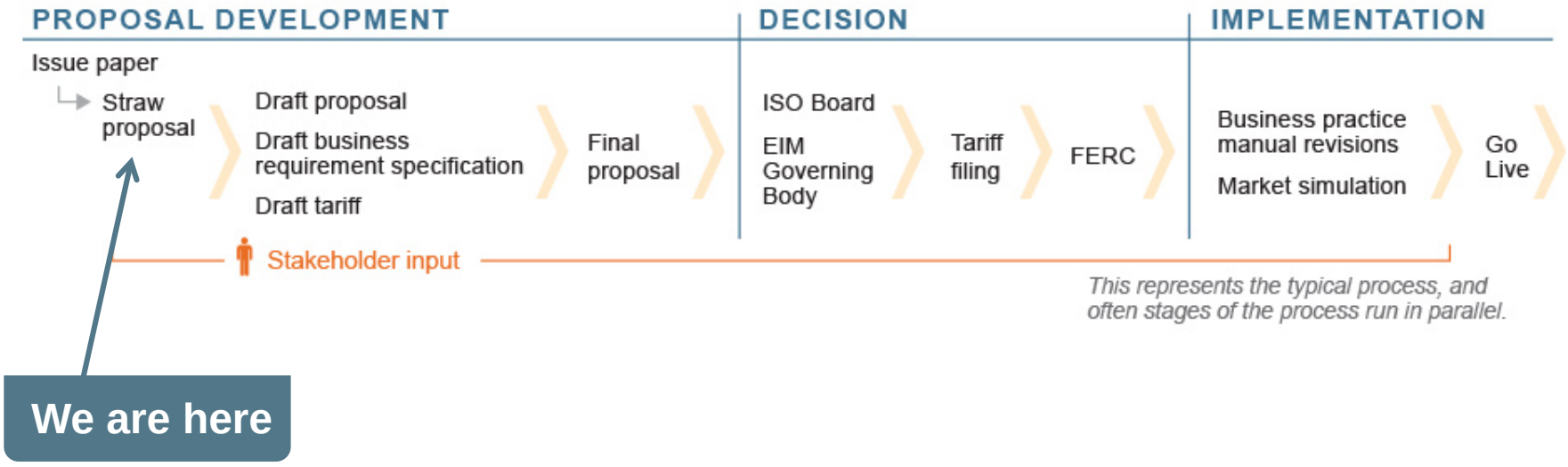
Resource Adequacy Enhancements: Portfolio Assessment

November 12, 2020

Agenda

Time	Topic	Presenter
9:00 – 9:10	Introduction	Isabella Nicosia
9:10 – 9:40	Background	Karl Meeusen Bob Emmert Mike Wu
9:40 – 10:30	Production simulation inputs and assumptions	
10:30 – 11:10	Results	
11:10 – 11:20	Interim Needs	
11:20 – 11:55	Framework	
11:55 – 12:00	Next steps	Isabella Nicosia

Stakeholder Process



Resource Adequacy Enhancements Policy Development Schedule

Date	Milestone
November 6	Supplement to the fifth revised straw proposal
November 12	Stakeholder working group meeting on supplement to the fifth revised straw proposal and other RA Enhancements elements
November 13	Market Surveillance Committee meeting
November 25	Stakeholder comments on supplement to the fifth revised straw proposal and working group meetings due
December 14	Draft final proposal
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Q1 2021	Present proposal to CAISO Board

The CAISO will conduct a monthly portfolio deficiency test of the shown RA fleet

- A production simulation tool to assess how likely the shown monthly RA fleet supports grid reliability
  - Can RA serve load under various load and net load conditions during all hours of the day
- Uses only shown RA fleet to determine if the CAISO can:
  - Serve forecasted gross and net-load peaks
  - Maintain adequate reserves and load following capability in that relevant RA compliance month
- Done for system level needs on monthly RA showings
  - Only showings where LSEs must meet 100 percent of the RA capacity requirements.
  - Local capacity needs will be assessed under existing methods

The need for this assessment is similar to the collective deficiency test CAISO conducts for local RA

- Increased number of energy and availability-limited resources on the system
- Some resource mixes provided to meet RA requirements may not ensure reliable operation of the grid during all hours of the day across the entire RA compliance month
- CAISO must assess how the shown RA fleet works collectively to meet system needs over all hours and under a broad range of load conditions
- A stochastic approach offers the greatest opportunity to assess the widest array of load, wind, and solar profiles and historic outage profiles

The CAISO objective is to provide insight and transparency into the assessment model, methods, and initial findings that inform the portfolio assessment

- The results presented here are instructive, though not conclusive
- CAISO will conduct modeling using other months' RA showings
  - Complete the picture about how likely the RA fleet meets grid reliability needs across all months
  - Provide more robust results and definitive findings about the level of reliability the RA fleet supports
- CAISO provides thoughts on a framework to determine the desired level of reliability RA procurement provides
  - Focuses on the questions that must be asked and answered to inform this question

The study results and recent reliability events confirm the need to take interim measures that focus on net-load peak and the hours immediately following

- RA must have components to reflect both net and gross load needs
  - Can no longer just focus the gross load peak
- This could be accomplished by setting an additional planning reserve margin that must be met with RA resources across these critical evening hours

Stochastic monthly assessments pose unique challenges for determining

- Two core challenges must be addressed:
  1. Establishing a defined reliability criteria or loss-of-load expectation that determines procurement targets and backstop procurement triggers; and
  2. Determining the quantity and attributes of capacity needed to address a portfolio deficiency
- These challenges that do not exist under the simple accounting tools currently used to ensure RA compliance
- CAISO does not explicitly answer these two questions
  - Instead, provides a framework to consider how to derive answers to these questions

The CAISO modeled two scenarios: July 2020 RA fleet and a “Thermal Scenario”

- Thermal Scenario was designed to approximate a baseline level of reliability for the original RA design by recreating a fleet similar to a 2005 RA fleet
  - Provides information about the probabilities of shortfalls the RA program generated at the outset
  - CAISO replaces all wind and solar capacity with thermal resources to reach a 115 percent planning reserve margin
- Allows the CAISO to compare the relative needs created by an RA fleet in 2005 and the July 2020 RA showings
  - Probabilities, time of day, duration, and magnitudes of deficiency
- Thermal Scenario in no way represents the actual levels of reliability offered since 2005 because there was excess capacity in the CAISO and across the west

