Slice of Day – Loss of Load Studies and Translation for RA proceeding

August 17, 2022

Energy Division and Astrapé Consulting

California Public Utilities Commission

Questions

- We invite clarifying questions at regular intervals throughout this presentation
- All attendees have been muted. **To ask questions**:
  - In Teams:
    - Please "raise your hand"
    - Host will call on you, and you can unmute.
    - Please "lower your hand" and mute yourself afterwards
  - For those with phone access only:
    - Dial *3 to "raise your hand". Once you have raised your hand, you'll hear the prompt, "You have raised your hand to ask a question. Please wait to speak until the host calls on you"
    - Teams host will unmute your microphone and you can proceed to ask your question
    - Dial *3 to "lower your hand"
- If you are not able to use audio to ask a question, you may type into the "Q&A" feature of this Teams presentation, though priority will be given to stakeholders who have "raised their hand" and use audio
- Should time not permit attention to every question, or if you would like to ask questions or comment informally, please email Energy Division staff.

Overview and Summary of presentation

- Summary of presentation: Staff are presenting work performed earlier in the IRP and RA proceedings, potential work for setting reliability targets in the Slice of Day (SOD) construct, and seeking to highlight some potential difficulties in translating earlier reliability studies into a SOD framework.

- Objective of presentation: Staff are seeking a conversation around clearly demonstrating the link between RA requirements in the SOD structure and overall IRP Reliability Need (TRN) expressed through a combination of LOLE studies with ELCC accreditation

Agenda/overview of presentation

Topic	Timing	Presenter
Introduction & context	5 min	Donald Brooks
Background on completed studies	10 min	Donald Brooks
Possible LOLE study for RA SOD structure • Objectives and possible timeline • Differences in approach with IRP study	10 min	Donald Brooks
Translation of LOLE results to Slide of Day framework • Approach • Numerical Example of SOD stack using NRDC tool • *Questions*	10 min	Kevin Carden
Challenges to translation – how to communicate • Managed demand versus gross demand – translation using SERMV outputs • Quantification of capacity credit	15 min	Donald Brooks Kevin Carden
Questions/Next steps	5 min	Donald Brooks Kevin Carden

Intro and Context – Background on completed studies

Donald Brooks
Energy Division

RA Decision (D).22-06-050 - PRM/LOLE

- Implementation Track:
  - "A minimum 17 percent planning reserve margin (PRM) is adopted for the 2024 Resource Adequacy year. The PRM for the 2024 RA year may be further revised in a June 2023 decision after a review of Energy Division's updates to the loss of load expectation modeling by stakeholders and the Commission."
- RA Reform Track:
  - "[C]onverting the results of the LOLE study to the counting rules applicable to the 24-hour framework should await the refreshed LOLE outputs from the IRP proceeding. Once refreshed LOLE outputs are available, conversion of the outputs to the 24-hour framework counting rules need to be completed, and NRDC's "proof of concept" template should be leveraged for the conversion."
  - Workstream 2 - (e). Appropriate PRM with single PRM initially for all months and hours informed by LOLE study, including NRDC's calibration tool.
  - LSEs must demonstrate sufficient capacity to meet their load requirements plus a PRM percentage in each hour ("Load+PRM").

D.22-06-050 Load Forecast

- "The California Energy Commission's (CEC) load forecast proposal shall be utilized for individual load-serving entities' hourly load forecasts in the 24-hour framework"
- The CEC load forecast process-
  - Similar to the current RA load forecast process- bottoms-up approach applied to the worst-day forecast
  - LSEs submit hourly load forecast associated with monthly worst day load (12 X 24)
  - Load forecast adjustment process similar to how it is done today (aggregate load forecasts benchmarked to be within 1% of IEPR)

Summary of 2022 IRP Approach

- **Reliability Modeling Approach**
  - Use the CPUC's SERVM model, with any appropriate updates, as the basis for need determination and resource accreditation
- **Need Determination**
  - Calculate total system need via a perfect capacity (PCAP) based total reliability need MW (TRN), then translate into a PCAP planning reserve margin (PRM) above median gross peak
  - A PCAP-based approach means removing from the reserve margin an allowance for forced outages of firm resources, and accrediting all resource types at their respective ELCC i.e., their perfect capacity equivalent, based on simulations that consider their risk of outages, resource availability, and their interaction with load and other resource types
  - Calculate marginal reliability need (MRN) relative to total reliability need (TRN) using a marginal ELCC study
  - Base LSE-specific need on share of marginal reliability need using new multi-year CEC LSE-specific managed peak share forecast
- **LSE Plan Resource Accreditation**
  - All resources will use marginal ELCCs
- **RESOLVE Updates**
  - Align PRM and ELCCs with LSE plan inputs (i.e. use same PCAP PRM and ELCCs from same SERVM model)
  - Change solar + wind ELCC surface to a solar + storage ELCC surface, include demand response (DR) on the storage dimension
  - Develop separate wind ELCC curves
  - All other resources will also use ELCC (firm resources, hydro, etc.)

Other Uses of the LOLE framework

Energy Division is using the LOLE reliability modeling framework in a variety of Commission proceedings in addition to IRP.

- Energy Division completed LOLE and ELCC studies in 2022 for the Resource Adequacy (RA) proceeding to inform the determination of wind, solar and storage resource ELCCs as well as the PRM for the 2023 and 2024 RA compliance years.
- Energy Division is using the LOLE framework with the "NoNewDER" portfolio for the Avoided Cost Calculator in the Integrated Demand Energy Resource proceeding to establish avoided costs.

These diverse applications of LOLE modeling all rely on the same IRP baseline dataset.

- Baseline dataset includes electric demand, baseline resources, generation profiles for non-firm resources, fuel prices, etc.
- Maintaining consistency and stability in datasets is critical for enabling modeling work across these proceedings to be relatable and consistent with each other.
- Modeling data is posted to the CPUC website (Unified RA+IRP Dataset page) for parties to review and comment
- Parties can provide feedback on methods and data either in the IRP proceeding during the regular IRP Inputs/Assumptions development process or in this RA proceeding as we develop our current study.

