Resource adequacy enhancements discussion

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Resource adequacy enhancements is a comprehensive initiative to enhance the RA program

1. Minimum system RA requirements*
2. Unforced capacity evaluations*
3. System RA showings and sufficiency testing
4. Must offer obligations and bid insertion modifications
5. Planned outage process enhancements
6. RA import provisions
7. Operationalizing storage resources
8. Flexible resource adequacy
9. Local resource adequacy
10. Backstop capacity procurement provisions

* These proposal elements will be discussed today

Resource adequacy enhancements policy development schedule

Date	Milestone
December 11	MSC
December 14	Draft final proposal
January 5-7	Stakeholder meeting on draft final proposal
January 21	Stakeholder comments on draft final proposal
Q1 2021	Draft BRS and Tariff
February 2021	Final proposal
March 2021	Present proposal to CAISO Board

UNFORCED CAPACITY (UCAP) EVALUATIONS

ISO proposes an unforced capacity construct to ensure resources' capacity values reflect availability

- ISO observes a 10% average system forced outage rate
- Current PRM, forced outage substitution rules, and RAAIM have proven inadequate to replace capacity on forced outage
- 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
- Unforced capacity evaluations promote procurement of the most dependable and reliable resources up front by accounting for historical unavailability in their capacity value
  - Allows the ISO to eliminate complicated and ineffective forced outage substitution rules

ISO proposes to integrate unforced capacity evaluations into the NQC process

- ISO will 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

OUTAGE DEFINITIONS, PRIORITIES, AND UCAP IMPACTS

ISO proposes to align ISO BA outages with existing RC West outage definitions

- Outage priorities (from highest to lowest)
  - Forced outage, urgent outage
  - Planned outage
  - Opportunity outage
- Forced and urgent outages will be considered in the UCAP calculation
  - With the exception of transmission induced outages and outages caused by certain force majeure events, such as natural disasters
- Planned and opportunity outages will not be considered in the UCAP calculation

UCAP METHODOLOGY: SEASONAL AVAILABILITY FACTORS

ISO proposes a seasonal availability factor methodology to determine UCAP values

- ISO proposes to utilize a seasonal availability factor based approach for UCAP determinations during the tightest system conditions by looking at the hourly RA Supply Cushion
  - 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
- Resource availability factors will incorporate historical forced and urgent derates and outages to determine the resource's expected future availability and contributions to reliability
- Basic UCAP methodology will be used for thermal and storage resources
- The ISO recognizes that this methodology will not be appropriate for all resource types and provides augmented methodologies to determine these resources' average availability

Identifying 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**
- 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
- Because net load is a 5 minute measure, to convert the supply cushion into an hourly value we take the mean of the supply cushion across all 12 RTD intervals to represent the supply cushion in each operating hour
- Proposal to calculate seasonal UCAP values for:
  - Peak Months- May - October
  - Off-Peak Months- November - April

ISO proposes to assess forced outages during 20% of tightest RA supply cushion hours

- Today we assess 5 RAAIM hours per day, which is roughly 20% of all hours
- Using RAAIM as basis, we are proposing to calculate UCAP based on the top 20% of tightest supply cushion hours for peak and off peak months
- Advantages
  - 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), or weighting of all hours
  - Provides consistency across evaluation periods, and more predictable risk of any one outage on a resource's capacity value
  - Provides observations for majority of days and covers a large enough sample size

ISO completed data analysis on the RA supply cushion hours for May 2018 through October 2020 (see Appendix slides)

- There is a significant difference in top 20% supply cushion MW threshold between peak and off-peak months
  - Peak months tight supply cushion hours are ≤ 8800 MWs
  - Off-peak months tight supply cushion hours are ≤ 2800 MWs
- Most UCAP assessment hours fall during evening net load ramp (68% of hours fall between HE 18-22), and morning ramp during off-peak months (10% of hours fall between HE 6-8)
- The median number of UCAP assessment hours per day are 4 hours during peak months and 5 hours during off peak months
- Supply cushion covers 81% of days per season on average

Summary of UCAP steps (Thermals and Storage)

1. Determine UCAP assessment hours by identify which hours fall into the top 20% of tightest supply cushion hours for each season

2. Determine hourly unavailability factors (HUF) by looking at outages for each UCAP assessment hours each season

$$\textbf{Hourly Unavailability Factor} = \frac{\textbf{Forced+Urgent Outage Impacts}}{\textbf{Pmax}}$$

3. Determine seasonal average availability factors (SAAF) using one minus the average HUFs for each season of prior year

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

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

$$\textbf{On Peak } NQC = \sum \textbf{Weighted Seasonal Average Availability Factors}^{\textbf{Summer}} * DQC$$

$$\textbf{Off Peak NQC} = \sum \textbf{Weighted Seasonal Average Availability Factors}^{\textbf{Winter}} * DQC$$