CAISO modified the Summer Loads and Resources Assessment (Summer Assessment) for this study

- Portfolio assessment only models the shown RA resources to assess the probability and magnitude of capacity shortfalls
  - Summer Assessment assumes that all resources are available to the CAISO to meet peak summer loads.
- The only exception to this rule is that the CAISO modeled all wind and solar capacity
  - RPS goals provide CAISO confidence that this capacity will be available comparably to RA capacity
- Non-RA resources internal to the CAISO and non-RA economic energy imports are not be considered

OVERVIEW OF THE CAISO'S PRODUCTION SIMULATION MODEL

Maintaining operational reserve requirements should be used to set the reliability standard

- CPUC and LRAs are responsible for defining service level reliability by establishing the RA requirements the LSEs under their jurisdiction must meet
- CAISO must determine if the portfolio of resources it is provided under the RA program are sufficient to meet its real time operational requirements, including NERC and WECC reliability standards
  - At a Stage Two Emergency the CAISO begins using non-spinning reserves to serve load and sets up firm load to be shed as contingency reserve in its place

What defines a “deficiency?”

- The CAISO defines a deficiency as follows:
  - Any hour in which the production simulation shows the CAISO would have to call a Stage Two Emergency. This means the model shows the CAISO would have inadequate capacity to meet the aggregate of non-spin, spin, regulation, and load
- Though included in the model, shortfalls in load following alone are not flagged as deficiencies

Overview of the iterations and output

- CAISO's model is run using 2,000 month-long iterations
- Each iteration pulls from data sets containing profiles for
  - Load
  - Wind
  - Solar
  - Resource outages
- Once all iterations are complete, the CAISO can compute the probability of a portfolio deficiency
- The model output can be expressed in terms of the probabilities of occurrence for the range of deficiency magnitudes observed

The CAISO expresses the results in different levels of granularity, including hourly, daily, and monthly

- Hourly level data used to assess the hours of need and durations of deficiencies
- The daily level results reflect the probability that any day within the production simulation is deficient
  - The magnitude of the deficiency for that day is the largest observed deficiency for the day
  - There are 62,000 daily observations in a 31 day study month
- Similarly, the CAISO provides data on an iteration level.
  - Shows that the RA fleet provided was not able to achieve a reliable outcome for a given iteration

The model simulates 35 WECC zones and 91 WECC interchange paths between zones

- The CAISO is represented by three of those zones
- The zonal interchange path limits were set based on the WECC Path Rating Catalog
- Net imports into the CAISO are limited to the amount of RA imports shown each month during on peak periods (hour-ending 16-21)
  - Net imports during off peak hours are allowed to historical off peak levels, currently 11,666 MW.
- Transmission limits within the zones were not modeled

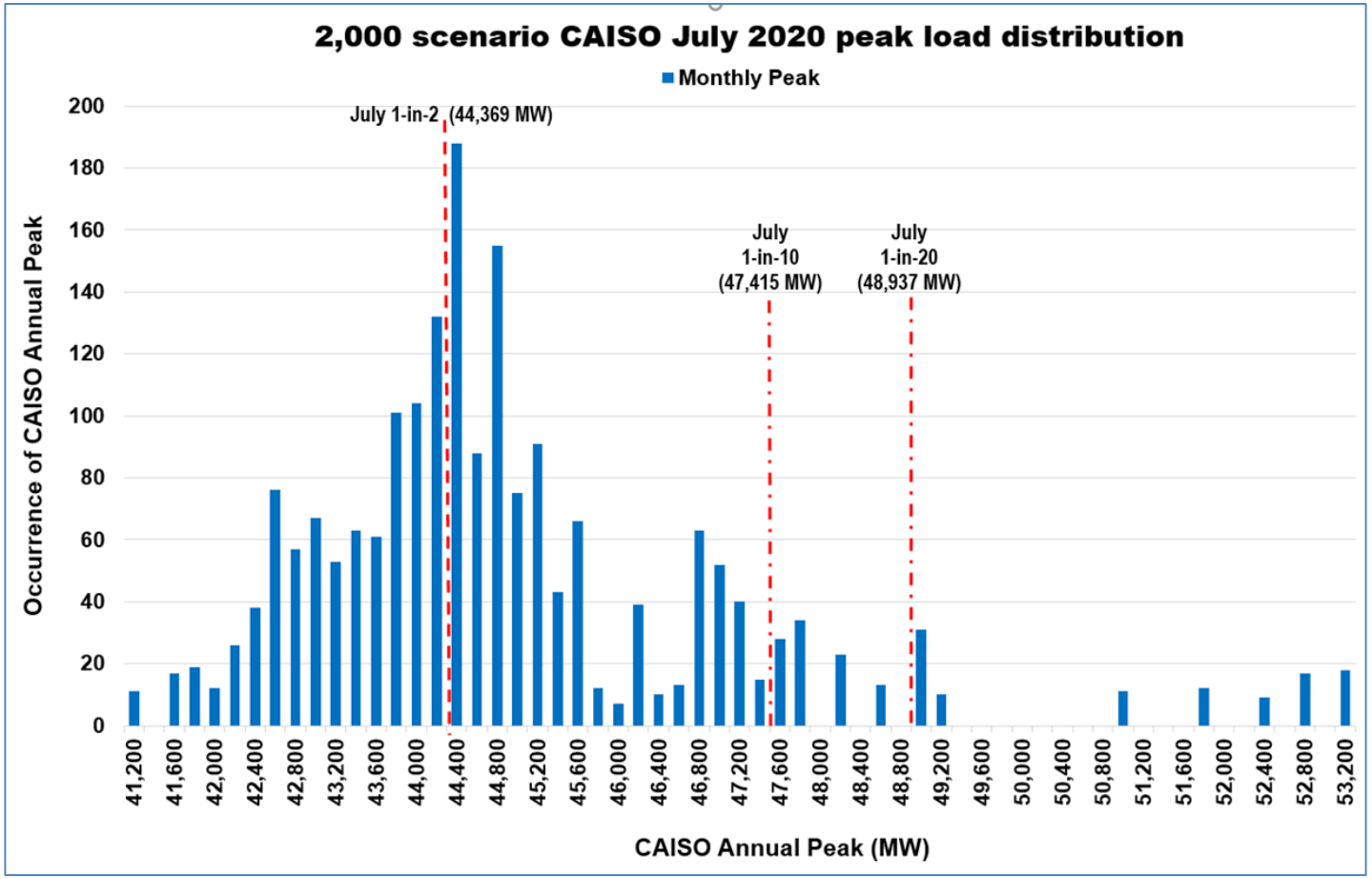
CAISO used the exact same load inputs in both the RA Showing and Thermal Scenarios

- CAISO load inputs into the model are based on the CAISO's load forecast process used for the CAISO summer assessment.
- CAISO's 1-in-2 peak load forecast for July 2020 is 44,369 MW compared to the CEC IEPR forecast of 44,217 MW for July.
- CAISO historical weather data from 1995 through 2019 used to generate 175 hourly load profiles

CAISO used the exact same load inputs in both the RA Showing and Thermal Scenarios (cont.)