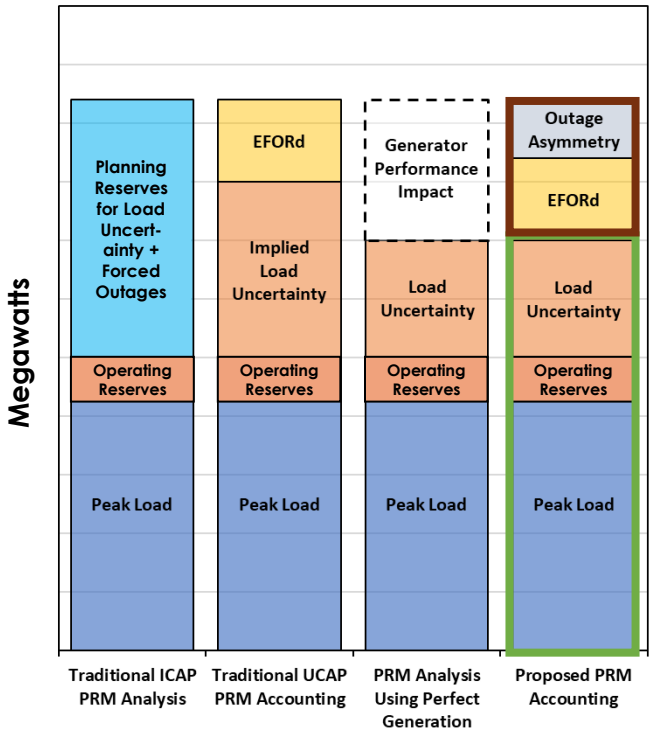
Types of PRMs

- **Installed Capacity (ICAP) PRM**
  - Measures resource MW using their installed capacity, accounting for forced outages in the reserve margin
- **Unforced Capacity (UCAP) PRM**
  - Measures resource MW using their unforced (i.e. outage de-rated) capacity, accounting for forced outages in resource accreditation
- **Perfect Capacity (PCAP) PRM – *for use in 2022 IRP LSE Plans***
  - Measures all resource MW using their perfect capacity equivalent (i.e. ELCC) capacity, accounting for forced outages and additional portfolio effects in resource accreditation

	Firm Resources	Non-firm Resources	Contributing Factors	Pros	Cons
ICAP	**Installed** capacity MW	ELCC MW	• Load/weather variability • Operating reserves • Forced outages	• Simpler firm resource accreditation	• "Tips the scales" in favor of firm resources
UCAP	**Unforced** capacity MW	ELCC MW	• Load/weather variability • Operating reserves	• Level playing field • Reliability need not impact by portfolio changes (retirements, etc.)	• UCAP may not reflect ELCC
PCAP	**ELCC** MW	ELCC MW	• Load/weather variability • Operating reserves		• More LOLP runs required

UCAP versus ICAP accounting - differences

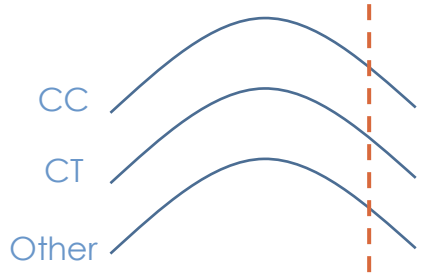
- UCAP accounting requires forced outage de-rate factors for each firm resource or resource class
  - E.g. UCAP = nameplate MW x (1 – EFORd %)*
  - UCAP PRM adjusted to remove forced outage impacts
  - However, EFORd changes as the firm fleet operations change, which would change the UCAP PRM as the resource mix changes
  - Secondly, EFORd is not the only component of a derate – also ambient conditions derate performance
- Perfect capacity (PCAP) accounting utilizes *effective capacity* (i.e. perfect capacity equivalent = ELCC) accreditation for all resources, based on:
  A. Their modeled performance (ideally inclusive of both EFORd and ambient derates)
  B. Interactive effects with other resources
- Firm generators can be accredited at their ELCC, providing consistency between firm and non-firm accreditation methods



Outages + interactive effects captured in **firm resource accreditation**

PCAP PRM based only on operating reserves + load uncertainty

Outage Probability Distributions (illustrative)



Simultaneous outages of generators 1+2+3 has asymmetric impact on reliability

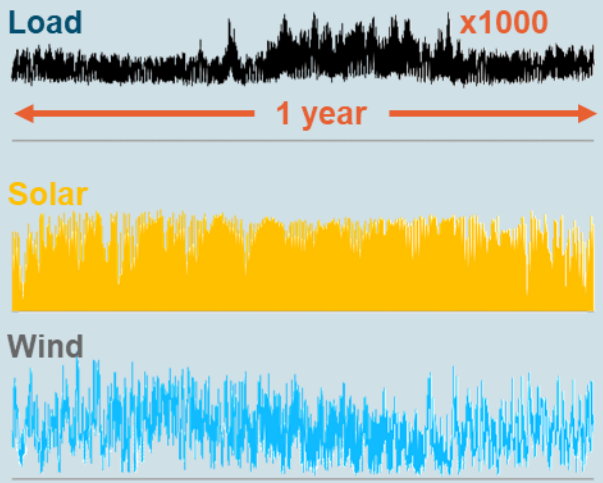
* Equivalent Forced Outage Rate demand (EFORd) is a SERVM output characterizing class average forced outage rates using generator performance data

Key Steps for Reliability Planning using LOLE Modeling

Step 1: Model + Data Development

Develop a robust dataset of the loads and resources in a loss of load probability (LOLP) model

LOLP modeling evaluates resource adequacy across all hours of the year under a broad range of weather conditions

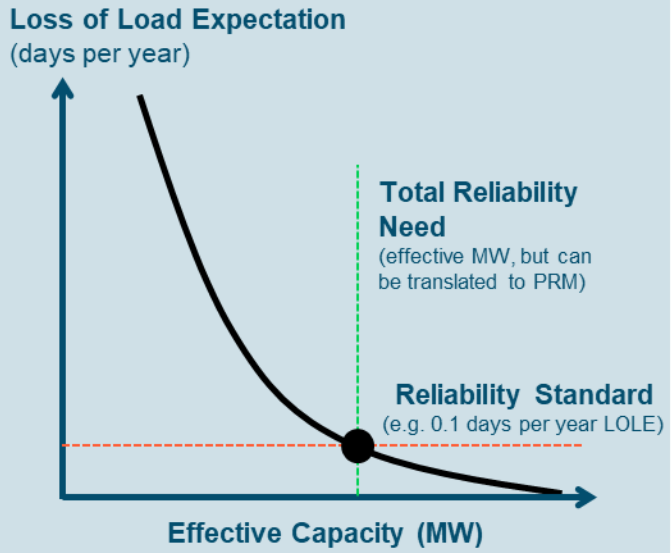


Robust probabilistic models + datasets are the foundation of any resource adequacy analysis

Step 2: Need Determination

Identify the Total Reliability Need to achieve the desired level of reliability

Factors that impact the amount of effective capacity needed include load & weather variability, operating reserve needs

