



Unforced Capacity Evaluation Proposal

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Agenda

- Overview of Use-Limited Thermals
- Forced outage rates
- UCAP
 - Methodology overview
 - Data
- Implementation Discussion

USE LIMITED THERMALS

Parties requested information on the use-limited thermal fleet

- CAISO pulled monthly average PMAX totals for thermal resources (Fuel type= Gas) that are registered in Masterfile as either Use Limited or Conditionally Available Resource (CAR)
 - Sample includes only CAISO internal resources (i.e. no tie gen, or EIM resources)
 - Includes QFs that are registered as a thermal fuel type
- A Use-limited Resource is defined in Tariff Section 30.4.6.1.1, and the resource must meet all 3 criteria:
 - (1)The resource has one or more limitations affecting its number of starts, its number of run hours, or its Energy output due to (a) design considerations, (b) environmental restrictions, or (c) qualifying contractual limitations; (2) The CAISO Market Process used to dispatch the resource cannot recognize the resource's limitation(s); and (3) The resource's ability to select hours of operation is not dependent on an energy source outside of the resource's control being available during such hours but the resource's usage needs to be rationed.

Use-Limited Thermal Fleet: 2021

Month	Non-Use limited MWs	Use Limited or CAR MWs	Total Thermal Fleet MWs	Percent Use Limited
1	22,953	7,765	30,717	25%
2	22,950	7,832	30,782	25%
3	22,684	8,099	30,783	26%
4	22,658	8,129	30,787	26%
5	22,686	8,146	30,832	26%
6	22,664	8,144	30,808	26%
7	22,650	8,157	30,807	26%
8	22,573	8,164	30,736	27%
9	22,579	8,166	30,744	27%
10	22,396	8,375	30,771	27%
11	22,289	8,497	30,786	28%
12	22,291	8,495	30,786	28%

Use Limitations

- Majority of registered use limitations are driven by air permits. Some represent physical limitations, and some units have water-related limits for steamers, but majority are related to emissions
- CAISO believes it would be prudent to factor in these use limitations into the thermal QC methodology and/or account for them in resource's hourly slice profiles

FORCED OUTAGE RATE OF THERMAL FLEET

Hourly Forced Outage rates

- Hourly outage takes the maximum of the summed curtailment within the hour for each resource and applies it to the whole hour in the data set
- Forced Outage rate takes the sum of curtailments of gas fleet divided by the sum of Pmax of gas fleet for the month
- Forced Outage rate at 8pm takes the sum of curtailments of gas fleet at HE 20 divided by the sum of Pmax of gas fleet at HE 20 for the month.
- Sample covers November 2018- October 2021
- Considers only gas generators

Monthly Average Hourly Outage Rate

	2018	2019	2020	2021	3-year avg.
January		5.20	5.99	5.48	5.56
February		6.88	4.53	6.27	5.89
March		4.73	5.76	5.88	5.46
April		7.35	8.34	10.01	8.57
May		7.01	7.38	8.61	7.67
June		8.14	7.98	12.65	9.59
July		5.57	6.74	8.92	7.08
August		6.33	7.90	7.57	7.27
September		5.91	10.33	6.85	7.70
October		5.31	8.93	7.24	7.16
November	6.22	7.39	5.63		6.41
December	6.98	8.54	7.95		7.82
Yearly Avg.	6.60	6.53	7.29	7.95	7.18

Seasonal Hourly Outage Rates

Season	2018-2019	2019	2019-2020	2020	2020-2021	2021	3-year average
Off Peak (November-April)	6.23		6.76		6.87		6.62
Peak (May-October)		6.38		8.21		8.64	7.74

Average Hourly Outage Rate at 8pm

	2018	2019	2020	2021	3-year avg.
January		9.50	5.39	5.17	6.69
February		6.86	4.31	6.26	5.81
March		4.65	5.95	6.44	5.68
April		6.92	8.53	9.51	8.32
May		7.06	7.57	8.23	7.62
June		8.26	8.18	12.13	9.52
July		5.69	7.52	12.79	8.67
August		6.85	8.26	7.92	7.68
September		6.10	10.69	7.29	8.03
October		4.99	9.00	6.88	6.96
November	5.80	6.75	5.40		5.98
December	6.80	7.88	7.71		7.46
Yearly Avg.	6.30	6.79	7.38	8.26	7.37

Seasonal Hourly Outage Rates at 8pm

Season	2018-2019	2019	2019-2020	2020	2020-2021	2021	3-year average
Off Peak (November-April)	6.76		6.47		6.75		6.66
Peak (May-October)		6.49		8.54		9.21	8.08

Hour	Mean	Std. Dev.	Min.	Max.
1	7.00	2.97	0.007	18.03
2	8.44	3.00	0.007	19.73
3	8.40	3.00	0.007	19.69
4	8.37	3.01	0.007	19.52
5	8.34	3.00	0.007	19.47
6	6.89	2.98	0.008	17.86
7	6.71	2.72	0.008	16.30
8	6.88	2.75	0.009	16.48
9	7.08	2.82	0.008	16.76
10	7.26	2.79	0.008	17.13
11	7.37	2.80	0.008	18.79
12	7.46	2.80	0.006	18.19
13	7.52	2.80	0.006	16.89
14	7.61	2.84	0.006	17.50
15	7.65	2.87	0.005	19.97
16	7.69	2.88	0.006	18.15
17	7.68	2.88	0.005	17.63
18	7.55	2.85	0.006	17.87
19	7.47	2.86	0.006	17.87
20	7.32	2.83	0.008	18.33
21	7.13	2.76	0.007	17.75
22	7.00	2.75	0.007	18.01
23	6.92	2.74	0.007	17.10
24	6.87	2.81	0.007	17.34

