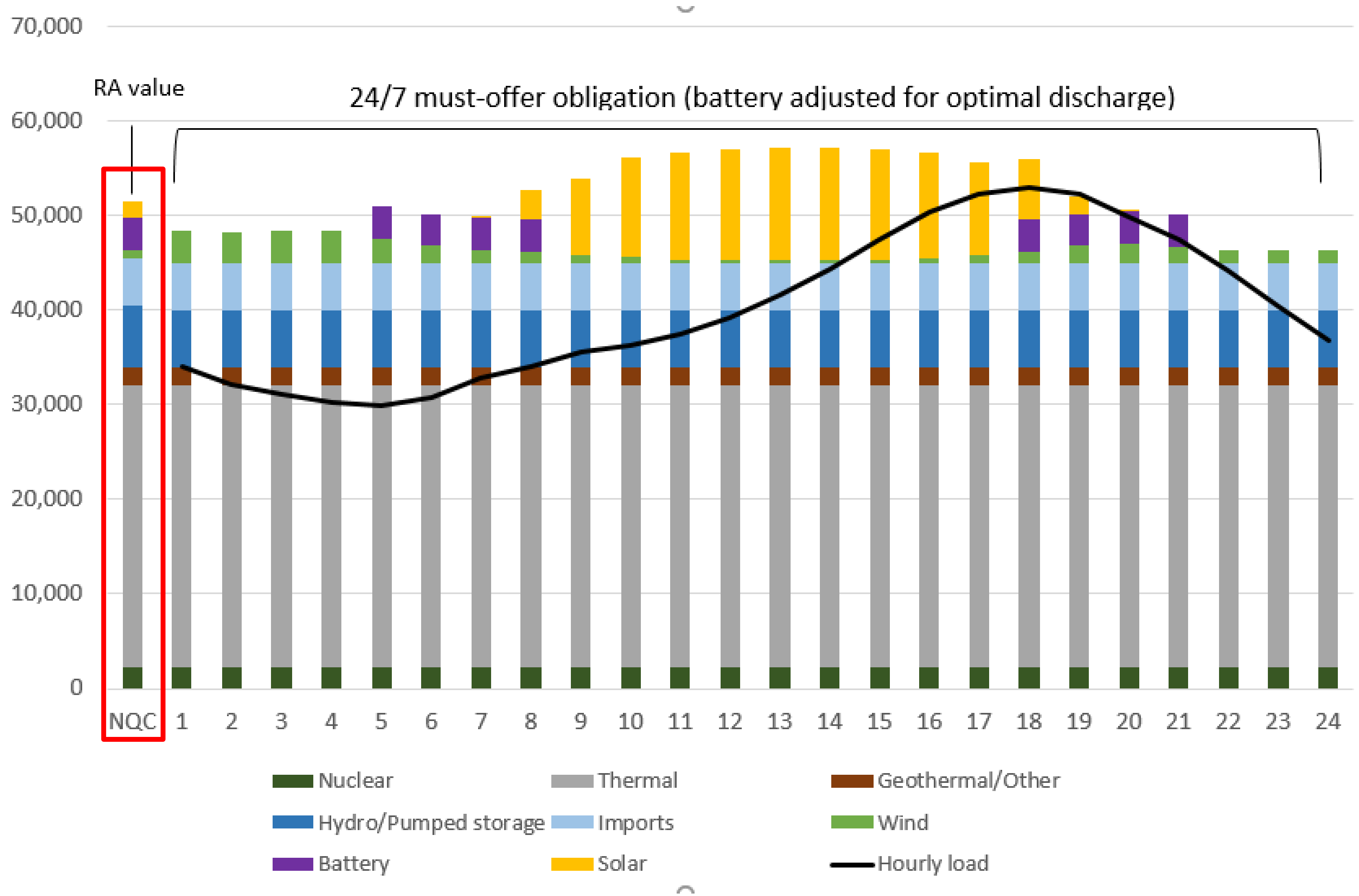
Deficiency Determination

Peak net load deficiency

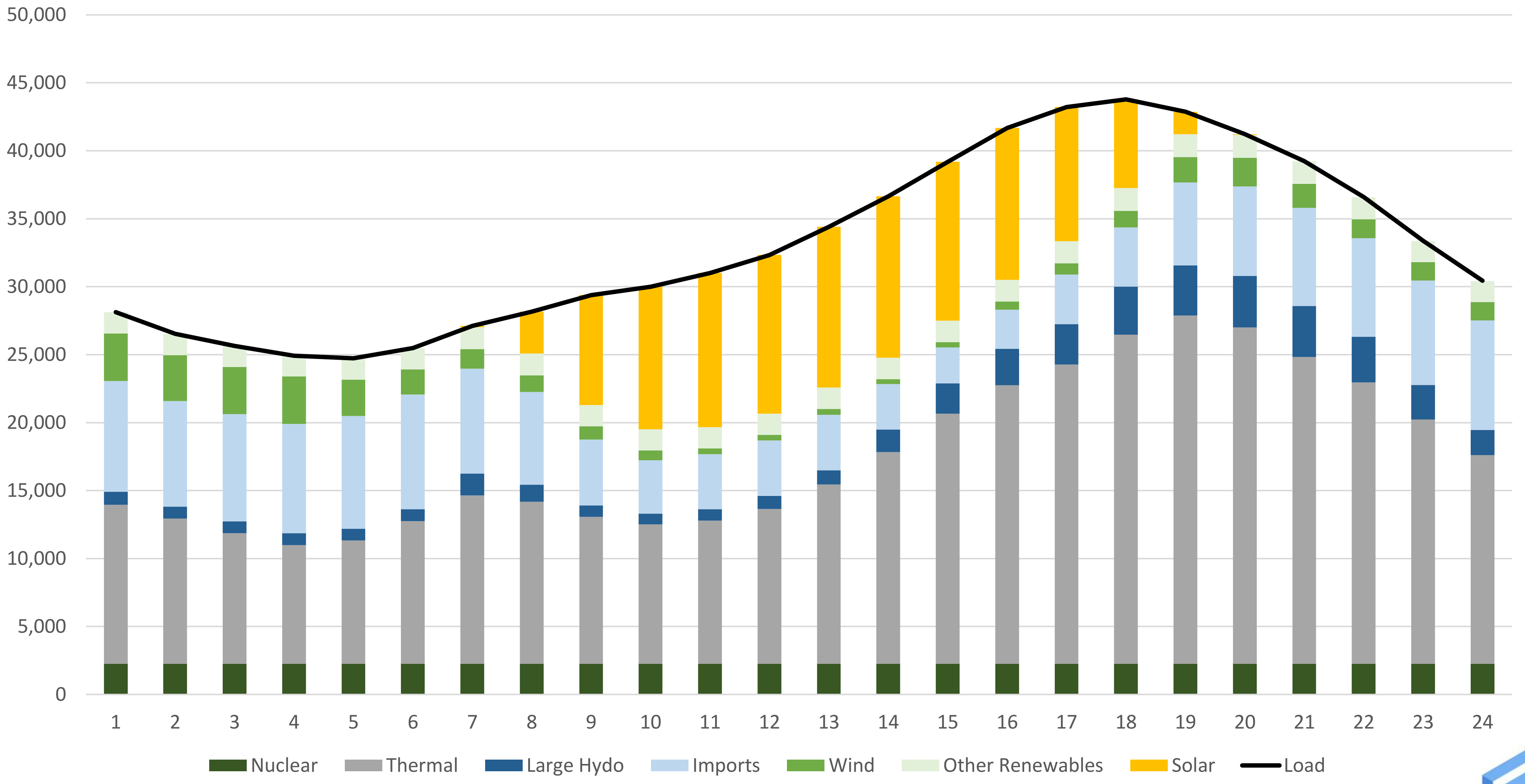
- CPUC/CAISO should first determine if there is a deficiency in slice 2 net peak slice in aggregate
- If there is an aggregate net peak slice deficiency,
  - Each LSE RA portfolio is validated against the LSE's coincident net peak load
  - Allocated to short LSEs based on percent short compared to total shortfall
- Timelines:
  - Annual Showings: LSEs have a 43-day after last business day in Oct opportunity to cure for annual showings (same as today in Annual CSP timeline)
  - Monthly Showings: LSEs have T-30 day before first day of RA month to cure for monthly showings (same as today in monthly CSP timeline)
- Any remaining deficiency is considered a system RA shortfall under existing rules