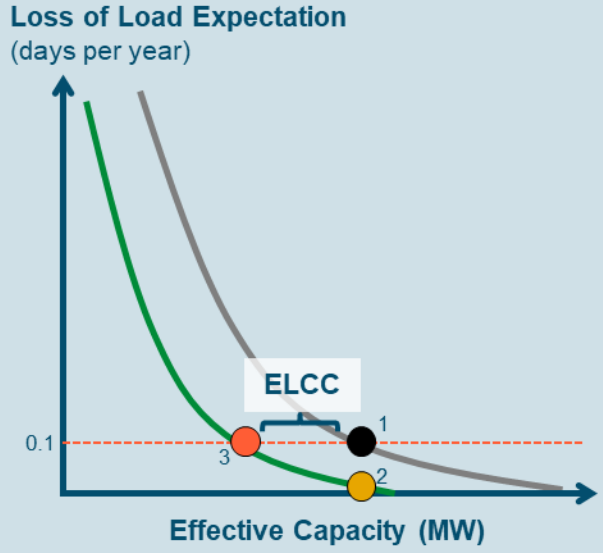


LOLP modeling provides Total Reliability Need in effective capacity MW to meet <0.1 days/yr LOLE, can be converted to a PRM

Step 3: Resource Accreditation

Calculate resource capacity contributions using effective load carrying capability

ELCC measures a resource's contribution to reliability needs relative to perfect capacity, accounting for performance across all hours



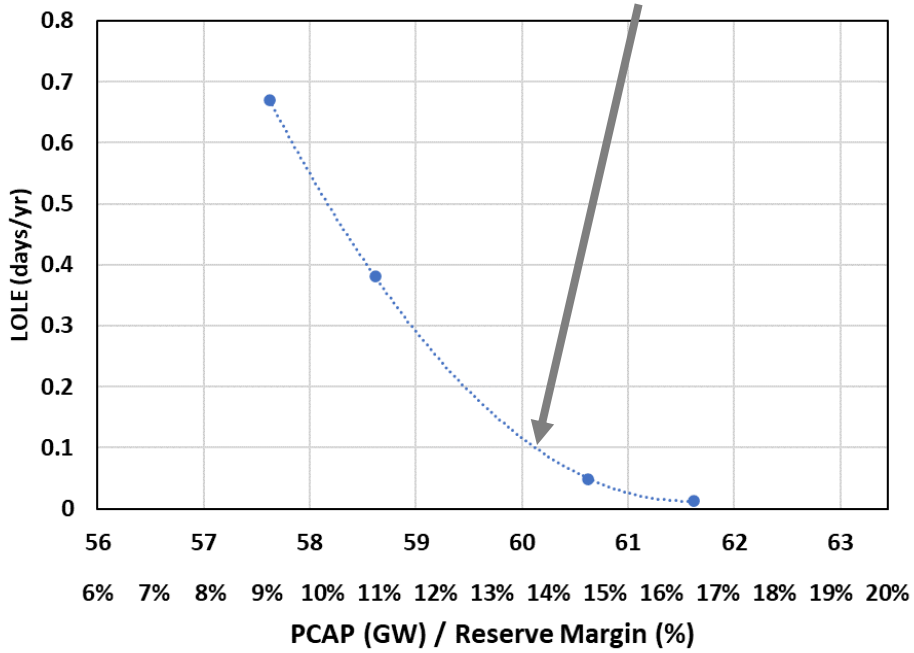
Effective or "perfect" capacity based accounting (UCAP or ELCC) counts all resources on a level playing field against that total reliability need

PCAP PRM Results

- A Perfect Capacity (PCAP) PRM analysis varies PCAP MW until 0.1 LOLE is achieved
- PCAP PRM is driven by
    A. Inter-annual load variability in historical weather dataset
    B. SERVM's load forecast error
    C. 6% operating reserves
- PCAP PRM was calculated for 2024, 2026, 2030, and 2035
- PRM is measured relative to median gross peak (i.e. BTM PV counted as a supply-side resource at ELCC)
- The PRM is NOT affected by resource portfolio, as all resources are compared in ELCC reliability contributions. If resources are accredited correctly, equal quantities are needed relative to electric demand.

SERVM's CAISO PCAP PRM Simulations (2024)

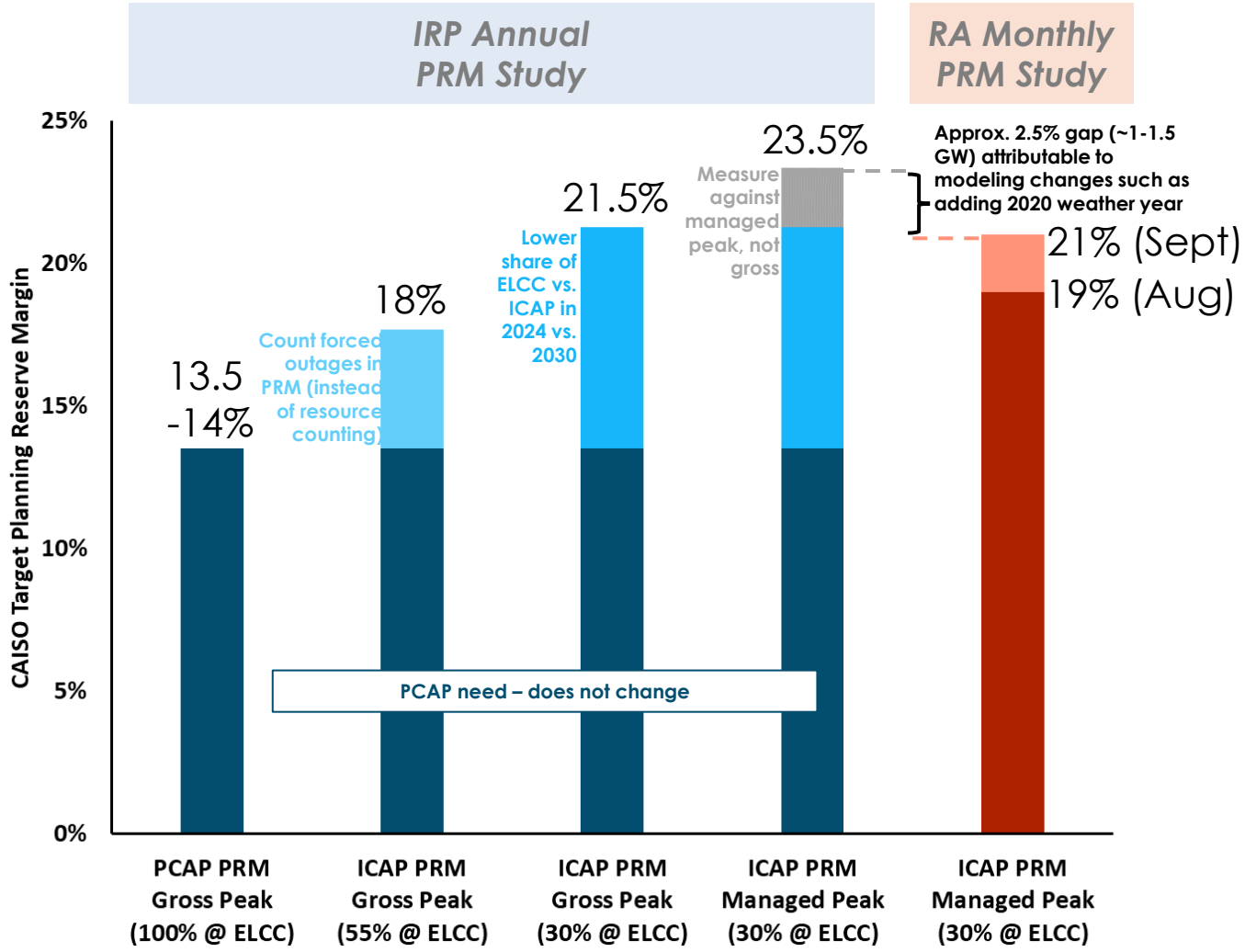
*LOLP simulations indicate an **13.8%** reserve margin needed to meet 0.1 days/year LOLE*