Descriptive Statistics for Hourly Outage Rates: Nov. 2018-October 2021

- Higher outage rate between 2-5 reflect increased environmental restrictions on some units
- Maximum outage rates can exceed the 15% PRM in certain hours

Average Hourly Rates by Nature of Work 2021

Nature of Work	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Avg.
AMBIENT_DUE_TO_FUEL_INSUFFICIENCY	0.01%	0.43%	0.00%	0.00%	0.00%	0.23%	0.06%	0.00%	0.01%	0.02%	0.08%
AMBIENT_DUE_TO_TEMP	1.44%	1.54%	1.38%	2.02%	1.88%	3.14%	2.11%	2.71%	2.24%	0.93%	1.94%
AMBIENT_NOT_DUE_TO_TEMP	0.04%	0.30%	0.04%	0.03%	0.00%	0.05%	0.01%	0.04%	0.08%	0.09%	0.07%
ANNUAL_USE_LIMIT_REACHED	0.00%	0.19%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%
ENVIRONMENTAL_RESTRICTIONS	0.49%	0.98%	0.22%	0.77%	0.62%	0.76%	0.46%	0.63%	0.58%	0.44%	0.60%
METERING_TELEMETRY	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%
MONTHLY_USE_LIMIT_REACHED	0.00%	0.00%	0.25%	0.01%	0.00%	0.24%	0.12%	0.18%	0.18%	0.22%	0.12%
OTHER_USE_LIMIT_REACHED	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%
PLANT_MAINTENANCE	0.70%	0.36%	1.33%	4.22%	1.80%	1.00%	0.90%	0.30%	0.22%	1.28%	1.21%
PLANT_TROUBLE	1.63%	1.44%	1.78%	1.98%	2.93%	6.54%	4.97%	3.22%	3.10%	3.60%	3.12%
RTU_RIG	0.00%	0.00%	0.00%	0.00%	0.15%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%
SHORT_TERM_USE_LIMIT_REACHED	0.53%	0.23%	0.32%	0.50%	0.60%	0.41%	0.18%	0.21%	0.32%	0.58%	0.39%
TRANSITIONAL_LIMITATION	0.00%	0.05%	0.00%	0.00%	0.01%	0.01%	0.00%	0.01%	0.00%	0.01%	0.01%
TRANSMISSION_INDUCED	0.55%	0.74%	0.53%	0.16%	0.04%	0.11%	0.07%	0.18%	0.10%	0.06%	0.25%
UNIT_SUPPORTING_STARTUP	0.08%	0.00%	0.00%	0.00%	0.01%	0.02%	0.01%	0.01%	0.00%	0.00%	0.01%
UNIT_TESTING	0.00%	0.01%	0.01%	0.31%	0.58%	0.14%	0.02%	0.05%	0.02%	0.01%	0.11%
Average Total forced outage rate	5.48%	6.27%	5.88%	10.01%	8.61%	12.65%	8.92%	7.57%	6.85%	7.24%	7.95%
Pmax of Gas Fleet	29840.38	30046.17	29114.52	28923.74	30491.27	30139.35	30608.19	30578.17	30505.6	30473.41	30072.08

Average Hourly Rates by Nature of Work 2020

Nature of Work	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Avg.
AMBIENT_DUE_TO_FUEL_INSUFFICIENCY	0.11%	0.00%	0.00%	0.03%	0.12%	0.08%	0.00%	0.00%	0.02%	0.19%	0.15%	0.00%	0.06%
AMBIENT_DUE_TO_TEMP	1.02%	1.12%	1.20%	1.33%	1.49%	2.44%	2.96%	3.75%	3.32%	2.68%	1.71%	1.45%	2.04%
AMBIENT_NOT_DUE_TO_TEMP	0.25%	0.03%	0.04%	0.04%	0.09%	0.06%	0.09%	0.01%	0.03%	0.26%	0.02%	0.05%	0.08%
ANNUAL_USE_LIMIT_REACHED	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.06%	2.07%	0.18%
ENVIRONMENTAL_RESTRICTIONS	0.54%	0.29%	0.32%	0.36%	0.40%	0.32%	0.48%	0.49%	0.45%	0.46%	0.38%	0.42%	0.41%
ICCP	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
METERING_TELEMETRY	0.00%	0.00%	0.04%	0.00%	0.02%	0.00%	0.00%	0.00%	0.01%	0.02%	0.00%	0.00%	0.01%
OTHER_USE_LIMIT_REACHED	0.00%	0.01%	0.02%	0.00%	0.02%	0.00%	0.00%	0.00%	0.01%	0.05%	0.00%	0.02%	0.01%
PLANT_MAINTENANCE	0.26%	0.08%	0.19%	1.61%	1.27%	2.91%	0.56%	0.60%	0.61%	1.15%	0.40%	1.32%	0.91%
PLANT_TROUBLE	3.40%	2.90%	2.94%	3.66%	3.58%	1.97%	2.51%	2.89%	5.41%	4.03%	2.42%	1.51%	3.10%
SHORT_TERM_USE_LIMIT_REACHED	0.00%	0.03%	0.75%	1.18%	0.32%	0.03%	0.07%	0.02%	0.29%	0.01%	0.46%	0.42%	0.30%
TRANSITIONAL_LIMITATION	0.03%	0.00%	0.00%	0.00%	0.02%	0.01%	0.00%	0.00%	0.01%	0.01%	0.01%	0.00%	0.01%
TRANSMISSION_INDUCED	0.05%	0.07%	0.04%	0.10%	0.01%	0.05%	0.01%	0.08%	0.09%	0.03%	0.00%	0.54%	0.09%
UNIT_SUPPORTING_STARTUP	0.01%	0.00%	0.00%	0.00%	0.02%	0.00%	0.01%	0.01%	0.02%	0.02%	0.00%	0.00%	0.01%
UNIT_TESTING	0.31%	0.01%	0.21%	0.02%	0.00%	0.07%	0.04%	0.03%	0.04%	0.01%	0.02%	0.14%	0.08%
Average Total forced outage rate	5.99%	4.53%	5.75%	8.33%	7.37%	7.96%	6.74%	7.89%	10.32%	8.92%	5.63%	7.94%	7.28%
Pmax of Gas Fleet	28512.25	29008.55	28653.98	30055.07	29921.83	29977.93	30527.37	30595.7	30588.85	30405.66	30050.05	30154.58	29870.99