Appendix

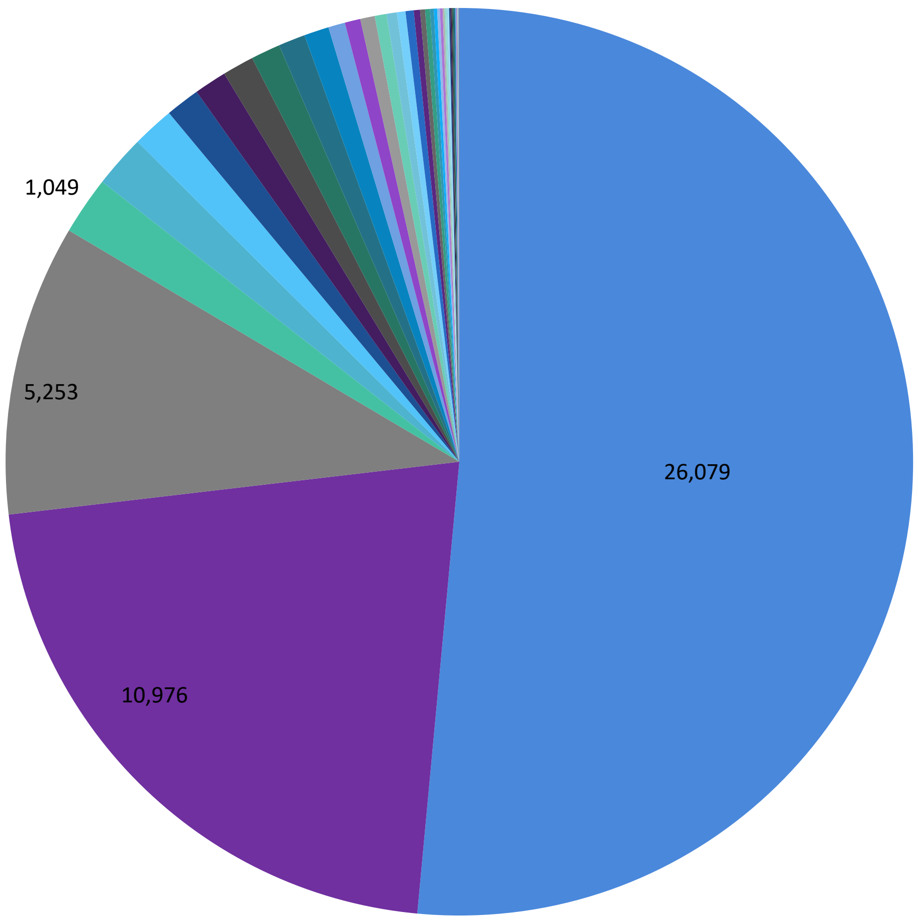
Capacity – Example September Capacity and MOO



Energy – September 2021 peak day energy profile



LSE peak load (from 2018 – even more CCAs now)



- Need a system framework that works with all load-serving entities
- Over 20 LSEs have less than 50 MW of peak load
- All LSEs except three, have less than 2,000 MW of peak load, including all CCAs

Need determination and related rules should address following current RA challenges

Challenge	Solution
RA construct does not accurately capture value of use-limited resources in either reserve margin or counting rules	Tying resource capacity value to its ability to show up when needed and carry load through risks of loss of load improves reliability and reduces uncertainties in PRM
RA construct is not maintaining 1 in 10 planning standard such that CA is operating at lower reliability threshold than majority of US	Setting probabilistically determined PRM through LOLE study set to 1:10 standard that is updated regularly as system conditions change better supports reliability
Inconsistency across CPUC and CAISO RA programs (CPUC IRP, CPUC RA, CAISO RA, CAISO CPM)	Seeking consistency across rules will reduce regulatory uncertainty, complexity and administrative costs leading to more cost-effective and reliable outcomes
RA contracts are bundled across system, local, and flex if applicable	Recognizing any rule changes to valuing resource capacity value for system needs must apply to local needs and inform flex needs to result in rational outcomes