- *PCAP PRM simulations for years 2024, 2026, 2030 and 2035 ranged between ~13.5-14.0%*
- *Equivalent 2030 ICAP PRM over gross peak is ~18-21.5%, depending on the share of resources counted at ELCC vs. installed capacity*
- *All PRMs calculated relative to CAISO median gross peak*

Comparing PRM Results to Recent RA Study

- Energy Division's February 2022 LOLE and ELCC Study[1] for the RA proceeding calculated monthly ICAP and UCAP PRMs above the CAISO managed peak
  - 2024 Jul-Sep ICAP PRM = 19-21% over CAISO managed peak
- This IRP study calculated an annual PCAP PRM above the CAISO gross peak using an updated SERVM model including recent extreme weather conditions in August 2020
  - 13.5-14% PCAP PRM over CAISO gross peak (2024-2035)
  - ~18% *ICAP PRM* over CAISO gross peak (2030 portfolio level of ELCC vs. ICAP)
  - ~21.5% ICAP PRM over CAISO gross peak (*2024 portfolio* level of ELCC vs. ICAP)
  - ~19.5-23.5% ICAP PRM over CAISO *managed peak*
    - Calculated by removing the IEPR peak shift from both the need and the gross peak
  - (Refer to the Appendix for methodology to compare PCAP PRM to ICAP PRM)
- Since the RA study, this IRP study found up to an extra ~2.5% ICAP PRM (or approximately 1-1.5 GW) required over CAISO managed peak to address extreme weather in 2020 captured by adding weather years through 2020 to the model (and other less significant updates)

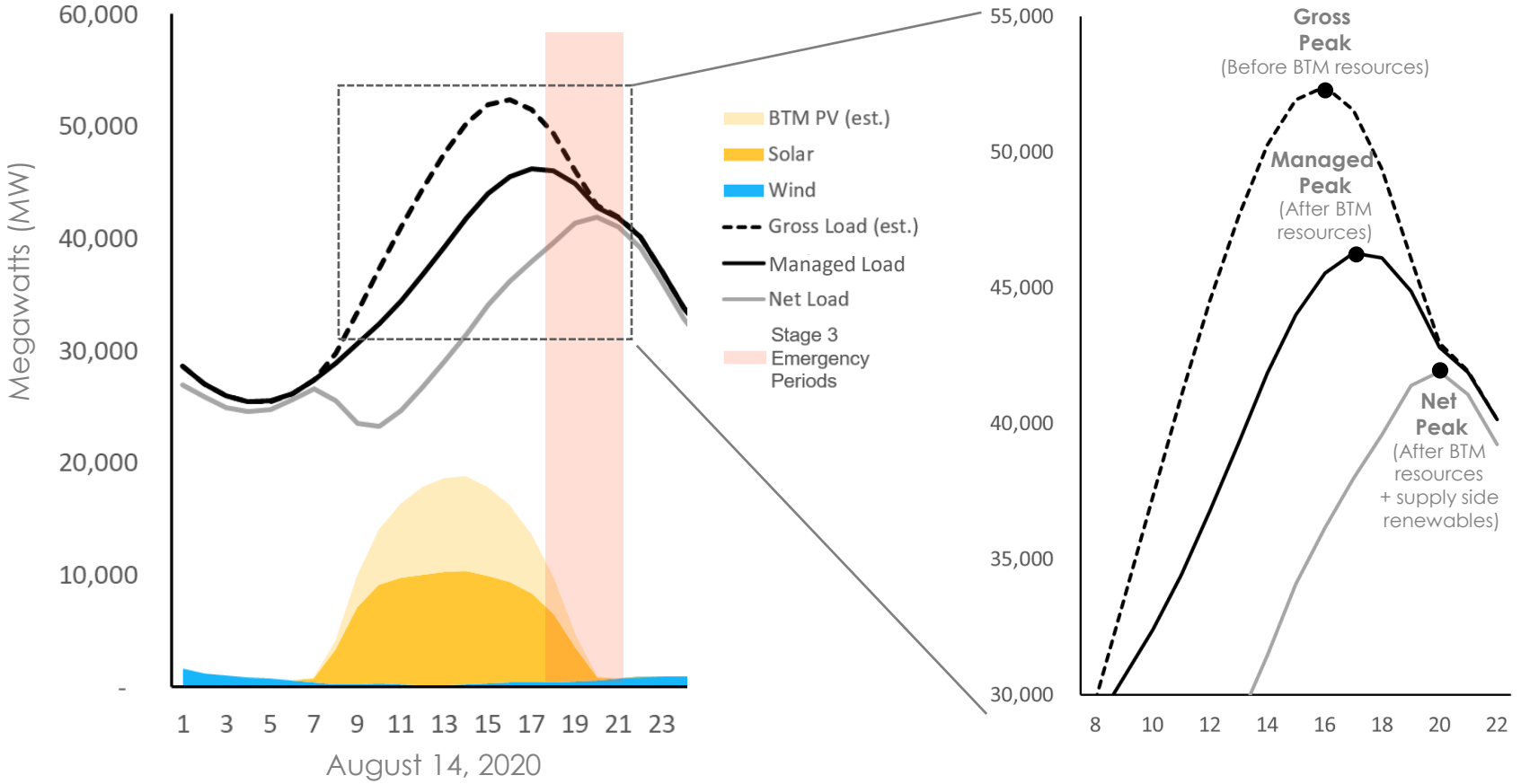


1. Available at: https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M452/K750/452750851.PDF

RA requirements are based on a "Managed Peak" Basis

PRM % over Managed Peak changes as BTM resources change

Total Reliability Need MW to meet 0.1 LOLE does not change depending on the load determinant
…but if measured against a lower load, the required PRM % will increase



Gross Peak + 15% = 7.9 GW reserve margin

Managed Peak + 15% = 6.9 GW reserve margin

To reach the same 7.9 GW reserves, a 17% PRM is required over managed peak

Defining PRM relative to gross/consumption peak avoids this issue
BTM PV treated as a resource via ELCC (per current IRP methods) and its growth does not change the PRM % required