Average Hourly Rates by Nature of Work 2019

Nature of Work	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
AMBIENT_DUE_TO_FUEL_INSUFFICIENCY	0.00%	0.00%	0.02%	0.00%	0.00%	0.13%	0.00%	0.00%	0.00%	0.00%	0.00%	0.18%	0.03%
AMBIENT_DUE_TO_TEMP	1.04%	0.82%	0.98%	0.94%	1.45%	2.10%	2.48%	2.77%	2.90%	1.83%	1.28%	1.11%	1.64%
AMBIENT_NOT_DUE_TO_TEMP	0.04%	0.11%	0.05%	0.13%	0.05%	0.08%	0.06%	0.13%	0.14%	1.04%	0.51%	0.31%	0.22%
ANNUAL_USE_LIMIT_REACHED	0.00%	0.00%	0.00%	0.00%	0.67%	0.33%	0.00%	0.00%	0.00%	0.00%	0.80%	1.11%	0.24%
ENVIRONMENTAL_RESTRICTIONS	0.03%	0.11%	0.00%	0.00%	0.01%	0.07%	0.07%	0.17%	0.19%	0.56%	0.72%	0.72%	0.22%
NEW_GENERATOR_TEST_ENERGY	0.00%	0.00%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
MONTHLY_USE_LIMIT_REACHED	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.49%	0.00%	0.04%
OTHER_USE_LIMIT_REACHED	0.72%	0.80%	0.83%	0.91%	0.31%	0.28%	0.29%	0.26%	0.16%	0.03%	0.03%	0.01%	0.38%
PLANT_MAINTENANCE	0.28%	1.16%	0.65%	0.43%	0.53%	0.96%	0.31%	0.71%	0.09%	0.43%	1.29%	1.49%	0.70%
PLANT_TROUBLE	2.37%	3.63%	2.03%	4.68%	3.84%	4.12%	2.29%	2.20%	2.19%	1.22%	1.84%	3.14%	2.80%
SHORT_TERM_USE_LIMIT_REACHED	0.00%	0.03%	0.05%	0.14%	0.00%	0.03%	0.00%	0.00%	0.01%	0.00%	0.15%	0.01%	0.03%
TECHNICAL_LIMITATIONS_NOT_IN_MARKET_MODEL	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.01%	0.00%	0.00%
TRANSITIONAL_LIMITATION	0.00%	0.00%	0.01%	0.02%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%
TRANSMISSION_INDUCED	0.67%	0.09%	0.04%	0.06%	0.11%	0.01%	0.05%	0.03%	0.20%	0.17%	0.20%	0.13%	0.15%
UNIT_CYCLING	0.05%	0.05%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
UNIT_SUPPORTING_STARTUP	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.02%	0.02%	0.02%	0.01%	0.01%	0.00%	0.01%
UNIT_TESTING	0.01%	0.07%	0.01%	0.02%	0.01%	0.01%	0.01%	0.02%	0.01%	0.03%	0.05%	0.32%	0.05%
Average Total forced outage rate	5.20%	6.88%	4.73%	7.35%	7.01%	8.14%	5.57%	6.33%	5.91%	5.31%	7.39%	8.54%	6.53%
Pmax of Gas Fleet	28591.46	28359.01	27932.78	28313.03	28825.22	28976.91	29316.6	30638.16	30394.38	30300.95	28968.22	29790.41	29200.59

UNFORCED CAPACITY EVALUATION METHODOLOGY

An unforced capacity construct ensures resources' capacity values reflect availability