- Produces a distribution of load profiles that include monthly peaks ranging from the mildest to the most extreme weather events
  - Forecasts for specific load events such as 1-in-2, 1-in-5, 1-in-10 and 1-in-20 can be determined from the range of forecasts produced
- These events follow the declining probability of the weather event as the event becomes more extreme
- In future studies, the CAISO will coordinate with the CPUC and CEC to develop a common set of hourly load profiles

Distribution of monthly peak loads



The CAISO tried to maintain consistent resource inputs to the greatest extent possible

Fuel Type	RA Showing Scenario	Thermal Scenario	Fuel Type	RA Showing Scenario	Thermal Scenario
Battery	106	106	**Solar (RA)**	4,233	--
Biomass	535	535	**Wind (RA)**	1,222	--
Coal	11	11	**HRCV**	29	29
Demand Response*	1289	1289	**Other**	45	45
Distribution	165	165	**Pumping Load**	131	131
Gas*	27,512	27,512	**Generic CCGT**	--	3932
Geothermal	994	994	**Generic SCGT**	--	2621
Hydro	4,316	4,316	**Total RA**	50,466	51,562
Nuclear	2150	2150	**Solar (non-RA)**	333	--
Pump Hydro	1391	1391	**Wind (RA)**	0	--
Interchange*	6335	6335	**Total**	50,799	51,562
*** Includes both RA showings and credits**					

The resource mix used by the CAISO in the RA showing scenario includes all generating resources provided on LSE RA showings

CAISO relies on the same wind and solar profiles generated for its Summer Assessment

- Includes the actual generation profiles from all participating wind and solar resources
- Modeling wind and solar based on actual historical operating profiles consistent with capacity values
  - NQC accounts for these types of production profiles when calculating the resources' ELCC
- Non-RA wind and solar resources have RPS production obligations and will have availability similar to their RA counterparts
  - The average of the coincident peak output of all solar resource profiles to be 11,708 MW (equivalent to approximately 333 MW of additional capacity above the RA showings)

The production simulation honors individual resource constraints to the greatest extent possible

- CAISO includes all capacity used for RA obligations, with the production simulation using CAISO confidential Masterfile parameters for each resource
  - Includes resource constraints such as minimum run time, minimum down and ramp rates
- The production simulation is currently not configured to model individual resource use-limitations such as maximum starts or run hours per month
- CAISO recognizes that this will result in a more optimistic result than if all use-limitations were modeled

For the Thermal Scenario, CAISO used the same resources as were included in the RA Showing scenario except for the wind and solar

- CAISO replaced wind and solar with sufficient generic thermal resources to meet a 115 percent PRM
- CAISO added 6,553 MW of capacity using a 60-40 split of combined cycle and simple cycle gas turbine resources
  - Combined cycle = 3,932 MW
  - Simple cycle = 2,621 MW

To determine the resource availability in both scenarios, the simulation model generates a unique forced outage profile

- 2,000 simulation scenarios based on historical forced outage rates for each dispatchable resource from the CAISO's Outage Management System (OMS)
- Generic resources used in the Thermal Scenario use the average forced outage rate for technology type
- Outage profiles for non-dispatchable resources are modeled based on aggregated historical hourly generation profiles
  - Includes biofuels, geothermal, wind, solar, run-of-river hydro, and non-dispatchable natural gas
  - Forced outage rates embedded within these profiles

Hydro resources are modelled using actual hydro MWh generation from similar hydro years

- Based on comparison of the current year's and historical snow water content and other water year conditions
- Maximum production levels for dispatchable hydro units are capped at the shown NQC
  - Resource may be capable of producing more than NQC, but CAISO's objective was to test the shown RA values
  - Based on CAISO's preliminary review of hydro resource availability, NQC seems to provide a reasonable cap on its overall maximum availability

Imports are modeled up to the shown RA value

- Production simulation respects all specific intertie line limits, but will not limit imports to MIC designated ties
  - For example, if an intertie has a 1,000 MW capacity and sum total of used MIC on the line equal to 500 MW, then the production simulation would allow for that line to flow 1,000 MW
- Imports are based on the intertie limits and the model's least cost dispatch
  - Uses the cost of surplus resources in other BAAs
- Capped at the level of imports shown for the month

Shown demand response resources are modeled as supply side resources that have triggering conditions

- Whenever the model depletes all available resources before meeting the load and ancillary service requirements the model will utilize demand response programs
- Assumes demand response resources are available regardless of time or day of the week
- Additional research needed to assesses the frequency of DR use and during which hours
  - How useful existing DR resources are at mitigating the probability of deficiencies
  - How future DR programs should be designed

CAISO reviewed all “RA credits” to ensure there is no exclusions or double counting

- The CAISO receives RA “credits” from various LSEs
  - Capacity that an LSE uses to meet its RA obligation, but may not represent as specific capacity resource (i.e. a generating resource with a specific resource ID shown on an RA showing)
- Credits include CAM, DR credits, LD Contracts, and CPM/RMR
  - CAM credits have been removed to avoid double counting
  - DR credits are included, but adjusted based on CAISO operational experience, currently 75%
  - LD contract credits are included by increasing the import limit
  - CPM/RMR credits are excluded to avoid double counting because all CPM/RMR resources are already modeled as specific resources (though not on an RA showing)

CAISO reviewed all “RA credits” to ensure there is no exclusions or double counting

- The following “credited” capacity in included in the model:
  - RMR: 289 MW
  - DR: 1,025 MW
  - LD: 471 MW
  - Total: 1,785 MW
- This capacity is already in the tables showing the modeled capacity