Conclusions from this PRM Study

- A 14% PCAP PRM over gross peak was found sufficient to meet 0.1 LOLE across multiple years
  - Corresponds to an ICAP PRM of 18 to 21.5% above gross peak or 19.5 to 23.5% above managed peak, depending on the CAISO system's proportion of resources counted at ICAP vs. counted with ELCC
  - All resources will be accredited at their PCAP equivalent MW (i.e. ELCC)
    - Corresponding ELCC values will be released in July 2022
- This PRM study incorporated recent extreme weather from 2020 into SERVM's weather year dataset
  - This increased the total reliability need by about 1 to 1.5 GW relative to the RA proceeding study reported in February 2022
- RESOLVE portfolios from the updated PSP modeling were found to be more reliable relative to 0.1 LOLE
  - Planned updates as part of this cycle's I&A to RESOLVE's PRM and resource ELCCs are expected to better align RESOLVE inputs with SERVM LOLP modeling fundamentals

Possible LOLE study for RA SOD Construct

Donald Brooks
Energy Division

Plans for LOLE study to support SOD implementation

- Staff will be continuing to perform LOLE reliability studies through the fall of 2022 to support IRP processes, including provision of reliable portfolios to the TPP process.
- Staff also intend to perform further updates to the dataset.
  - Update to latest IEPR including High Electric Vehicles scenario
  - Update Baseline resources to include those that came online or began development since previous reconciliation and posting in late 2021
  - Further evaluation of wind, solar and hydro generation shapes

LOLE study of 2024 compliance year

- Staff propose to INCLUDE "Baseline" resources online and about to come online., and EXCLUDE:
  - Projects not approved or planned development not contracted (in short, the "review" or "planned_new" resources from LSE IRP plans)
  - Capacity added by RESOLVE in capacity expansion
- Staff will calibrate reliability to 0.1 LOLE by adding Perfect Capacity, not generic RESOLVE capacity, and will report the quantity added.
- This is in reverse of what was performed for IRP and for previous RA studies in 2022, where all planned/RESOLVE capacity was included, and 0.1 LOLE was calibrated by removing excess aging thermal capacity.

Methodology Differences since IRP modeling

LOLE study of 2024 compliance year

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Calculation of PRM for SOD construct from LOLE study Demonstration and example

Simone Brant
Energy Division

ED Calibration Exercise

- SERVM portfolio of resources for 2024
  - Includes RESOLVE additions and removal of most CHP, CTs
- Used 70% Exceedance Profiles for solar and wind at peak hour of each month from IEPR 2024 load forecast
- For simplicity hybrids and co-located resources treated as stand-alone
- 2022 QC values applied to all other resources except 2023 LIP values for DR
- Assumed 4,000 MW imports plus Hoover and Palo Verde
  - Unspecified imports removed November-April to make more realistic

Resource Totals

Resource Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Thermal	23,193	23,197	23,182	23,147	23,129	23,017	22,979	22,975	23,030	23,139	23,223	23,237
CHP	1,221	1,197	1,199	1,172	1,183	1,212	1,199	1,193	1,171	1,184	1,209	1,224
Nuclear	2,915	2,915	2,915	2,915	2,915	2,915	2,915	2,915	2,915	2,915	2,915	2,915
Biomass/gas	600	599	584	562	576	597	601	604	604	577	570	586
Hydro	5,881	5,753	5,926	6,435	6,587	7,030	7,627	7,329	6,567	5,775	5,563	5,794
Geothermal	1,180	1,180	1,176	1,167	1,168	1,165	1,168	1,169	1,170	1,172	1,180	1,181
DR	975	1,026	991	1,119	1,168	1,295	1,351	1,392	1,405	1,215	1,105	975
Imports	-	-	-	-	4,000	4,000	4,000	4,000	4,000	4,000	-	-
Solar	-	-	0	43	2,898	4,452	7,251	6,037	451	3	-	-
Wind	0	29	133	1,396	1,862	2,156	1,592	1,324	503	16	-	0
Storage	3,478	3,478	3,493	3,532	3,532	3,532	3,532	3,532	3,532	3,532	3,532	3,530
Total	**39,442**	**39,375**	**39,599**	**41,488**	**49,017**	**51,370**	**54,213**	**52,469**	**45,348**	**43,527**	**39,297**	**39,442**

Equivalent PRM

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Calibrated MW	39,442	39,375	39,599	41,488	49,017	51,370	54,213	52,469	45,348	43,527	39,297	39,442
2024 IEPR Peaks	32,538	31,478	30,307	33,366	37,517	42,707	45,908	46,500	47,325	38,861	32,411	33,895
PRM	21%	25%	31%	24%	31%	20%	18%	13%	-4%	12%	21%	16%
RA LOLE Study	33,364	31,957	31,341	32,502	35,180	44,089	47,253	46,380	43,152	36,452	33,359	34,018
PRM	18%	23%	26%	28%	39%	17%	15%	13%	5%	19%	18%	16%

Discussion

- Solar value at the September peak hour is very low – 1-4%. Undervalues compared to ELCC
- Should we be using the annual peak to calibrate?
- SERVM values misaligned with IEPR – lower in September, higher in July