- Unforced capacity evaluations promote procurement of the most dependable and reliable resources up front by accounting for historical unavailability in their capacity value
 - Current PRM, forced outage substitution rules, and RAIM have proven inadequate to replace capacity on forced outage, moving to a UCAP construct would allow the ISO to eliminate complicated and ineffective forced outage substitution rules
- UCAP dynamically changes with the fleet's forced outage rate
 - Relying solely on the PRM, which is a static value, may lead to over/under procurement if future outage rates change
 - The PRM would now only need to cover operating reserves and forecast error to the extent that resource counting sufficiently accounts for forced outages

A seasonal availability factor methodology can be used to determine UCAP values

- CAISO continues to recommend using a seasonal availability factor based approach for UCAP determinations during the tightest system conditions by looking at the hourly RA Supply Cushion
- Resource availability factors incorporate historical forced and urgent derates and outages to determine the resource's expected future availability and contributions to reliability
- Basic UCAP methodology can be used for dispatchable thermal resources and storage resources

Resource availability can be calculated on a seasonal basis measured on tight RA supply cushion hours

- This approach considers different impacts of availability during seasons across the year to better reflect unit reliability
- A low RA supply cushion indicates the system has fewer assets available to react to unexpected outages or load increases, indicating a high real-time system resource adequacy risk
- This method captures how tight the system would be if we only had the RA fleet to rely on - Makes no assumptions about economic energy, because with tightening conditions across the West this may no longer be a viable assumption, or prudent design of the RA program

Defining the Tightest RA Supply Cushion Hours

- **RA Supply Cushion = Daily Shown RA (excluding wind and solar) – Planned Outages – Opportunity Outages – Urgent Outages – Forced Outages – Net Load – Contingency Reserves**
- RA Supply cushion represents how much shown RA MWs are leftover after we take into account outages, serving net demand, and covering contingency reserves
- Contingency Reserves represents Regulation Up, Spin and Non-Spin Reserves
- Measured in MWs
- All inputs are averaged across the hour

Assess applicable outages during the top % of tightest RA supply cushion hours

- The CAISO recommends looking at forced outage rates under a subset of hours that represent the hours of greatest RA supply risk
- Advantages of this approach
 - Penalizing resources for being on a forced outage when the grid needed them
 - These assessment hours can fall at any point in the day, and thus resources are incentivized to always be available
 - Simpler than an EFORd methodology (allows for utilization of OMS rather than GADs data)
 - Provides consistency across evaluation periods, and more predictable risk of any one outage on a resource's capacity value
 - Data indicates that observations covers the majority of days, concentrates UCAP assessment hours in the peak/net load peak period, and a large enough sample size

Seasons selected to calculate UCAP values can be align with Slice of Day

- The CAISO proposes to calculate seasonal UCAP values for:
 - Peak Months: May – October
 - Off-Peak Months: November – April
- Under SCE's proposal, resources would have the same UCAP value in each month of the season, and the same value in all hourly slices
- Under Gridwell/Vistra proposal, resources would have the same UCAP value in each month of the season and at the peak and net load peak slice

Existing Nature of Work Categories included in UCAP

Nature of Work	Impacts UCAP?
Ambient Due to Temperature	Yes
Ambient Not Due to Temperature	Yes
Ambient due to Fuel insufficiency	Yes
AVR/Exciter	Yes
Environmental Restrictions	Yes
Short term use limit reached	Yes
Annual use limit reached	Yes
Monthly use limit reached	Yes
Other use limit reached	Yes
ICCP	Yes
Metering/Telemetry	Yes
New Generator Test Energy	No
Plant Maintenance	Yes
Plant Trouble	Yes
Power System Stabilizer (PSS)	Yes
Ramp Rate	Yes
RTU/RIG	Yes
Transitional Limitation	Yes
Transmission Induced	No
Technical Limitations not in Market Model	No
Unit Supporting Startup	Yes
Unit Testing	No – if CAISO initiated, Yes- if other test
Off Peak Opportunity	N/A – included as separate outage type under RC definitions
Short Notice Opportunity	N/A – included as separate outage type under RC definitions
RIMS testing	Yes
RIMS Outage	Yes

Summary of UCAP steps

1. Determine UCAP assessment hours by identify which hours fall into the top % of tightest RA supply cushion hours for each season
2. Determine hourly unavailability factors (HUF) by looking at forced and urgent outages for each UCAP assessment hours each season
3. Determine seasonal average availability factors (SAAF) using one minus the average HUFs for each season of prior year
4. Determine weighted seasonal average availability factors (WSAAF) by multiplying the prior three year SAAFs by (45% Y1, 35% Y2, 25% Y3)
5. Apply WSAAFs for each season to deliverable capacity (DQC) to determine monthly NQC (On-peak and Off-peak) values for each resource

Proposed UCAP calculation steps

- CAISO would determine each resource's Hourly Unavailability Factor (HUF) for each of the top % tightest RA Supply cushion hours per season

$$\text{Hourly Unavailability Factor} = \frac{\text{Forced} + \text{Urgent Outage Impacts}}{P_{\max}}$$

- CAISO would utilize the average of Hourly Unavailability Factors (HUF) for each season for each of the past 3 years to create a Seasonal Average Availability Factor (SAAF) for each resource

$$\text{Seasonal Average Availability Factor} = 1 - \frac{\sum \text{Hourly Unavailability Factors}}{\text{Number of Observed Hours}}$$

Proposed UCAP calculation steps (continued)