CAISO proposes the following UCAP methodologies for non-conventional generation

- Wind and Solar: Use ELCC values as NQC
- Demand response: Use ELCC if adopted, otherwise use historic performance and test events relative to dispatch at DRP level
- QFs: Historic performance relative to dispatch
- Hydro: Longer term historical year weighted average assessment
- Hybrids: Consider dynamic limits in the HUF calculation
- Imports: Consider transmission curtailments for non-frim transmission in addition to outages
- Non-dispatchable resources: If QC methodology takes into historic account forced outage rates, DQC will equal NQC
- New Resources: Start with DQC and weight early years of availability data more heavily until 3 years of data are reached

RA showings converted from DQC to NQC (UCAP)

Fuel Type	Peak Month WSAAF	June DQC Shown	June NQC Estimate
Battery	0.964	110.00	106.04
Biomass	0.849	540.00	458.46
Coal	0.965	18.00	17.37
Demand Response*	0.984	235.00	231.24
Gas	0.875	27,002.00	23,626.75
Geothermal	0.868	984.00	854.11
Hydro*	0.816	5,544.00	4,523.90
Nuclear	0.940	1,640.00	1541.60
Pump Hydro*	0.816	1,285.00	1048.56
Interchange*	0	4,118.00	4118.00
Solar	ELCC	3,303.00	3,303.00
Wind	ELCC	1,688.0	1,688.0
HRCV	0.933	29.00	27.06
Other	0.984	0.13	0.13
Pumping Load		59.00	59.00
Total		46,555.13	41,603.22

- Taking the RA showings for June 2020, we applied the Peak Month WSAAF to estimate the new NQC value of the June 2020 RA Showings
- Shows a 10.64% reduction, which matches the roughly 10% forced outage rate of the system.
- Note DR, Hydro, and interchange resources are estimates based on forced outage rates, which differs from the proposed methodologies
- Does not distinguish b/ween dispatchable and non dispatchable resources
- Appendix slides provide more details on WSAAF calculations by Fuel Type

MINIMUM SYSTEM RA REQUIREMENTS

ISO must set minimum RA requirements

- ISO defers to local regulatory authority to set system RA requirements
- Historically in California a PRM has accounted for three things:
  - Reserves
  - Forecast error
  - Forced outages
- No longer necessary to consider forced outage rates in determining these needs because the forced outage rate of resources is embedded in the UCAP/NQC value
- The ISO proposes a minimum system UCAP/NQC requirement that all LSEs must meet and show as RA
  - LRAs may set their specific RA requirements at any level above this minimum threshold

To set minimum requirements, the ISO must establish four parameters

- Requirement based on gross peak or net peak
- Forecast (i.e. 1-in-2, 1-in-5, or 1-in-10 load/net-load)
- Reserves needed at peak
- Forecast error cushion (inversely related to forecast)
  - i.e. If using 1-in-2, add an additional 5-7% for forecast error, if using 1-in-10 forecast, no additional forecast error needed
- ISO proposes to set minimum requirement at 1-in-5 load plus six percent of that forecast
  - Comparable to 1-in-2 forecast plus 10 percent PRM UCAP
  - Allows LRA to set higher obligations
  - Mirrors preliminary CPUC estimated UCAP to achieve 1-in-10 LOLE
  - ISO can continue testing net-peaks

ISO will backstop if the overall system showings are deficient in meeting the minimum requirement

- LRAs may set RA requirements that exceed this minimum threshold, but requirements should not fall below this level
- If a LRA sets a PRM below the minimum threshold, then the ISO will designate CPM capacity to backstop the shortfall if the overall system RA showings are deficient
- In such cases, the CAISO proposes to allocate the costs first to LSEs that did not meet a minimum showing of their forecast plus the default PRM

APPENDIX: PROPOSED OUTAGE DEFINITIONS AND EXISTING PLANNED OUTAGE STUDY WINDOWS AND EXAMPLES

ISO proposes to align ISO BA outages with existing RC West outage definitions

- **Forced Outage** – Facility/equipment that is removed from service in real-time with limited or no notice
- **Urgent Outage** – Facility/equipment that is known to be operable, yet carries an increased risk of a forced outage occurring
  - Facility/equipment remains in service until personnel, equipment and/or system conditions allow the outage to occur
  - Urgent outages allow facilities to be removed from service at an optimal time for overall system reliability
  - The work may or may not be able to wait for the short range outage window
  - An urgent outage must have a justification of its urgency documented in the BA/TOP comments section of the outage submission