RESULTS

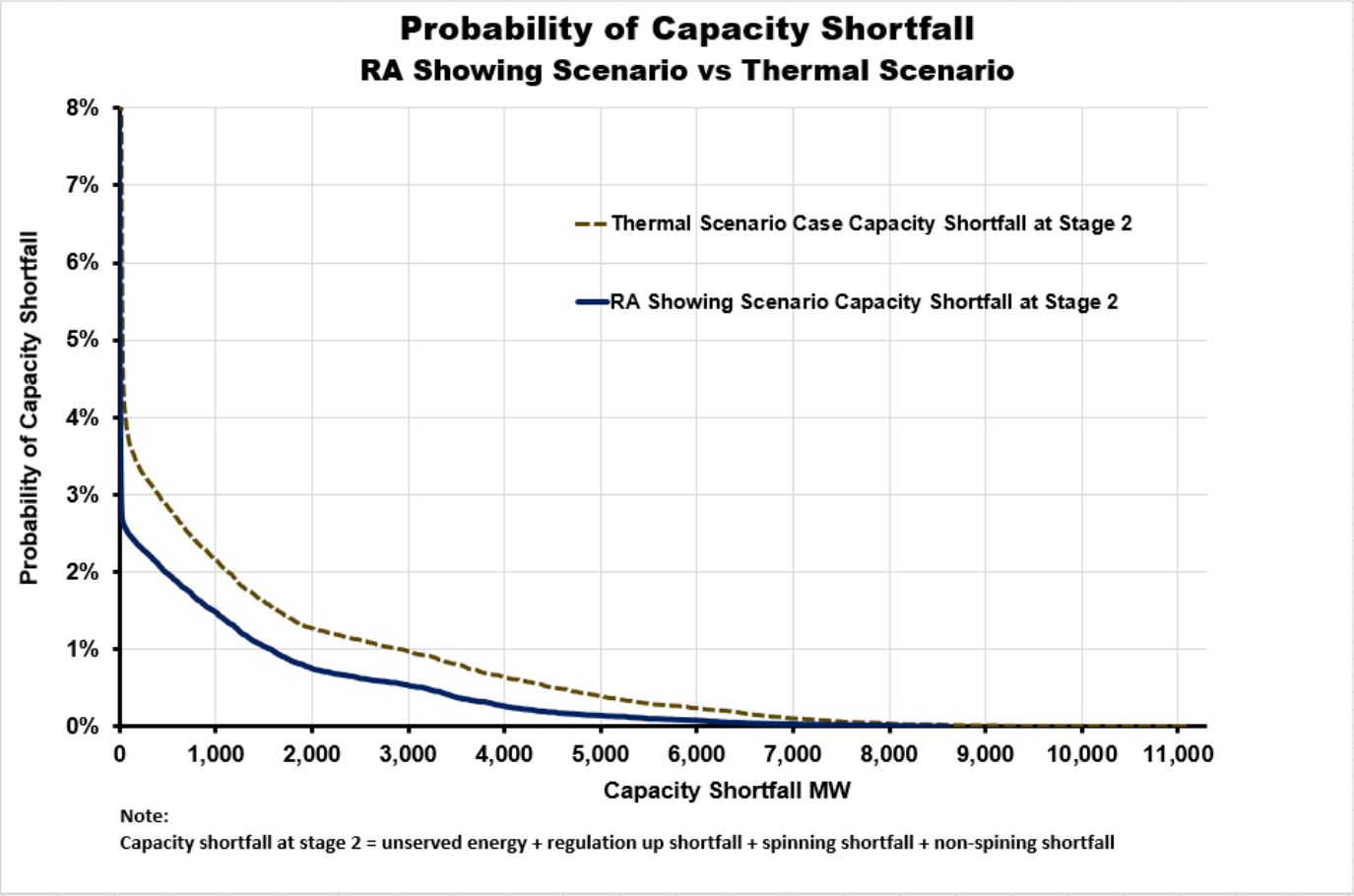
Stochastic monthly assessments pose unique challenges

- Stochastic production simulation provides a distribution of potential outcomes and probabilities, not yes-no
  - There are clear yes-no answers regarding the adequacy of the portfolio of resources when using an “RA accounting” or deterministic production simulation
- CAISO attempts to provide a clear, transparent overview of the results both for the Thermal and RA Showing scenarios
- The goal is to establish the data needed to build the framework to determine
  - The adequacy of a given portfolio and
  - How much additional capacity may be needed if the fleet is determined to be inadequate

CAISO primarily focuses on the probability of a deficiency at a daily granularity

- CAISO calculates the probability of a deficiency looking at the whole day
- The CAISO also considered using both iteration (monthly) and hourly level granularity
  - Solving for the maximum shortfall in a given day should solve all deficiencies on that same day
    - There is sufficient variability over any given monthly profile to make the connection more difficult
  - Using monthly granularity, the CAISO would be sacrificing the robust data created by looking at 62,000 different days
    - It would treat an iteration with one hour of shortfall the same as it would an iteration that was short for all hours or all days
- Daily granularity is consistent with the unit of measure applied to the CPUC's IRP Process