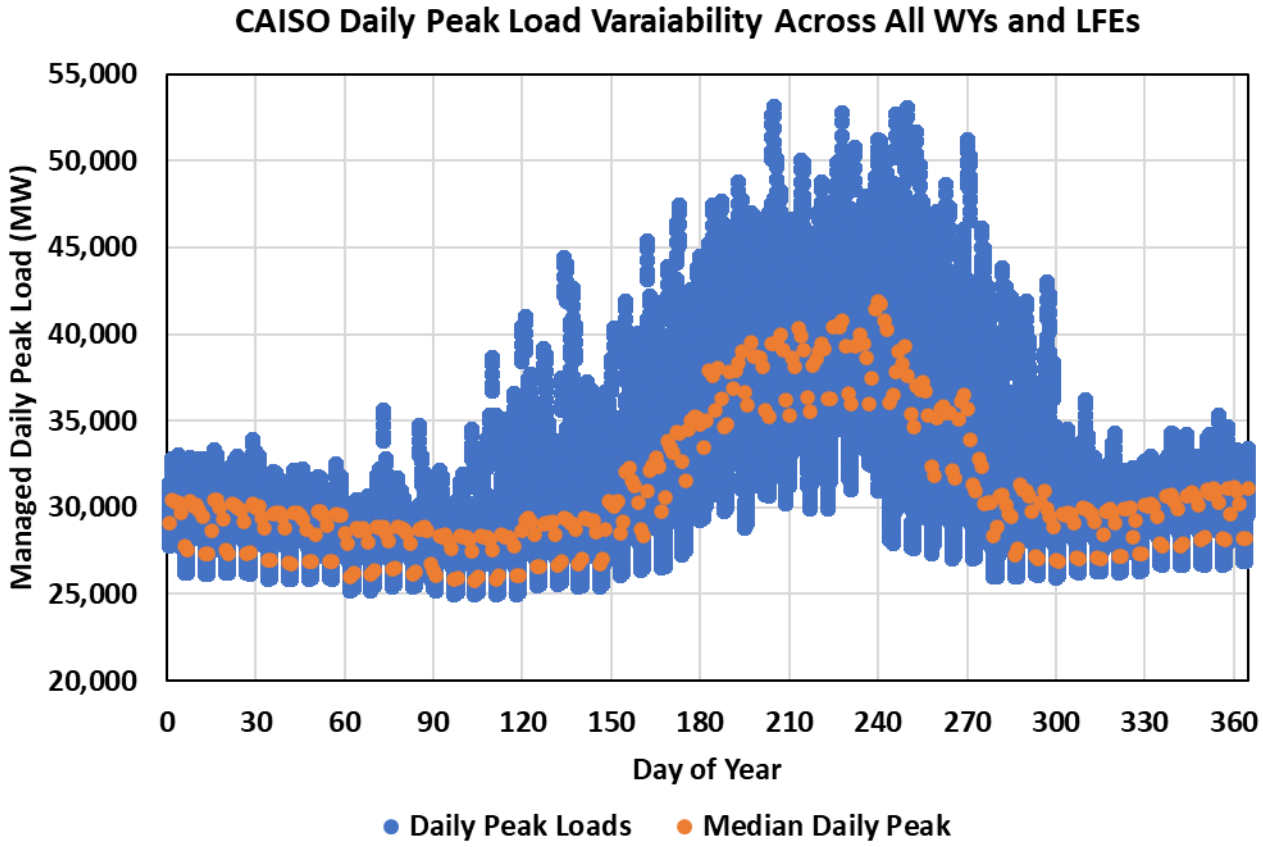
Challenges in translating LOLE results into SOD Construct

Kevin Carden

Astrape Consulting

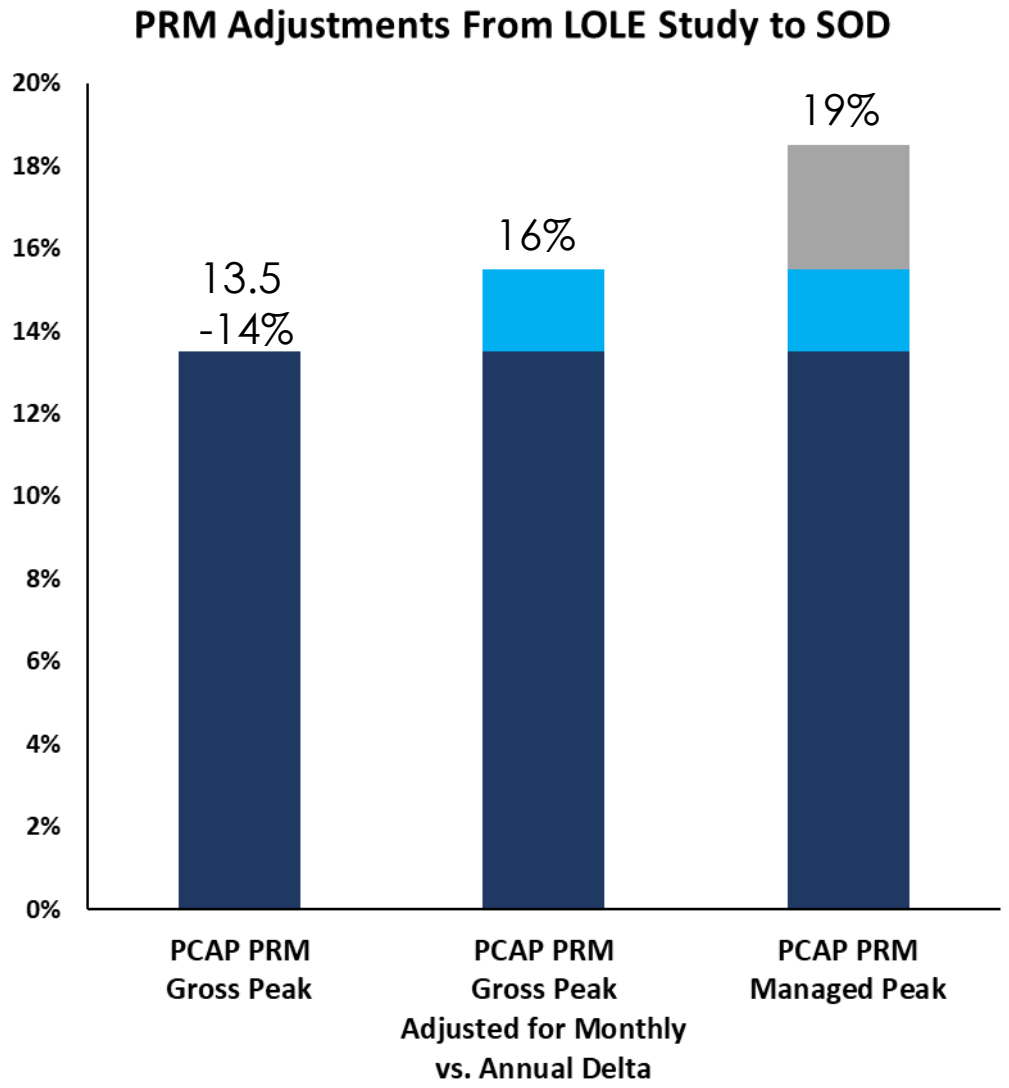
Challenges in translating LOLE results to SOD

- What load profile is appropriate to use to set obligation in the 12x24 SOD?
  - LOLE modeling utilizes 23 weather years (WY) and 5 load forecast error (LFE) multipliers