*Full requirements are documented in the RC0630 Procedure

ISO proposes to align ISO BA outages with existing RC West outage definitions

- **Planned Outage** – Facility/equipment outage with enough advance notice to meet short range submittal requirements

- **Opportunity Outage** – A Facility/equipment outage that can be taken due to a change in system conditions, weather or availability of field personnel

  - Opportunity outages did not meet the short range window requirements

  - Opportunity outages that cause reliability issues or conflict with other submitted or confirmed outages of a higher priority cannot be implemented

  - Opportunity outages should have an emergency return time of 8 hours or less

*Full requirements are documented in the RC0630 Procedure

ISO BA and RC West outage processes are designed to work in tandem but outage definitions are different under these processes

- In the ISO balancing authority (BA) outage process, generator owners (GO) and participating transmission owners (PTO) submit outages to the ISO BA
- In the RC West outages process, BAs and transmission operators (TOP) submit outages to the RC on behalf of generator owners and transmission owners
- Both processes include a long-range, mid-range, and short-range study window process for planned outages and a real-time process for other outage types
- Currently, outage definitions differ in the ISO BA outage process and the RC West outage process

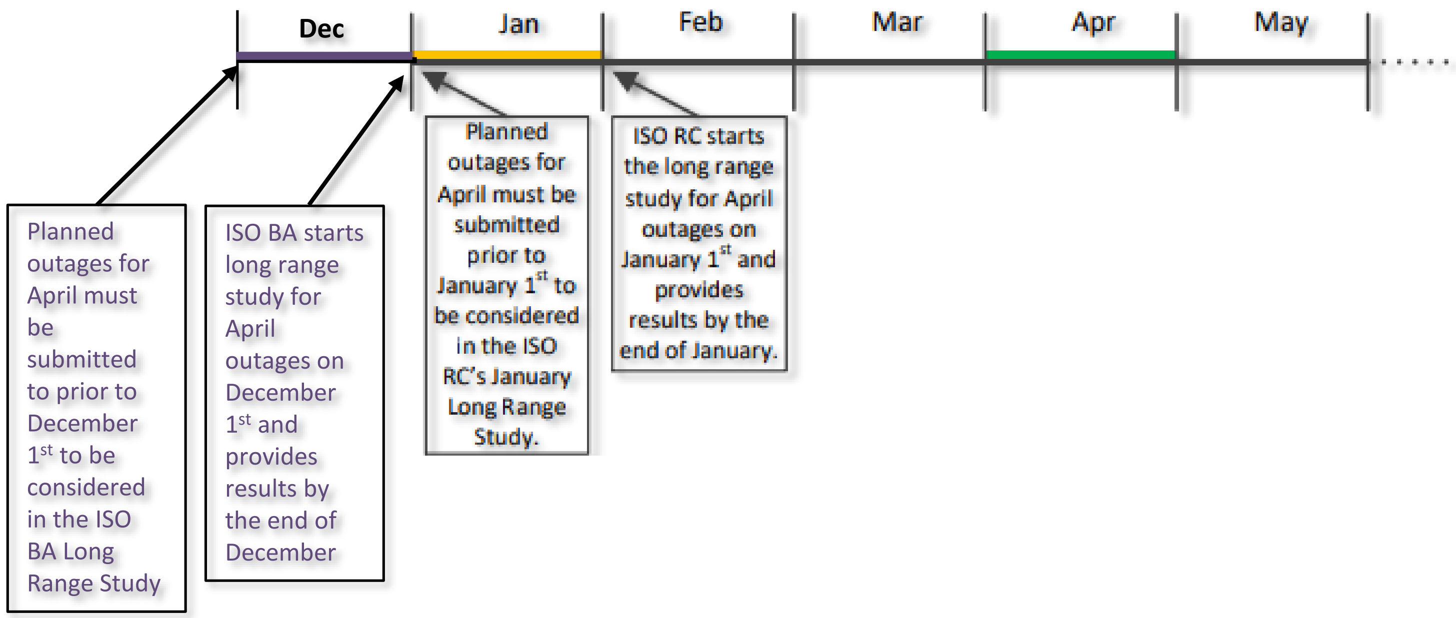
Purpose of outage definition proposal

- Align ISO BA outage definitions with existing RC West outage definitions
- Classify outage definitions for UCAP purposes
- Maintain existing timelines for both the ISO BA outage process and RC outage process, to the extent possible

Existing long range study window

- Long range study window process is optional
- Long range outage submission deadlines:
  - Generator Owners (GO) and Participating Transmission Owners (PTO) submit outages to ISO BA: Prior to the first day of the month one full calendar month in advance of the Reliability Coordinator's (RC) long-range submission deadline
    - ISO provides study results prior to the RC's Long-Range outage submission deadline
  - Balancing Authorities (BA) and Transmission Operators (TOP) submit outages to RC West: Prior to the first day of the month three months prior to the start of the month being studied
    - RC West provides study results no later than the end of the month after outage submittal