- CAISO proposed the following percentage weights for the availability factor calculation by year from most recent to most historic: 45-35-20%
- In other words, the following percentage weights will be applied to the seasonal availability factors:
 - 45% weight for the most recent year's seasonal availability factor
 - 35% weight on the second year
 - 20% on the third year
- CAISO would then apply proposed weighting to each of the three previous annual periods (for each on-peak and off-peak season) to create Weighted Seasonal Average Availability Factors (WSAAF)

$$\text{Weighted Seasonal Average Availability Factor} = \text{Annual Weighting} * \text{Seasonal Average Availability Factor}$$

Proposed UCAP calculation steps (continued)

- Once the Weighted Seasonal Average Availability Factors (WSAAF) are established for each season of each of prior 3 years, CAISO would sum the factors and apply them to each resource's DQC to determine the resource's seasonal UCAP/NQC ratings

On Peak UCAP/NQC

$$= \sum \text{Weighted Seasonal Average Availability Factors}^{\text{Summer}} * \text{DQC}$$

Off Peak UCAP/NQC

$$= \sum \text{Weighted Seasonal Average Availability Factors}^{\text{Winter}} * \text{DQC}$$

UCAP for New Resources

- For new resources, the CAISO will set the resources UCAP/NQC equal to its DQC
- The subsequent two years of availability data more be weighted more heavily, and the DQC value would quickly roll off until the resource has three years of operational data
- The CAISO proposes the following weights:
 - Year 0 (i.e. before operational data is available): DQC
 - Year 1 70% Year 0 SAAF; 30% DQC
 - Year 2 55% Year 1 SAAF; 45% Year 0 SAAF
 - Year 3 45% Year 2 SAAF; 35% Year 1 SAAF; 20% Year 0 SAAF

Unforced capacity evaluations can be incorporated into the NQC process

- CAISO could conduct a two step process to assess resources' QCs that include resources' deliverability and availability
 - Step 1: Conduct resource deliverability assessment and adjust QC for deliverability, creating Deliverable QC (DQC) for the resource
 - Step 2: Apply non-availability factor to DQC, resulting in the NQC value for the resource under the UCAP construct
 - Capacity value will still be expressed in terms of NQC, addressing stakeholder concerns about existing contracts
 - Must Offer Obligation will be in terms of DQC

UCAP DATA ANALYSIS

Distribution of RA Supply Cushion Hours (in MWs):

Percentile	Off Peak Months 2018-2019	Peak Months 2019	Off Peak Months 2019-2020	Peak Months 2020	Off Peak Months 2020-2021	Peak Months 2021
1	-2020	-3089	-1559	-4791	-416	-1289
5	-429	1573	457	-110	1739	1908
10	897	4218	1954	2874	3147	4358
15	1918	6022	3051	4716	4175	7748
20	2904	7295	4010	6051	5047	6273
25	3649	8313	4700	7171	5687	8689
50	6615	12302	7658	11080	8641	12180
75	9835	15720	11614	14877	13425	16462
90	13249	19133	15463	19331	17833	20615
95	14786	20920	17637	21068	19123	22440
99	16887	23459	20384	23580	21336	24818

Note: A negative value indicates there was a capacity shortfall- did not have enough Shown RA to cover Outages, Net Load, and Contingency Reserves

Summary of Comparison of three suggested Assessment Windows for UCAP

	Top 20%	Top 15%	Top 10%
Number of UCAP AH during Peak Months	883	662	442
Number of UCAP AH during Off Peak Months	874/869	651/655	434/437
% of UCAP AH between HE 17-22	74.5%	82.3%	89.1%
Median number of UCAP AH during Peak Months	4.6	3.3	1.7
Median Number of UCAP AH during Off Peak Months	4.6	3.7	2
% of Day covered by sample	84%	73%	58%

UCAP Assessment window trades off % of days with more hours between HE 18-22. CAISO continues to believe that the top 20% provides the strongest incentive to be available 24x7, while allowing for some outages during unstressed conditions

(See Appendix for full Data Analysis)

Estimating fleet UCAP by fuel type: Natural Gas

$$NQC = \sum \text{Weighted Seasonal Average Availability Factors}^{\text{Season}} * DQC$$

Year	Peak Months SAAF	Annual Weight	Weighted SAAF (Summer / On-Peak)
3	0.925	20%	0.416
2	0.908	35%	0.318
1	0.899	45%	0.180
Total = 100%			0.914
Year	Off Peak SAAF	Annual Weight	Weighted SAAF (Winter / Off-Peak)
3	0.933	20%	0.420
2	0.933	35%	0.327
1	0.9331	45%	0.186
Total = 100%			0.933

Natural gas fleet WSAAF (Peak Months)	Natural gas fleet WSAAF (Off Peak Months)	Natural Gas Fleet	On-Peak NQC	Off-Peak NQC
0.914	0.933	30,808 MWs	28,144.42 MWs	28,737.38 MWs

Note: Uses Top 20% of RA Supply Cushion. Provided as close estimate of the natural gas fleet's UCAP value, actual resource NQC values will vary