Results: Probability of capacity shortfall



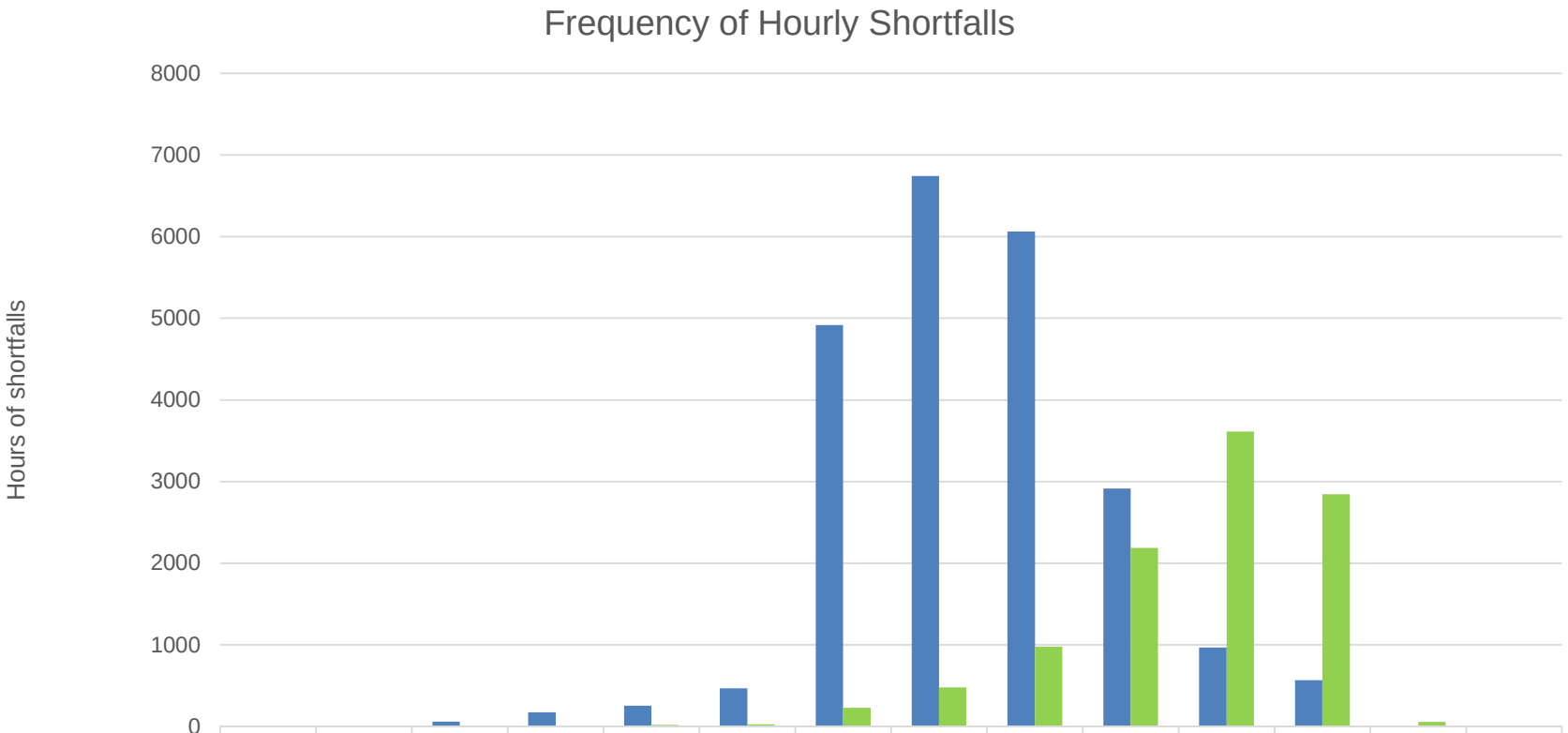
Results: Capacity shortfalls and probabilities

Probability of a shortfall greater than X MW			MW shortfall at X probability		
MW shortfall	RA Showing	Thermal	**Probability**	RA Showing	Thermal
500	1.98	2.82	**4**	12	56
1000	1.49	2.14	**3.5**	15	147
2000	0.75	1.27	**3**	21	397
3000	0.54	0.97	**2.5**	94	709
4000	0.26	0.63	**2**	483	1124
5000	0.15	0.39	**1.5**	983	1636
6000	0.09	0.23	**1**	1585	2905
7000	0.04	0.1	**0.5**	3183	4487
8000	0.02	0.03	**0.01**	5706	7035

CAISO also reviewed a collection of frequency distributions

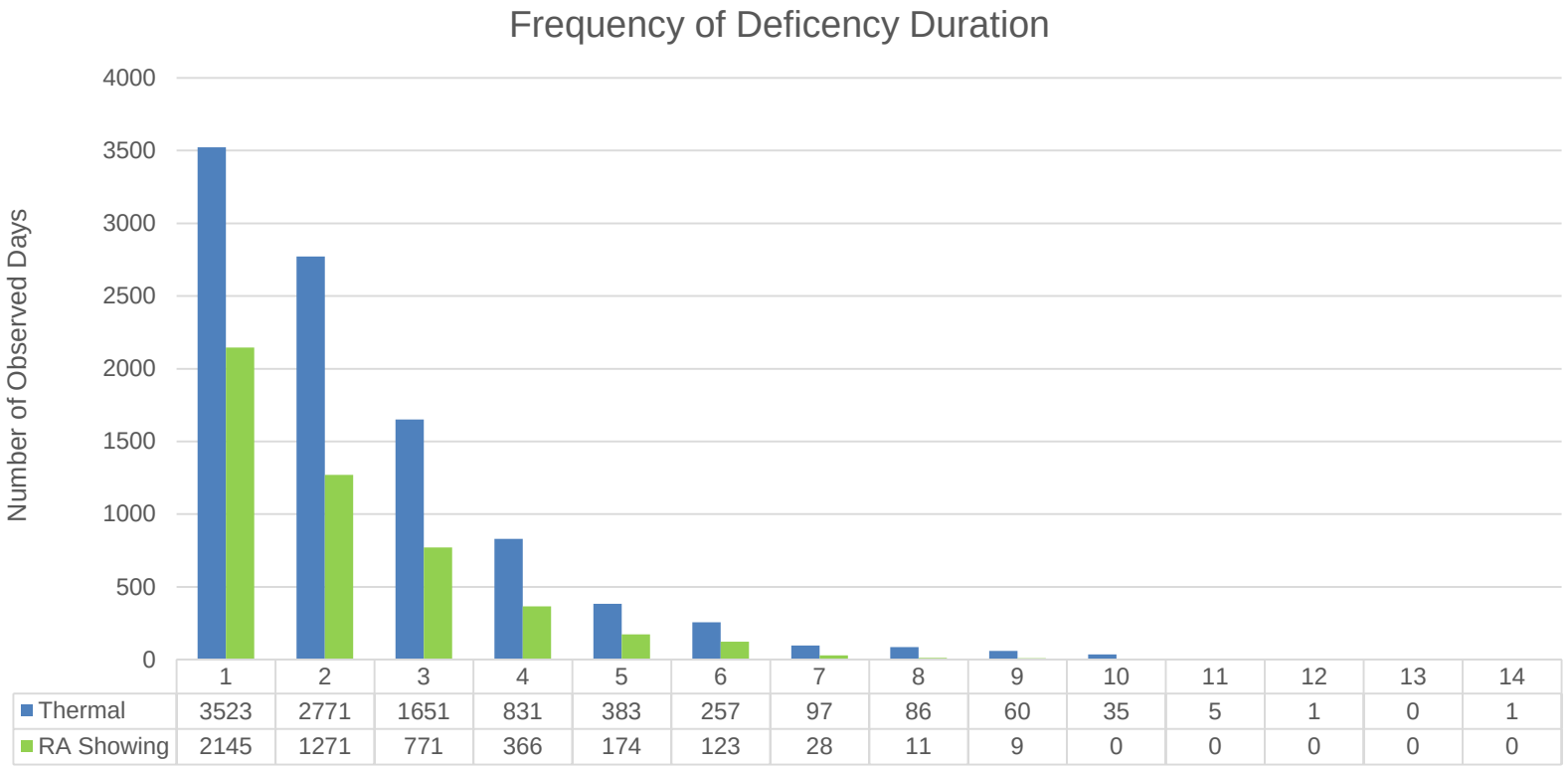
- These distributions can be informative when trying to
  - Assess potential additional risks that may be present
  - Provide guidance on the type of resource needed to deal with the deficiencies