Long range study window example

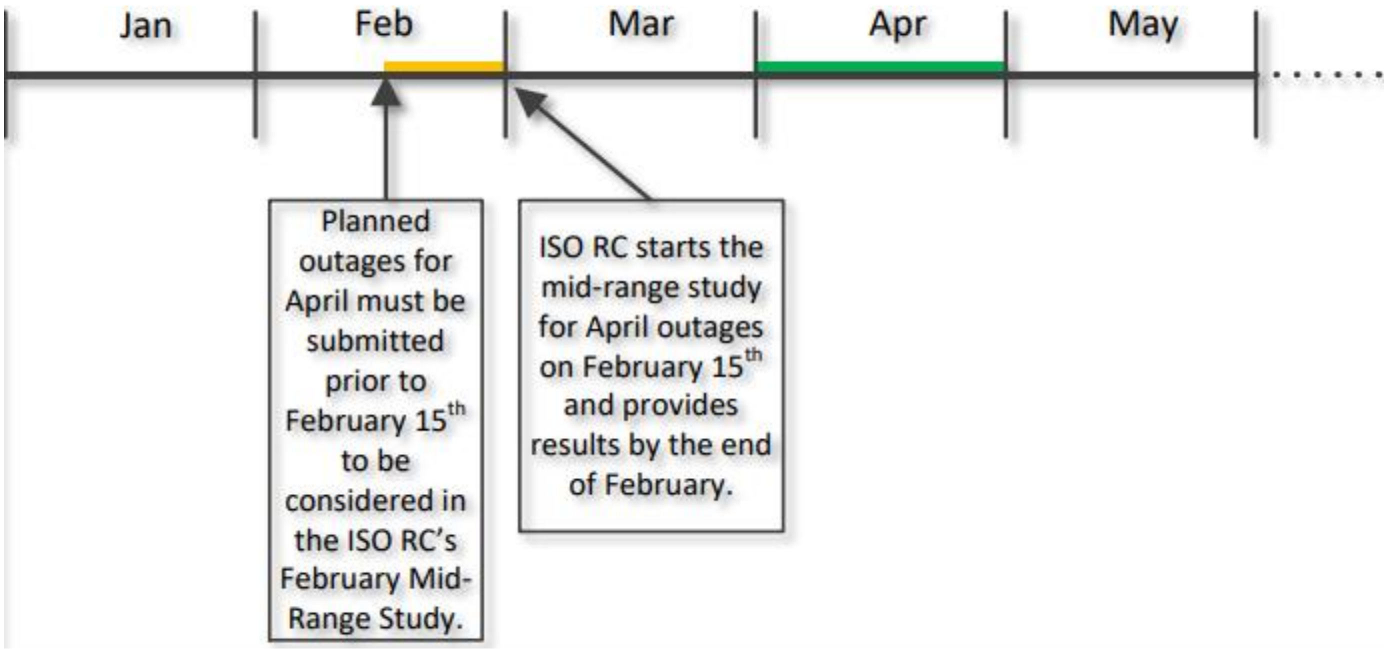


CAISO BA outage submission (GOs and PTOs submit to CAISO BA)
RC outage submission (TOPs and BAs submit to RC)

Existing mid range study window

- Mid range study window process is optional
- RC West qnd ISO BA study timelines are the same
- Mid range outage submission deadlines:
  - GO/PTO submit outages to ISO BA and BAs/TOPs submit outages to RC West: prior to 45 days prior to the start of the month being studied (e.g., outages occurring in April must be submitted prior to 0001 on February 15th)
    - ISO BA and RC West provides study results no later than the end of the month of outage submittal

Mid-range study window example



ISO BA outage submission (GOs and PTOs submit to ISO BA) &
RC West outage submission (TOPs and BAs submit to RC West)

Existing short range study window

- Short range study process is mandatory
- Short range submission deadlines
  - GO/PTO submit outages to ISO BA: No less than 5 full business days in advance of the Reliability Coordinator's short-range submission deadline
  - BA/TOP submit outages to RC West: one (1) week prior to the start of the week being studied

Short range study window example

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
June 4	5	6	7	8	9	10
Planned outages in the yellow colored week should be submitted to the CAISO BA by 0001 on Monday						
11	12	13	14	15	16	17
Planned outages in yellow colored week should be submitted by 0001 on Monday						
18	19	20	21	22	23	24
Planned outage start time (Monday)	Planned outage start time (Tuesday)	Planned outage start time (Wednesday)	Planned outage start time (Thursday)	Planned outage start time (Friday)	Planned outage start time (Saturday)	Planned outage start time (Sunday)