Example Resources WSSAF value by different samples of UCAP Assessment Hours

Resource	Top 20%		Top 15%		Top 10%		Top 5%		Top 1%	
	Off Peak	Peak	Off Peak	Peak	Off Peak	Peak	Off Peak	Peak	Off Peak	Peak
Season										
Combined Cycle 1	0.985	0.975	0.985	0.975	0.984	0.977	0.987	0.975	0.976	1.00
Combined Cycle 2	0.899	0.867	0.896	0.860	0.886	0.851	0.869	0.827	0.856	0.768
Steamer 1	0.859	0.794	0.866	0.790	0.873	0.784	0.876	0.773	0.882	0.766
Steamer 2	0.986	0.926	0.985	0.924	0.983	0.918	0.978	0.908	0.980	0.915
CT 1	0.956	0.927	0.955	0.938	0.949	0.938	0.945	0.928	0.949	0.912
Peaker 1	0.883	0.940	0.890	0.937	0.900	0.940	0.912	0.931	0.949	0.867
Peaker 2	0.953	0.973	0.959	0.074	0.943	0.978	0.945	0.980	0.970	0.991
Total Gas Fleet	0.933	0.914	0.933	0.918	0.933	0.910	0.933	0.904	0.930	0.890
Assessment Hours per season	874	883	651	662	434	441	217	221	44	45

To get the final NQC value, multiple the WSSAF by the DQC of each resource

IMPLEMENTATION DISCUSSION

CPUC's Slice of Day framework will likely require changes in CAISO's systems and processes

Key Questions to be Addressed in a CAISO Stakeholder Process:

1. What system and process changes (and data availability) would be required to enable the CAISO to operate effectively along with a SOD construct, e.g. modifications to:
 - i. Must offer obligations and bid insertion rules
 - ii. Outage replacement rules
 - iii. Capacity Procurement Mechanism validation, triggers, and cost allocation
 - iv. Interconnection study inputs and assumptions
2. How does SOD align with other LRA programs in CAISO, i.e. CPUC slice of day versus other non-SOD/capacity-only constructs?

APPENDIX: UCAP ASSESSMENT HOURS DISTRIBUTION

Top 20% HE	Off Peak Months 2018-2019		Peak Months 2019		Off Peak Months 2019-2020		Peak Months 2020		Off Peak Months 2020-2021		Peak Months 2021	
	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.
1	2	0.23	11	1.25	8	0.92	19	2.15	16	1.84	23	2.60
2	2	0.23	5	0.57	3	0.34	9	1.02	13	1.50	11	1.25
3	1	0.12	1	0.11	1	0.11	2	0.23	7	0.81	5	0.57
4	1	0.12	0	0.00	1	0.11	2	0.23	7	0.81	2	0.23
5	1	0.12	2	0.23	2	0.23	1	0.11	9	1.04	3	0.34
6	11	1.27	8	0.91	21	2.40	1	0.11	22	2.53	5	0.57
7	54	6.22	18	2.04	53	6.06	10	1.13	45	5.18	3	0.34
8	36	4.15	10	1.13	32	3.66	11	1.25	25	2.88	1	0.11
9	5	0.58	3	0.34	9	1.03	0	0.00	2	0.23	0	0.00
10	2	0.23	3	0.34	4	0.46	0	0.00	0	0.00	0	0.00
11	0	0.00	1	0.11	2	0.23	0	0.00	0	0.00	0	0.00
12	0	0.00	2	0.23	1	0.11	1	0.11	0	0.00	0	0.00
13	0	0.00	4	0.45	0	0.00	6	0.68	0	0.00	0	0.00
14	0	0.00	10	1.13	2	0.23	12	1.36	1	0.12	3	0.34
15	1	0.12	18	2.04	3	0.34	27	3.06	1	0.12	11	1.25
16	8	0.92	25	2.83	15	1.72	34	3.85	5	0.58	23	2.60
17	41	4.72	42	4.76	52	5.95	46	5.21	43	4.95	35	3.96
18	102	11.75	69	7.81	104	11.90	80	9.06	96	11.05	72	8.15
19	135	15.55	112	12.68	129	14.76	121	13.70	129	14.84	115	13.02
20	149	17.17	151	17.10	137	15.68	143	16.19	141	16.23	141	15.97
21	143	16.47	149	16.87	131	14.99	146	16.53	127	14.61	150	16.99
22	109	12.56	128	14.50	103	11.78	115	13.02	99	11.39	131	14.84
23	55	6.34	82	9.29	47	5.38	70	7.93	57	6.56	99	11.21
24	10	1.15	29	3.28	14	1.60	27	3.06	24	2.76	50	5.66
Total	874	100.0	883	100.0	874	100.0	883	100.0	869	100.0	883	100.0