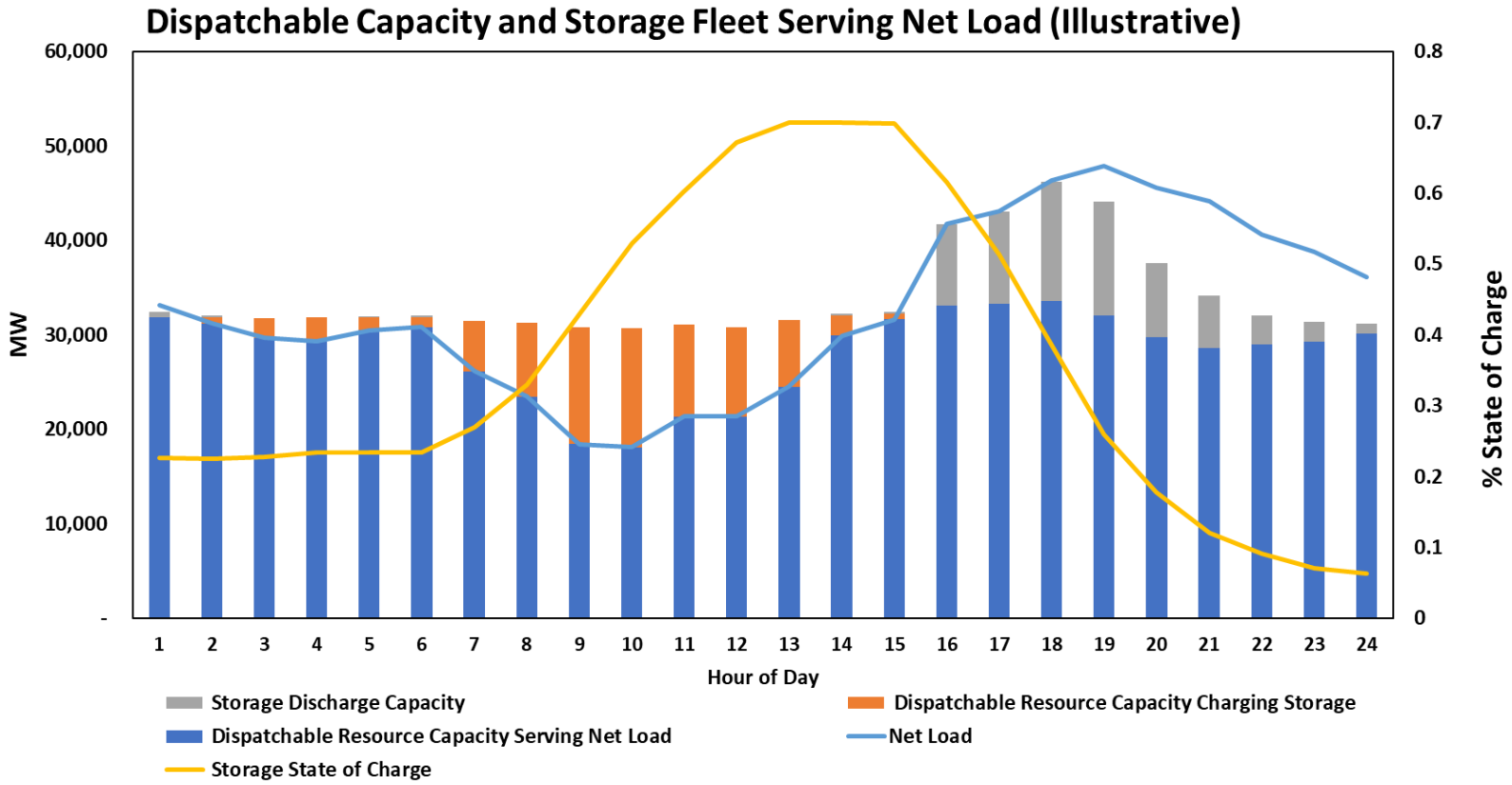
Challenges in translating LOLE results to SOD

- What is the appropriate PRM to apply to the 12x24 load profile?
  - LOLE modeling produced a PRM value which covers load variability and contingency reserves against an expected range of demand and supply variability.
  - Challenge #1: Disconnect between the distribution of weather years simulated for LOLE modeling and the single 12x24 constructed profile meant to represent the worst day. There is variability in which month the annual peak occurs across the weather years as well as which hour of the day it occurs.
  - Challenge #2: SOD is based on managed peak (net demand side resources), not gross consumption peak, meaning need to translate overall LOLE metrics to a managed peak framework, without confusing the effect of the demand side resources.



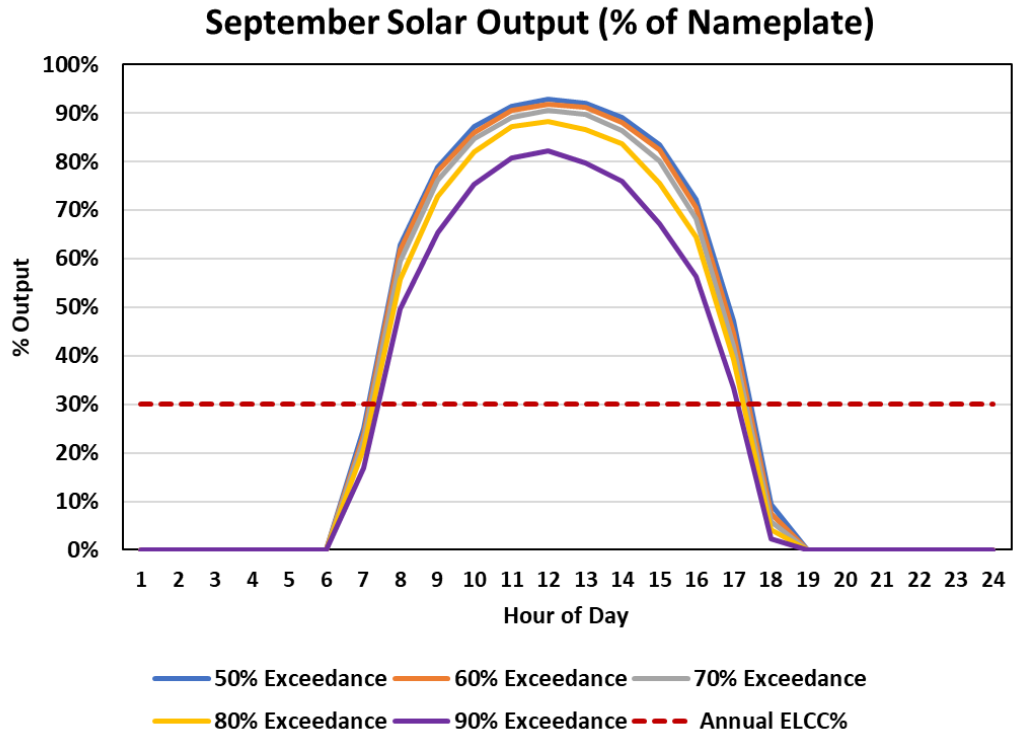
Challenges in Translating LOLE results to SOD

- How to appropriately accredit resources?
  - Several challenges in putting together a 12x24 storage profile related to:
    - Interaction with other energy limited resources (DR, PSH)
    - Assessing charging constraints, which is dependent on stochastic outages of thermal fleet and weather dependent solar profiles