CAISO BA outage submission (GOs and PTOs submit to CAISO BA)
RC outage submission (TOPs and BAs submit to RC)

REAL-TIME STUDY WINDOW

Outages submitted after the short range submission deadline – current process

- Today, BA/TOP outages submitted after the short range study window are either a planned if its submitted before T-7 (T = start of the outage) or forced if it is submitted T-7 or after
  - Planned outages that fall between short range window and T-7 are currently studied as opportunity outages in the RC study process
  - Forced outages (submitted at T-7 or after) are submitted when resource has increased risk of breaking, or if outage happens in real time
- Today, RC opportunity, urgent, and forced outages can be used after the short range study window closes

Outages submitted after the short range submission deadline – proposed process

- If outages are not submitted as planned (i.e., before the short range window ends), outages should be submitted as opportunity, urgent, or forced in alignment with the RC outage definitions
  - Opportunity and urgent outages should not be abused to avoid submitting outages in the planned outage timeframe
    - ISO will have discretion over whether a submitted opportunity outage is studied and approved
    - Planned outages will be prioritized over opportunity outages
    - Because urgent outages have the same priority as forced outages, they will be subject to UCAP

APPENDIX: RA SUPPLY CUSHION ANALYSIS

Monthly distribution of the hourly supply cushion

P	1	2	3	4	5	6	7	8	9	10	11	12
1%	-692	-2641	-2268	-2127	1529	-3097	-4213	-2691	1937	-23	-3354	-3136
5%	1132	-597	-590	711	3704	955	-1518	1059	4650	2390	-1804	-720
10%	2158	626	662	2314	5229	3777	1050	3252	6884	4330	-609	400
20%	**4019**	**2444**	**2325**	**4924**	**7333**	**7228**	**4726**	**6678**	**10612**	**6648**	**1270**	**2432**
25%	4674	3308	3075	5855	8143	8230	6368	7981	11690	7634	2221	3279
50%	7801	6434	5798	9494	10949	11827	10836	12446	15627	11314	5257	6338
75%	10589	10624	9943	13299	14290	15630	16346	15942	18782	14353	7945	9469
90%	13697	14120	13794	17412	16958	19670	20620	18893	21739	17864	10827	12595
95%	15230	15570	15207	19164	17969	21436	23144	20680	23664	20227	12544	14348
99%	17753	18402	16842	20782	20325	23246	26594	24368	28161	22911	14710	17509
Mean	7857	6988	6549	9590	11068	11712	11097	11816	15099	11166	5178	6455

- The October distribution of hourly supply cushion looks more similar to peak/summer months than an off peak month.
  - It has a similar high mean of 11,000+ MWs, and
  - The 20th percentile tends to be above 5000 for peak months and under 5000 for off peak month, and October is over 5000 MMs, and thus similar to peak months.

Seasonal distribution of supply cushion hours (in MWs):

Percentile	Peak Months 2018	Off Peak Months 2018-2019	Peak Months 2019	Off Peak Months 2019-2020	Peak Months 2020
1.0	-2985	-2318	-1109	-2868	-3598
5.0	554	-439	3545	-697	1251
10.0	2752	967	5866	628	4377
20.0	5806	2878	8759	2734	7653
25.0	6843	3639	9820	3573	8800
50.0	10551	6687	14217	6715	12990
75.0	13895	10030	17923	10790	16939
90.0	16709	13478	21237	14322	20696
95.0	18298	14993	23135	16741	22473
99.0	20999	17376	26522	20018	24829
Hours	4416	4344	4416	4367	4416

Note: A negative value indicates there was a capacity shortfall- did not have enough shown RA to cover outages, net load, and contingency reserves

Distribution of the top 20% of supply cushion hours by operating hour shows

- The following table shows the distribution of the top 20% of tight supply conditions hours by operating hour
- As expected, the majority of tight supply cushion hours are around the evening ramp/peak- HE 18-22, averages 68.8% of hours. In off peak months, we also see a spike during the morning ramp
- However, because there are hours that fall outside these ramps, it further incentivizes resources to be available for all hours, b/c there is a chance a tight supply cushion hour could fall outside these predictable periods
- This approach will include a majority of the possible days (averages 81%)