Top 15% HE	Off Peak Months 2018-2019		Peak Months 2019		Off Peak Months 2019-2020		Peak Months 2020		Off Peak Months 2020-2021		Peak Months 2021	
	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.
1	1	0.15	3	0.45	1	0.15	8	1.21	6	0.92	7	1.06
2	2	0.31	1	0.15	1	0.15	2	0.30	6	0.92	0	0.00
3	1	0.15	0	0.00	0	0.00	0	0.00	4	0.61	0	0.00
4	1	0.15	0	0.00	0	0.00	0	0.00	4	0.61	0	0.00
5	1	0.15	0	0.00	0	0.00	0	0.00	6	0.92	0	0.00
6	1	0.15	1	0.15	5	0.76	0	0.00	13	1.99	0	0.00
7	24	3.69	5	0.76	40	6.11	1	0.15	28	4.29	0	0.00
8	21	3.23	5	0.76	22	3.36	1	0.15	12	1.84	0	0.00
9	3	0.46	2	0.20	5	0.76	0	0.00	0	0.00	0	0.00
10	0	0.00	0	0.00	2	0.31	0	0.00	0	0.00	0	0.00
11	0	0.00	0	0.00	1	0.15	0	0.00	0	0.00	0	0.00
12	0	0.00	0	0.00	0	0.00	1	0.15	0	0.00	0	0.00
13	0	0.00	4	0.60	0	0.00	2	0.30	0	0.00	0	0.00
14	0	0.00	6	0.91	0	0.00	8	1.21	0	0.00	0	0.00
15	0	0.00	15	2.27	1	0.15	15	2.27	1	0.15	5	0.76
16	2	0.31	20	3.02	6	0.92	28	4.23	3	0.46	15	2.27
17	28	4.30	32	4.83	44	6.72	40	6.04	30	4.60	27	4.08
18	87	13.36	56	8.46	92	14.05	64	9.67	85	13.04	52	7.85
19	113	17.36	92	13.90	111	16.95	100	15.11	103	15.80	100	15.11
20	135	20.74	127	19.18	115	17.56	125	18.88	119	18.25	126	19.03
21	121	18.59	125	18.88	105	16.03	119	17.98	105	16.10	123	18.58
22	84	12.90	106	16.01	75	11.45	88	13.29	79	12.12	111	16.77
23	23	3.53	50	7.55	25	3.82	45	6.80	37	5.67	71	10.73
24	3	0.46	12	1.81	4	0.61	15	2.27	11	1.69	25	3.78
Total	651	100.0	662	100.0	655	100.0	662	100.0	651	100.0	662	100.0

Top 10% HE	Off Peak Months 2018-2019		Peak Months 2019		Off Peak Months 2019-2020		Peak Months 2020		Off Peak Months 2020-2021		Peak Months 2021	
	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.
1	1	0.23	0	0.00	0	0.00	0	0.00	1	0.23	0	0.00
2	1	0.23	0	0.00	1	0.23	0	0.00	0	0.00	0	0.00
3	1	0.23	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
4	1	0.23	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
5	1	0.23	0	0.00	0	0.00	0	0.00	1	0.23	0	0.00
6	0	0.00	0	0.00	3	0.69	0	0.00	6	1.38	0	0.00
7	12	2.76	0	0.00	16	3.66	0	0.00	15	3.46	0	0.00
8	8	1.84	0	0.00	10	2.29	0	0.00	8	1.84	0	0.00
9	0	0.00	0	0.00	2	0.46	0	0.00	0	0.00	0	0.00
10	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
11	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
12	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
13	0	0.00	1	0.23	0	0.00	1	0.23	0	0.00	0	0.00
14	0	0.00	3	0.68	0	0.00	3	0.68	0	0.00	0	0.00
15	0	0.00	8	1.81	0	0.00	10	2.26	1	0.23	0	0.00
16	0	0.00	15	3.39	3	0.69	20	4.52	1	0.23	5	1.13
17	20	4.61	19	4.30	28	6.41	29	6.56	22	5.07	16	3.62
18	60	13.82	35	7.92	69	15.79	48	10.86	64	14.75	33	7.47
19	86	19.82	73	16.52	91	20.82	72	16.29	79	18.20	71	16.06
20	101	23.27	97	21.95	95	21.74	94	21.27	91	20.97	100	22.62
21	88	20.28	96	21.72	72	16.48	85	19.23	79	18.20	102	23.08
22	46	10.60	69	15.61	39	8.92	50	11.31	49	11.29	76	17.19
23	7	1.61	22	4.98	8	1.83	22	4.98	15	3.46	34	7.69
24	1	0.23	4	0.90	0	0.00	8	1.81	2	0.46	5	1.13
Total	434	100.0	442	100.0	437	100.0	442	100.0	434	100.0	442	100.0

Top 5% HE	Off Peak Months 2018-2019		Peak Months 2019		Off Peak Months 2019-2020		Peak Months 2020		Off Peak Months 2020-2021		Peak Months 2021	
	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.
1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
3	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
4	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
5	1	0.46	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
6	0	0.00	0	0.00	0	0.00	0	0.00	1	0.46	0	0.00
7	3	1.38	0	0.00	4	1.83	0	0.00	4	1.84	0	0.00
8	2	0.92	0	0.00	2	0.92	0	0.00	4	1.84	0	0.00
9	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
10	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
11	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
12	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
13	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
14	0	0.00	0	0.00	0	0.00	1	0.45	0	0.00	0	0.00
15	0	0.00	3	1.36	0	0.00	3	1.36	0	0.00	0	0.00
16	0	0.00	6	2.71	0	0.00	10	4.52	1	0.46	0	0.00
17	3	1.38	12	5.43	12	5.50	14	6.33	8	3.69	3	1.36
18	35	16.13	23	10.41	49	22.48	27	12.22	37	17.05	12	5.43
19	55	25.35	41	18.55	58	26.61	47	21.27	48	22.12	42	19.00
20	66	30.41	64	28.96	51	23.39	51	23.08	53	24.42	70	31.67
21	39	17.97	42	19.00	34	15.60	41	18.55	43	19.82	58	26.24
22	11	5.07	24	10.86	8	3.67	19	8.60	16	7.37	32	14.48
23	2	0.92	6	2.71	0	0.00	8	3.62	2	0.92	4	1.81
24	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	217	100.0	221	100.0	218	100.0	221	100.0	217	100.0	221	100.0