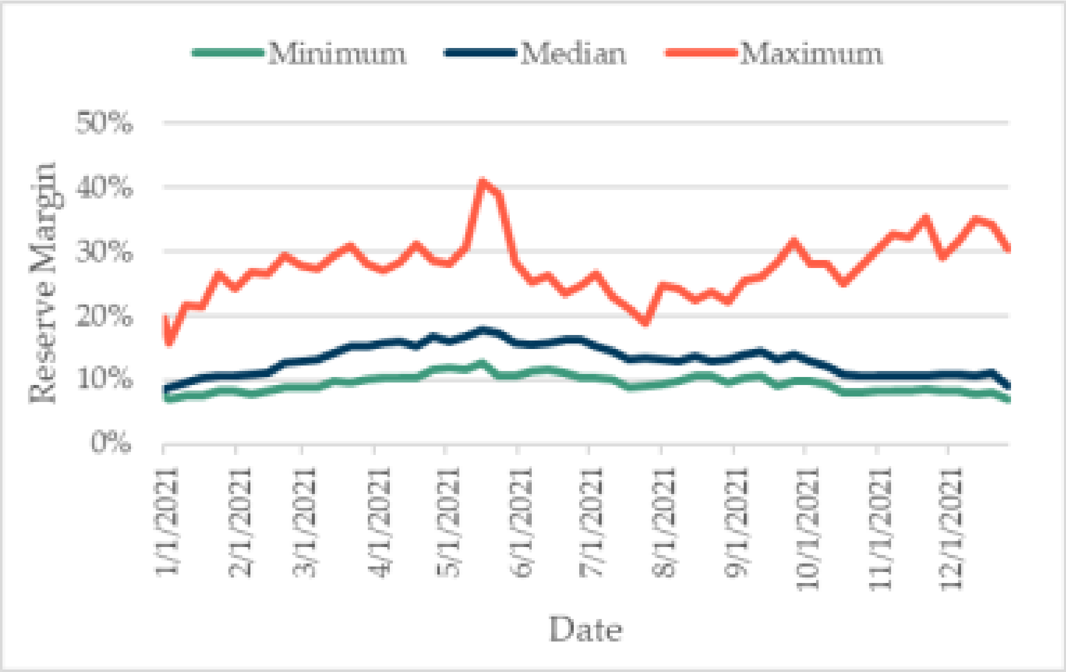
WECC Assessment RA Spotlight: CA & Mexico

- To account for increased variability challenges a probabilistic approach to LOLE is needed
- WECC provided analysis showing that planning reserve margins need to account for the demand and resource availability variations to better meet 1 in 10 standard
- WECC found annual PRM of 15% is enough to maintain median 1 in 10 threshold, however in May and June a PRM closer to 40% may be needed to maintain 1 in 10 during the month

WECC Assessment RA Spotlight: CA & Mexico

- WECC calculated PRM for every hour of the 2021 needed to meet 1 in 10 threshold
  - “The planning reserve margin in 2021 ranges from 7% to 41% with the lowest value occurring in January and the highest value occurring in May.”
  - “There are 3,624 hours in which the planning reserve margin is at or above 15%.”
  - “This means, if a flat 15% reserve margin were applied to all hours of the year, over 40% of the hours would not meet the ODITY threshold.”
- Similar statistics provided for demand variability and resource variability which scenarios can inform LOLE

Figure 11: Planning Reserve Margin Plot—Percent



Source: Western Assessment of Resource Adequacy Subregional Spotlight: California and Mexico (CAMX)
https://www.wecc.org/Administrative/Western%20Assessment_California%20and%20Mexico%20Report.pdf

CPUC Energy Division shows similar results that annual needs are generally reliable at just above the 1 in 10 threshold sufficient but specific months are meeting lower thresholds

- CPUC noted in its November 23, 2020 presentation that "the current Planning Reserve Margin has become increasingly divorced from a LOLE study framework"
- Current PRM calculated in 2004 with a very different mostly thermal electric fleet, which is more dispatchable and less complicated to plan for
- Energy Division staff performed LOLE modeling for 2022 study year to compare portfolio that meets 0.1 based on 2019 IEPR
  - Note, the NQC used based on most recent technology factors posted which may be over accounting VERs resulting in these results potentially leading to even higher modeled PRM to meet 1 in 10 if the ELCC are updated
- From results for the two peak months, Aug and Sep, average of 9.5% and 17.6% UCAP is a 13.5% PRM or average of 25.6% and 20% equals a 22.8% PRM in a ICAP calculation.

CAISO LOLE results for 2022 study year

LOLE (expected outage events/year)	0.12208
LOLH (hours/year)	0.18693
LOLH/LOLE (hours/event)	1.531242
EUE (MWh)	136.23
annual load (MWh) – CAISO total	245,818,857
normalized EUE (%)	0.00005542%
Non-spin loss of Reserve Energy (MWh)	47,137.4
Spin loss of Reserve Energy (MWh)	0.0
Spinning Reserves Shortage (Hours)	0.0001
Normalized Non-spin loss of reserve energy (%)	0.01918%

Month	LOLE
1	0
2	0
3	0
4	0
5	0
6	0
7	0.035828
8	0.084415
9	0.001835
10	0
11	0
12	0

Source: Track 3.B Workshops: Day 2, https://www.cpuc.ca.gov/-/media/cpuc-website/files/uploadedfiles/cpuc_public_website/content/utilities_and_industries/energy/energy_programs/electric_power_procurement_and_generation/procurement_and_ra/ra/track-3b-day-2-presentation.pdf