HE	Peak Months 2018		Off Peak Months 2018-2019		Peak Months 2019		Off Peak Months 2019-2020		Peak Months 2020	
	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.
1	3	0.34	4	0.46	18	2.04	5	0.57	16	1.81
2	1	0.11	2	0.23	7	0.79	2	0.23	2	0.57
3	0	0.00	1	0.12	4	0.45	1	0.11	0	0.00
4	0	0.00	1	0.12	4	0.45	1	0.11	0	0.00
5	0	0.00	2	0.23	5	0.57	1	0.11	0	0.00
6	2	0.23	8	0.92	17	1.93	9	1.03	2	0.23
7	12	1.36	54	6.21	26	2.94	51	5.84	12	1.36
8	9	1.02	38	4.37	17	1.93	34	3.89	12	1.36
9	2	0.23	8	0.92	5	0.57	10	1.15	0	0.00
10	2	0.23	2	0.23	4	0.45	5	0.57	0	0.00
11	1	0.11	0	0.00	3	0.34	3	0.34	0	0.00
12	1	0.11	0	0.00	5	0.45	0	0.00	1	0.11
13	7	0.79	0	0.00	6	0.68	0	0.00	7	0.70
14	14	1.59	1	0.12	8	0.91	1	0.11	14	1.59
15	24	2.72	4	0.46	13	1.47	2	0.23	25	2.83
16	33	3.74	8	0.92	23	2.60	12	1.37	35	3.96
17	40	4.52	40	4.60	32	3.62	54	6.19	50	5.66
18	78	8.83	95	10.93	61	6.91	106	12.14	77	8.72
19	119	13.48	127	14.61	106	12.00	127	14.55	119	13.48
20	152	17.21	147	16.92	129	15.74	133	15.23	145	16.42
21	151	17.10	143	16.46	143	16.19	129	14.78	138	15.63
22	125	14.16	114	13.12	125	14.16	112	12.83	110	12.46
23	78	8.83	56	6.44	79	8.95	56	6.41	77	8.72
24	29	3.28	14	1.61	34	3.85	19	2.18	38	4.30
Total	883	100.0	869	100.0	883	100.0	873	100.0	883	100.0

Distribution UCAP assessment hours per day

- The following table shows the distribution of the number of days with how many UCAP assessment hours observed
- 81.53% of days captured
- Peak months have a median of 4 UCAP assessment hours per day and off peak months have a median of 5 UCAP assessment hours per day

# of tight supply hours per day	Peak Months 2018		Off Peak Months 2018/2019		Peak Months 2019		Off Peak Months 2019/2020		Peak Months 2020	
	# of Days	% of Days	# of Days	% of Days	# of Days	% of Days	# of Days	% of Days	# of Days	% of Days
0	25	13.59	28	15.47	36	19.57	46	25.27	34	18.48
1	8	4.35	2	1.10	7	3.80	2	1.10	5	2.72
2	13	7.07	8	4.42	10	5.43	4	2.20	21	11.41
3	26	14.13	24	13.26	23	12.50	10	5.49	21	11.41
4	20	10.87	19	10.50	25	13.59	13	7.14	22	11.96
5	34	18.48	29	16.02	21	11.41	22	12.09	12	6.52
6	9	4.89	23	12.71	15	8.15	29	15.93	14	7.61
7	9	4.89	13	7.18	7	3.80	18	9.89	9	4.89
8	13	7.07	12	6.63	11	5.98	17	9.34	12	6.52
9	6	3.26	14	7.73	12	6.52	6	3.30	9	4.89
10	8	4.35	2	1.10	4	2.17	5	2.75	5	2.72
11	3	1.63	0	0.00	3	1.63	3	1.65	7	3.80
12	4	2.17	4	2.21	1	0.54	3	1.65	5	2.72
13	3	1.63	3	1.66	0	0.00	1	0.55	5	2.72
14	1	0.54	0	0.00	1	0.54	1	0.00	0	0.00
15	1	0.54	0	0.00	1	0.54	0	0.00	1	0.54
16	0	0.00	0	0.00	0	0.00	1	0.55	1	0.54
17	1	0.54	0	0.00	1	0.54	0	0.00	1	0.54
18	0	0.00	0	0.00	3	1.63	0	0.00	0	0.00
19	0	0.00	0	0.00	2	1.09	1	0.55	0	0.00
20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
21	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
22	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
23	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
24	0	0.00	0	0.00	1	0.54	0	0.00	0	0.00
Total	184	100.00	181	100.0	184	100.0	182	100.0	184	100.0

APPENDIX: WSAAF BY FUEL TYPE

Pulled CIRA data to estimate the fuel type WSAAF to assess fleet impact

- Daily outage rates where taken from CIRA and merged with the UCAP assessment hours for May 2018 - October 2020
- Off Peak Year 3 was estimated as the average of Year 1 and 2
- While individual resource’s outage data may vary from the fleet wide fuel type average, this data can provide some estimation of the impact of moving towards a UCAP paradigm