APPENDIX: UCAP ASSESSMENT HOURS PER DAY

Top 20% HE	Off Peak Months 2018-2019		Peak Months 2019		Off Peak Months 2019-2020		Peak Months 2020		Off Peak Months 2020-2021		Peak Months 2021	
# of UCAP AH per day	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.
0	23	13	28	15	39	22	31	17	23	13	33	18
1	5	3	6	3	3	2	10	5	14	8	2	1
2	6	3	14	8	9	5	16	9	13	7	15	8
3	19	10	25	14	17	9	20	11	27	15	17	9
4	25	14	25	14	18	10	21	11	18	10	21	11
5	28	15	17	9	24	13	21	11	18	10	21	11
6	26	14	18	10	17	9	14	8	14	8	21	11
7	22	12	13	7	12	7	12	7	16	9	18	10
8	12	7	13	7	15	8	7	4	15	8	11	6
9	7	4	5	3	10	6	7	4	6	3	11	6
10	3	2	7	4	5	3	7	4	4	2	6	3
11	5	30	3	2	5	3	5	3	5	3	2	1
12	0	0	4	2	4	2	4	2	3	2	1	1
13	0	0	0	0	1	1	3	2	1	1	1	1
14	0	0	2	1	1	1	2	1	3	2	1	1
15	0	0	1	1	0	0	2	1	2	1	1	1
16	0	0	2	1	0	0	1	1	0	0	0	0
17	0	0	1	1	0	0	0	0	0	0	0	0
18	0	0	0	0	1	1	0	0	0	0	2	1
19	0	0	0	0	0	0	1	1	0	0	0	0
Total	181	100	184	100	181	100	184	100	181	100	184	100

Top 15% HE	Off Peak Months 2018-2019		Peak Months 2019		Off Peak Months 2019-2020		Peak Months 2020		Off Peak Months 2020-2021		Peak Months 2021	
	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.
0	38	21	49	27	55	30	53	29	47	26	53	29
1	3	2	7	4	8	4	10	5	9	5	4	2
2	12	7	17	9	13	7	20	11	15	8	10	5
3	19	16	23	13	12	7	17	9	26	14	23	13
4	18	15	24	13	17	9	28	15	19	10	18	10
5	18	15	22	12	17	9	18	10	18	10	27	15
6	16	14	11	6	20	11	12	7	18	10	19	10
7	9	5	7	4	17	9	7	4	10	5	13	7
8	6	3	6	3	13	7	12	7	8	4	5	3
9	2	1	7	4	5	3	3	2	4	2	5	3
10	0	0	6	3	2	1	7	4	4	2	5	3
11	0	0	1	1	1	1	1	1	0	0	2	1
12	0	0	3	2	0	0	4	2	2	1	0	0
13	0	0	1	1	1	1	2	1	1	1	0	0
14	0	0	0	0	0	0	0	0	1	1	0	0
Total	181	100	184	100	181	100	184	100	181	100	184	100

Top 10% HE	Off Peak Months 2018-2019		Peak Months 2019		Off Peak Months 2019-2020		Peak Months 2020		Off Peak Months 2020-2021		Peak Months 2021	
	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.
0	64	35	80	43	76	42	88	48	73	40	78	42
1	12	7	7	4	5	3	7	4	12	7	7	4
2	14	8	15	8	21	12	10	10	16	9	11	6
3	27	15	23	13	19	10	10	5	21	12	26	14
4	26	14	24	13	14	8	20	11	18	10	18	10
5	27	15	14	8	19	10	9	5	17	9	23	13
6	5	3	4	2	15	8	10	5	16	9	9	5
7	4	2	5	3	7	4	5	3	2	1	5	3
8	2	1	5	3	3	2	6	3	4	2	4	2
9	0	0	2	1	1	1	4	2	2	1	3	2
10	0	0	3	2	1	1	3	2	1	1	0	0
11	0	0	1	1	0	0	3	2	0	0	0	0
12	0	0	1	1	0	0	0	0	0	0	0	0
Total	181	100	184	100	181	100	184	100	181	100	184	100

Top 5% HE	Off Peak Months 2018-2019		Peak Months 2019		Off Peak Months 2019-2020		Peak Months 2020		Off Peak Months 2020-2021		Peak Months 2021	
	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.
# of UCAP AH per day												
0	105	58	119	65	112	62	127	69	115	63	111	60
1	9	5	12	7	10	5	9	5	10	5	6	3
2	22	12	19	10	20	11	10	5	11	6	25	14
3	15	14	7	4	11	6	9	5	18	10	20	11
4	11	6	11	6	11	6	14	8	16	9	12	7
5	9	5	5	3	13	7	1	1	8	4	6	3
6	0	0	4	2	3	2	5	3	2	1	1	1
7	0	0	2	1	0	0	2	1	1	1	3	2
8	0	0	2	1	1	1	4	2	1	1	0	0
9	0	0	3	2	0	0	2	1	0	0	0	0
10	0	0	0	0	0	0	1	1	0	0	0	0
Total	181	100	184	100	181	100	184	100	181	100	184	100