Results show deficiency hours shifted from gross-peak hours in the Thermal Scenario to the evening net-load peak hours in the RA Showing Scenario



	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Thermal Scenario	1	9	61	172	255	467	4915	6742	6062	2914	967	568	3	1
RA Showing	0	0	1	9	18	26	228	479	977	2187	3611	2844	57	0

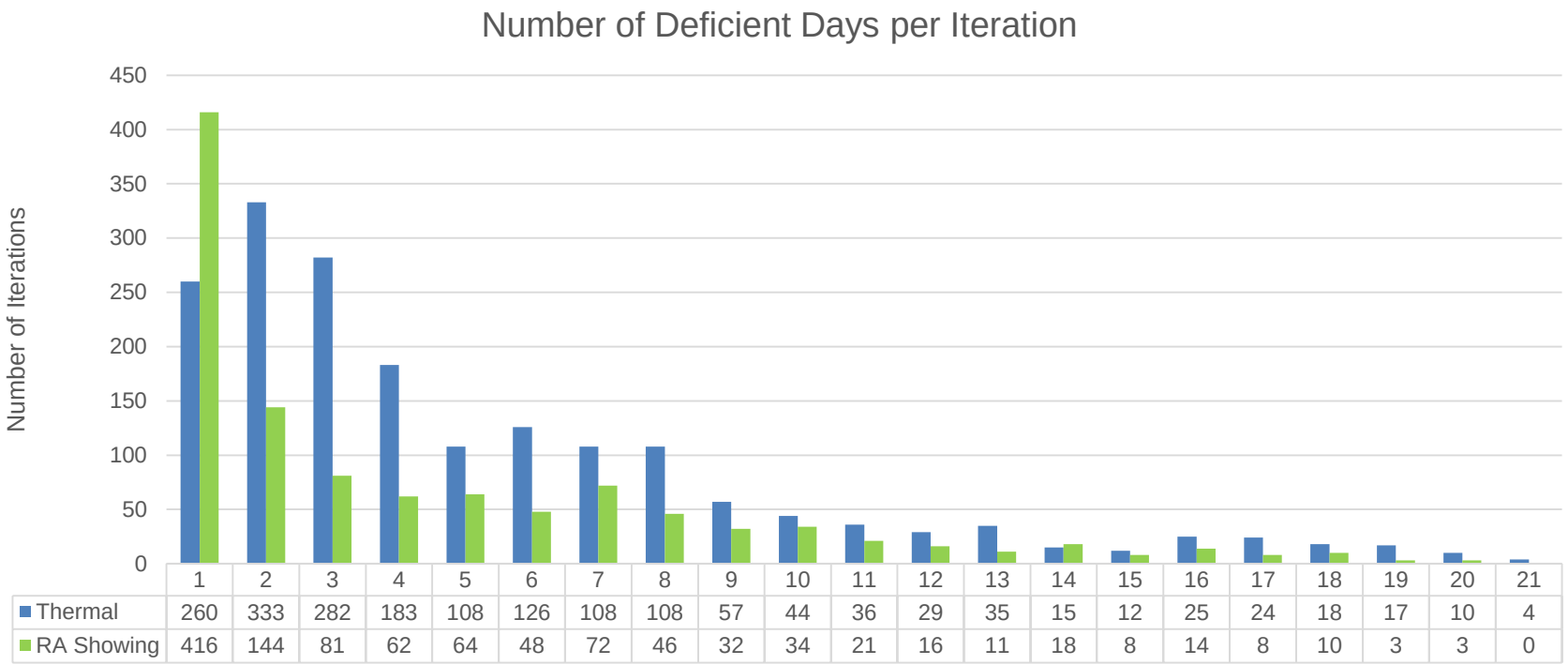
Over 90 percent of the days with deficiencies had deficiencies of less than four hours in duration



	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Thermal	3523	2771	1651	831	383	257	97	86	60	35	5	1	0	1
RA Showing	2145	1271	771	366	174	123	28	11	9	0	0	0	0	0

The duration of the deficiencies is important to determining the both nature of the deficiency and potential solutions