Estimating fleet UCAP by fuel type: Bio Gas

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

Year	Peak Months SAAF	Annual Weight	Weighted SAAF (Summer / On-Peak)
3	0.854	20%	0.171
2	0.819	35%	0.290
1	0.882	45%	0.397
		Total = 100%	0.864
Year	**Off Peak SAAF**	**Annual Weight**	**Weighted SAAF (Winter / Off-Peak)**
3	0.891	20%	0.178
2	0.882	35%	0.287
1	0.857	45%	0.386
		Total = 100%	0.851

Bio-gas fleet WSAAF (Peak Months)	Bio-gas fleet WSAAF (Off Peak Months)	Example DQC of Bio-gas resource	On-Peak NQC	Off-Peak NQC
0.864	0.851	30 MW	25.92MW	25.53 MW

Note: Based on daily outage rates weighted by the number of UCAP assessment hours, actual resource NQC values will vary

Estimating fleet UCAP by fuel type: Bio Mass

$$\mathbf{NQC} = \sum \mathbf{Weighted\ Seasonl\ Average\ Availability\ Factors}^{\mathbf{Season}} * \boldsymbol{DQC}$$

Year	Peak Months SAAF	Annual Weight	Weighted SAAF (Summer / On-Peak)
3	0.848	20%	0.170
2	0.830	35%	0.291
1	0.872	45%	0.392
		Total = 100%	0.849
Year	**Off Peak SAAF**	**Annual Weight**	**Weighted SAAF (Winter / Off-Peak)**
3	0.838	20%	0.168
2	0.819	35%	0.308
1	0.901	45%	0.405
		Total = 100%	0.891

Bio-mass fleet WSAAF (Peak Months)	Bio-mass fleet WSAAF (Off Peak Months)	Example DQC of Bio-mass resource	On-Peak NQC	Off-Peak NQC
0.849	0.891	50 MW	42.45 MW	44.55 MW

Note: Based on daily outage rates weighted by the number of UCAP assessment hours, actual resource NQC values will vary

Estimating fleet UCAP by fuel type: Coal

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

Year	Peak Months SAAF	Annual Weight	Weighted SAAF (Summer / On-Peak)
3	0.915	20%	0.183
2	0.979	35%	0.343
1	0.977	45%	0.430
		Total = 100%	0.965
Year	**Off Peak SAAF**	**Annual Weight**	**Weighted SAAF (Winter / Off-Peak)**
3	0.942	20%	0.188
2	0.901	35%	0.315
1	0.984	45%	0.443
		Total = 100%	0.946

Coal fleet WSAAF (Peak Months)	Coal fleet WSAAF (Off Peak Months)	Example DQC of Coal resource	On-Peak NQC	Off-Peak NQC
0.965	0.946	10 MW	9.65 MW	9.46 MW

Note: Based on daily outage rates weighted by the number of UCAP assessment hours, actual resource NQC values will vary

Estimating fleet UCAP by fuel type: Natural Gas

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

Year	Peak Months SAAF	Annual Weight	Weighted SAAF (Summer / On-Peak)
3	0.886	20%	0.177
2	0.869	35%	0.304
1	0.875	45%	0.394
		Total = 100%	0.875
Year	**Off Peak SAAF**	**Annual Weight**	**Weighted SAAF (Winter / Off-Peak)**
3	0.893	20%	0.179
2	0.901	35%	0.315
1	0.884	45%	0.398
		Total = 100%	0.892

Natural gas fleet WSAAF (Peak Months)	Natural gas fleet WSAAF (Off Peak Months)	Example DQC of Natural Gas resource	On-Peak NQC	Off-Peak NQC
0.875	0.892	500 MW	437.5 MW	446 MW

Note: Based on daily outage rates weighted by the number of UCAP assessment hours, actual resource NQC values will vary

Estimating fleet UCAP by fuel type: Geo-Thermal

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

Year	Peak Months SAAF	Annual Weight	Weighted SAAF (Summer / On-Peak)
3	0.893	20%	0.179
2	0.848	35%	0.297
1	0.872	45%	0.392
		Total = 100%	0.868
Year	**Off Peak SAAF**	**Annual Weight**	**Weighted SAAF (Winter / Off-Peak)**
3	0.788	20%	0.158
2	0.877	35%	0.307
1	0.699	45%	0.315
		Total = 100%	0.780

Geo-thermal fleet WSAAF (Peak Months)	Geo-thermal fleet WSAAF (Off Peak Months)	Example DQC of Geo-thermal resource	On-Peak NQC	Off-Peak NQC
0.868	0.780	35 MW	30.38 MW	27.3 MW

Note: Based on daily outage rates weighted by the number of UCAP assessment hours, actual resource NQC values will vary

Estimating fleet UCAP by fuel type: HRCV (Heat Recovery)