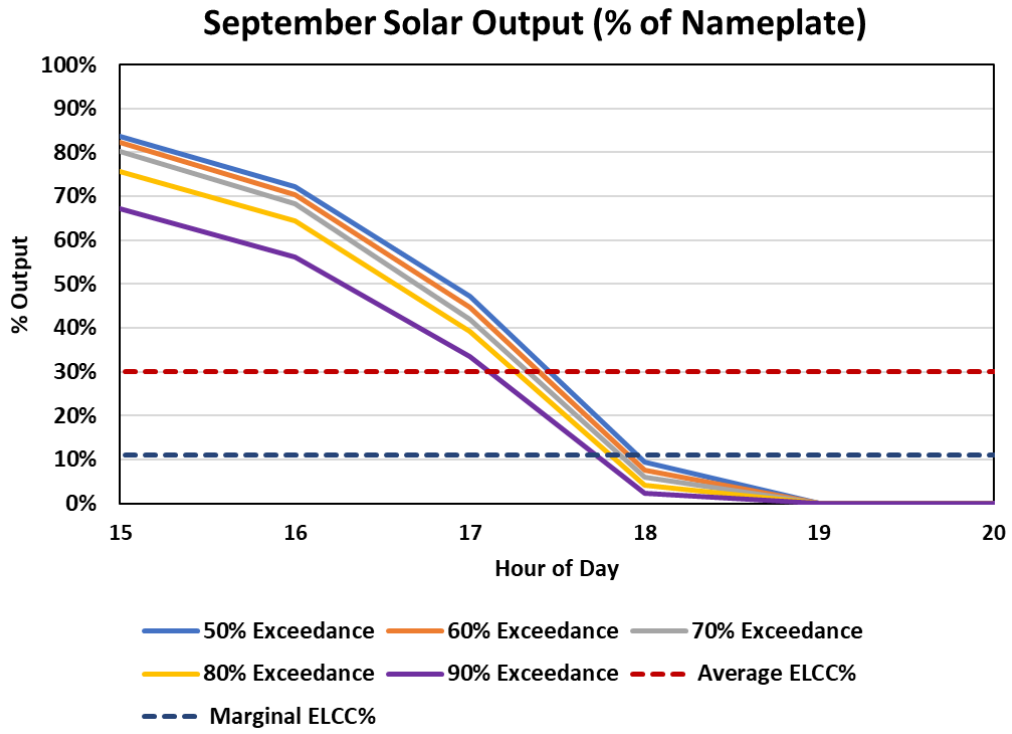
Challenges in translating LOLE results to SOD

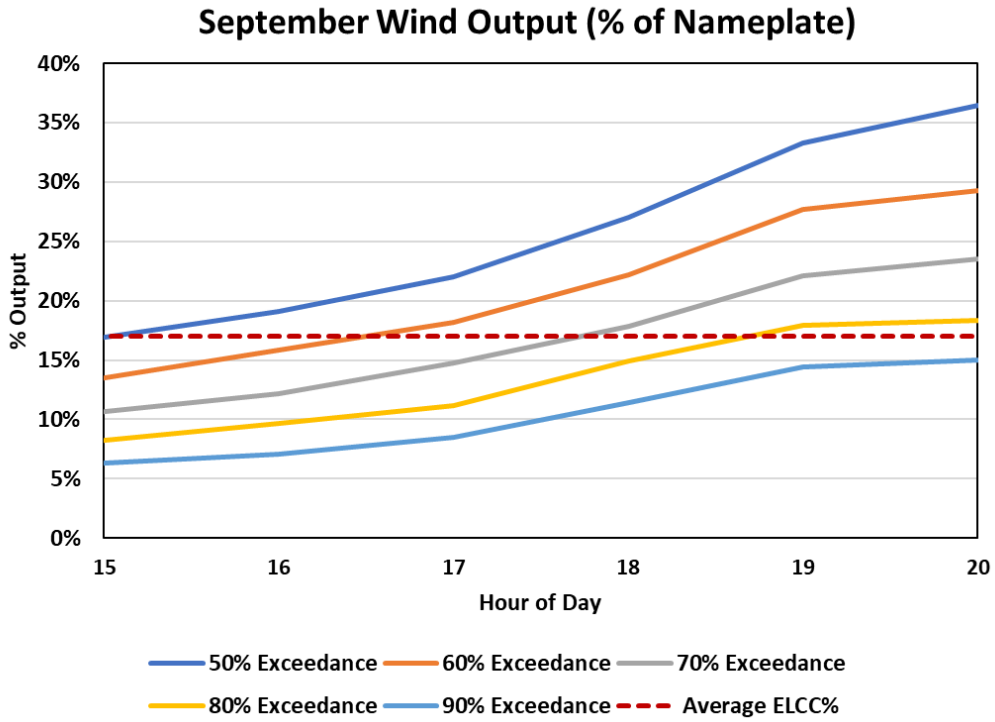
- How to appropriately accredit resources?
  - Firm resources can be accredited at their annual ELCC values or UCAP values in order to count towards the SOD requirements. 90% Firm ELCC (5% EFORd + fleet outage asymmetry)
  - Non-firm resources challenge: output below 10% during managed net load peak period (HE18-20), but retains higher average ELCC due to synergies with storage and between non-firm resources



Challenges in translating LOLE results to SOD

- How to appropriately accredit resources?
  - Firm resources can be accredited at their annual ELCC values in order to count towards the PCAP PRM obligation: 90% Firm ELCC (5% EFORd + fleet outage asymmetry)
  - Solar challenge: output below 10% during managed net load peak period (HE18-20), but retains an average ELCC of ~30% due to synergies with storage





Challenges in translating LOLE results to SOD

- How to resolve differences between SOD spreadsheet accounting and 0.1LOLE calibrated LOLE study for the same portfolio of resources?
  - Case 1: SOD accounting shows several GW of excess capacity above PRM requirement every hour of year
  - Case 2: SOD accounting shows several hours of capacity below the PRM requirement

  - Challenges – how do we translate LOLE results to a particular hour of day?
  - How do we translate peak to all months of the year? All hours/slices of the day?

Possible plan to translate LOLE results to SOD

- How to resolve differences between SOD spreadsheet accounting and 0.1LOLE calibrated LOLE study for the same portfolio of resources?

  Possible methodology – create a median expected managed monthly peak from SERVM profiles (gross electric demand and demand modifier profiles) across all 23 weather years and LFE levels.

  Calculate percentage value of reserves required based on firm capacity UCAP and exceedance value non-firm generation profiles divided by median managed peak.

  Perform this calculation at hour of highest EUE or average hour of highest EUE in each of the four summer months. It is expected that highest EUE will move from HE18 to HE 19 during 2024 compliance year, based on earlier LOLE studies.

  RA study demonstrated that PRM calculated over peak months is sufficient for offpeak months of the year, if resources given correct accreditation of capacity credit

Questions/Next Steps

- Staff intend to complete the LOLE study of 2024 compliance year and present results in later workshops.
- Staff will continue to solicit ideas for how to translate the results of a LOLE study into the SOD framework.