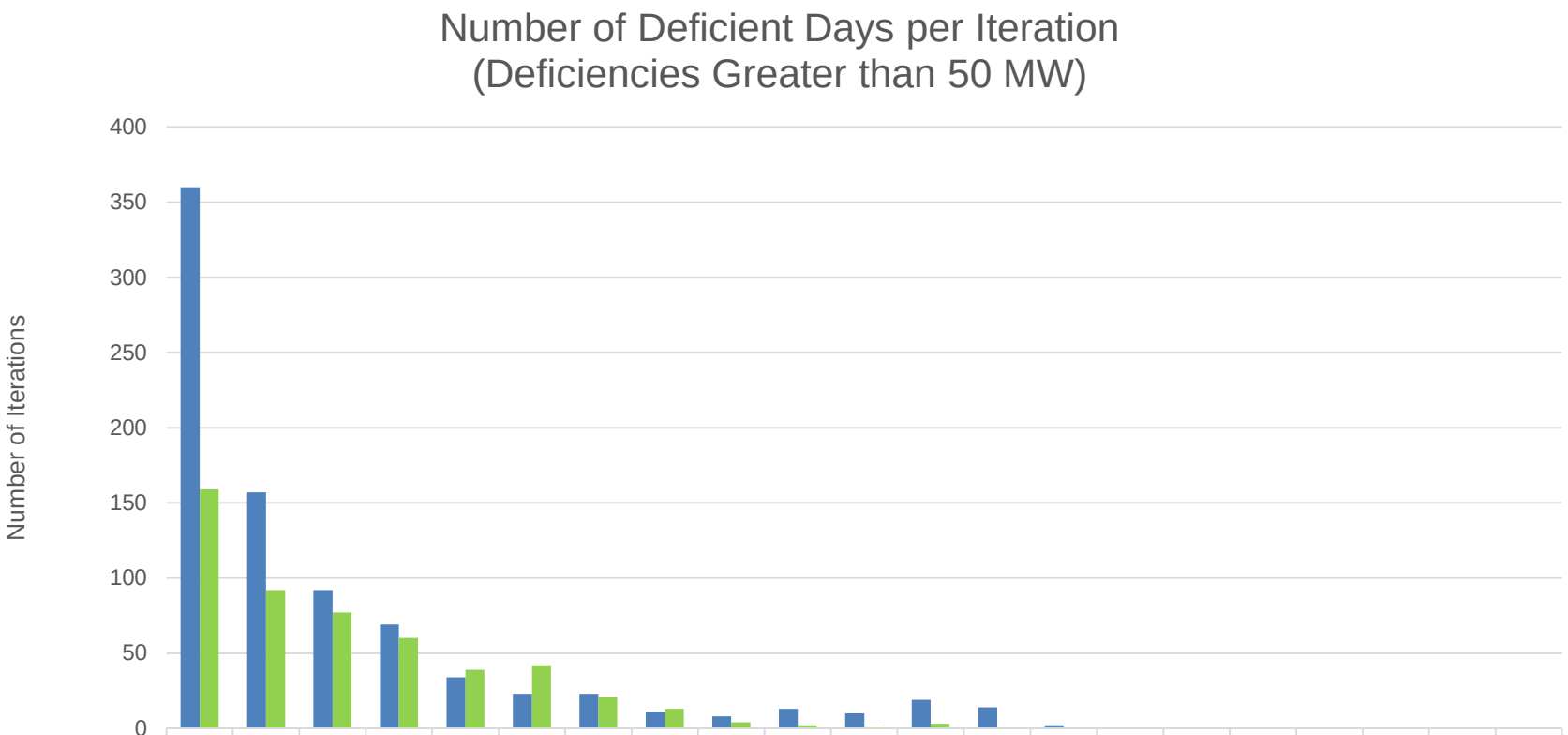
Most iterations have 5 or fewer deficient days



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Thermal	260	333	282	183	108	126	108	108	57	44	36	29	35	15	12	25	24	18	17	10	4
RA Showing	416	144	81	62	64	48	72	46	32	34	21	16	11	18	8	14	8	10	3	3	0

This data is useful to determine how use-limitations should be considered when resolving deficiencies

Most iterations have 5 or fewer deficient days (cont.)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Thermal	360	157	92	69	34	23	23	11	8	13	10	19	14	2	0	0	0	0	0	0	0
RA Showing	159	92	77	60	39	42	21	13	4	2	1	3	0	0	0	0	0	0	0	0	0

INTERIM NEEDS

A secondary RA requirement must be promptly instituted to ensure sufficient RA capacity is available across the net-load peak hours

- RA focused on the gross peak load misses the urgent needs during the net-load peak and subsequent hours
- In addition to the current gross peak requirements, a secondary the net-load peak requirement in needed
- It is premature to remove the gross load peak requirement
  - SCE has proposed to transition to only a net-load peak requirement only
- For an interim period, these additional net load RA requirements could be set on deterministic modeling with a planning reserve margin
- The two requirements would stay in place until there is a more comprehensive measure for resource adequacy

FRAMEWORK

CAISO carries the ultimate obligation for maintaining the reliability of the bulk power system

- The RA program is the first line of defense in this effort
  - The last line of defense is controlled involuntary firm load shedding
- RA procurement is a means to provide for a certain probability of service level reliability
  - Service level reliability refers to the targeted level of reliability to firm load, taking into account some marginal level of accepted probability of interruption due to supply shortage
- It is possible to maintain system level reliability by using controlled load shedding, which reduces service level reliability but maintain system or grid reliability

To establish procurement obligations it is necessary determine if some level of load shedding is acceptable

- RA program provided enough capacity in July 2020 to ensure service level reliability at approximately a 96-97 percent probability
  - If the RA program was to guarantee a service level reliability level of near 100 percent, based on modeling results, it would need an additional 8,637 MW of capacity
- Is the three percent shown in this study, or some other probability, acceptable?
  - As an alternative, procurement could be set at a level to procure sufficient capacity ensure near zero probability of load shedding
- A key consideration for determining the desired service level reliability is willingness to incur the costs needed to insure a given probability

The CAISO has provided data to establish a foundational framework to answer the primary questions

- The two core challenges that must be addressed are:
  1. Establishing a defined reliability criteria or loss-of-load expectation that determines procurement targets and backstop procurement trigger
  2. Determining the quantity and attributes of capacity needed to address a portfolio deficiency

To answer the first question, three decisions must be made

1. The correct granularity of the RA program: Annual, Seasonal, or Monthly?
2. The application of an annualized planning standard
3. The desired service level reliability target

These questions may be aske and answered in different orders

The desired level of reliability ultimately selected must be uniformly across all the CAISO footprint

- It is neither possible nor desirable for different LRAs to plan to different standard
  - When the CAISO system is stressed and load shed is imminent, grid operators are attempting to use all means to maintain system reliability
  - They rely on the entire pool of resources within its footprint and across the WECC for help
- LRAs planning to lower standards are leaning on other members of the pool since the CAISO manages the reliability of the grid uniformly

The monthly RA program must be reevaluated to determine the efficiency and efficacy in meeting the desired reliability standard

- Alternatives to the monthly program include transitioning to an annual or seasonal construct
- This will determine, in part, how reliability provided by the RA program is measured because
  - It will determine how an annual reliability metric is allocated over the year
  - Historically, planning standards have been done on a yearly basis with the goal of a one day in ten years (1-in-10) loss of load expectation
- CPUC must also examine the benefits of multi-year procurement obligations

California is unique in the sense that the RA program is administered monthly

- All other organized markets with RA programs are run annually
  - This means that applying an annual standard is measured over all twelve months at the same time
  - Because of the monthly program, it is not possible to apply the same test
- Must predetermine twelve monthly probabilities
  - The application of annual standard is necessary to ensure that all 12 months are bound together by a single guiding reliability standard
- Maintaining a monthly standard adds complexity to setting procurement targets to meet an annual reliability goal

If a monthly RA program is maintained, then an annual planning standard must be allocated over twelve individual months

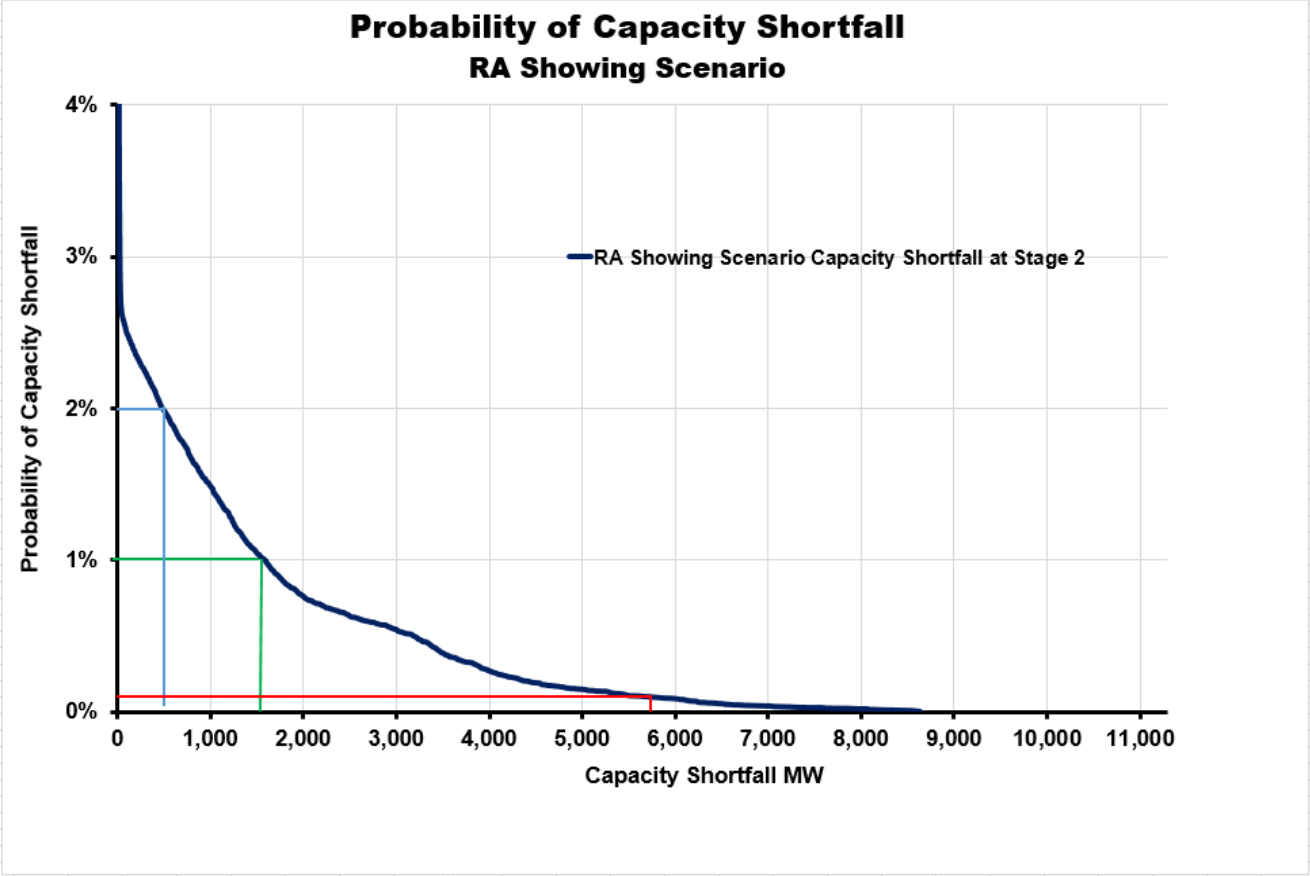
There are at least two different ways it could apply an annual standard over a full year: Uniformly of shaped

- Applying a 1-in-10 LOLE standard uniformly over all twelve months, or a 0.1 day over the year, then each month could have 0.008 days in any given month
- A shaped standard over the year could allow higher probabilities of loss of load in the peak months and lower probabilities of loss-of-load in the off-peak months
  - Helps balance costs and reliability
    - Summer procurement targets closer to forecasted peak because capacity is scarce and more costly to procure
    - Non-summer targets set higher when capacity is more abundant and cheaper

The desired service level reliability standard is defined by determining an acceptable loss of load probability when setting its RA procurement targets

- Based on the from the CAISO's study results, the July 2020 RA showing would provide for approximately a three percent LOLE
  - This probability translates to a 0.93 days expected loss of load in July
  - If July is representative of all 12 months, This would result in an equivalent 10.95 days LOLE for the year
- That is not to say that the CAISO would shed firm load during each instance when it is short of RA
  - It does mean the CAISO would lean more heavily on backstop procurement

Where the probability intersects the vertical axis defines the service level reliability through forward procurement



What actions are necessary in the event that the amount of capacity shown is insufficient to achieve the desired service level reliability

- CAISO must determine which resources can cure the deficiency given the desired reliability standard, how much capacity to backstop to meet that standard and the time of day and duration of the capacity shortfall
- The quantity of capacity needed to cure the deficiency can be estimated using the probabilities for deficiencies
  - i.e. How much capacity is needed to have the curve of the probability of a deficiency intersect the horizontal axis at the desired level of expected loss-of-load (This is only an estimate)

CAISO's ability to take adequate supplemental action will be directly impacted by the choice regarding the granularity of the RA program

- If a monthly RA program is maintained, then study and notification timelines will be very condensed
  - Limited opportunity to notify LSE of deficiencies and allow LSE to cure deficiencies
  - No opportunity to rerun the study process
- Annual or seasonal processes with enough lead time could allow for a more robust assessment of the study results and supplemental procurement by LSEs.
- The duration, frequency and timing of the need are critical to ensuring the capacity will resolve the deficiency

NEXT STEPS

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Comments

- Please submit written comments on working group discussion by November 25, 2020 using the ISO's commenting tool, found on the initiative page: https://stakeholdercenter.caiso.com/StakeholderInitiatives/Resource-adequacy-enhancements