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

Year	Peak Months SAAF	Annual Weight	Weighted SAAF (Summer / On-Peak)
3	0.959	20%	0.192
2	0.879	35%	0.308
1	0.962	45%	0.422
		Total = 100%	0.933
Year	**Off Peak SAAF**	**Annual Weight**	**Weighted SAAF (Winter / Off-Peak)**
3	0.876	20%	0.175
2	0.809	35%	0.283
1	0.944	45%	0.425
		Total = 100%	0.883

HRCV fleet WSAAF (Peak Months)	HRCV fleet WSAAF (Off Peak Months)	Example DQC of HRCV resource	On-Peak NQC	Off-Peak NQC
0.933	0.891	15 MW	13.99 MW	13.25 MW

Note: Based on daily outage rates weighted by the number of UCAP assessment hours, actual resource NQC values will vary

Estimating Fleet UCAP by Fuel Type: LESR (Energy Storage)

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

Year	Peak Months SAAF	Annual Weight	Weighted SAAF (Summer / On-Peak)
3	0.975	20%	0.195
2	0.964	35%	0.337
1	0.958	45%	0.431
		Total = 100%	0.964
Year	**Off Peak SAAF**	**Annual Weight**	**Weighted SAAF (Winter / Off-Peak)**
3	0.948	20%	0.190
2	0.969	35%	0.339
1	0.927	45%	0.417
		Total = 100%	0.946

Storage fleet WSAAF (Peak Months)	Storage fleet WSAAF (Off Peak Months)	Example DQC of Storage resource	On-Peak NQC	Off-Peak NQC
0.964	0.946	25 MW	24.09 MW	23.65 MW

Note: Based on daily outage rates weighted by the number of UCAP assessment hours, actual resource NQC values will vary.

Estimating fleet UCAP by fuel type: Nuclear

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

Year	Peak Months SAAF	Annual Weight	Weighted SAAF (Summer / On-Peak)
3	0.983	20%	0.197
2	0.999	35%	0.349
1	0.875	45%	0.394
		Total = 100%	0.940
Year	**Off Peak SAAF**	**Annual Weight**	**Weighted SAAF (Winter / Off-Peak)**
3	0.957	20%	0.191
2	0.946	35%	0.331
1	0.968	45%	0.436
		Total = 100%	0.958

Nuclear fleet WSAAF (Peak Months)	Nuclear fleet WSAAF (Off Peak Months)	Example DQC of Nuclear resource	On-Peak NQC	Off-Peak NQC
0.940	0.958	800 MW	751.7 MW	766.4 MW

Note: Based on daily outage rates weighted by the number of UCAP assessment hours, actual resource NQC values will vary

Estimating fleet UCAP by fuel type: Waste

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

Year	Peak Months SAAF	Annual Weight	Weighted SAAF (Summer / On-Peak)
3	0.957	20%	0.191
2	0.857	35%	0.300
1	0.846	45%	0.380
		Total = 100%	0.872
Year	**Off Peak SAAF**	**Annual Weight**	**Weighted SAAF (Winter / Off-Peak)**
3	0.865	20%	0.173
2	0.894	35%	0.313
1	0.835	45%	0.376
		Total = 100%	0.862

Waste fleet WSAAF (Peak Months)	Waste fleet WSAAF (Off Peak Months)	Example DQC of Waste resource	On-Peak NQC	Off-Peak NQC
0.872	0.862	15 MW	13.08 MW	12.93 MW

Note: Based on daily outage rates weighted by the number of UCAP assessment hours, actual resource NQC values will vary

APPENDIX: TOP 10% SUPPLY CUSHION, UCAP ASSESSMENT HOURS

California ISO

Distribution of supply cushion hours (in MWs): October= Peak month

Percentile	2018 Peak Months	2018-2019 Off-Peak Months	2019 Peak Months	2019-2020 Off Peak Months
1.0	-2985	-2318	-1109	-2868
5.0	554	-439	3545	-697
10.0	2752	967	5866	628
20.0	5806	2878	8759	2734
25.0	6843	3639	9820	3573
50.0	10551	6687	14217	6715
75.0	13895	10030	17923	10790
90.0	16709	13478	21237	14322
95.0	18298	14993	23135	16741
99.0	20999	17376	26522	20018
Hours	4416	4344	4416	4367

Calpine suggested using the top 10% to tightest supply cushion hours, the following analysis shows the impact this would have

Distribution of the top 10% of supply cushion hours by operating hour: October as on peak

HE	Peak Months 2018		Off Peak Months 2018-2019		Peak Months 2019		Off Peak Months 2019-2020	
	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.	# of Obs.	% of Obs.
1	0	0.00	1	0.23	2	0.45	1	0.23
2	0	0.00	1	0.23	1	0.23	0	0.00
3	0	0.00	1	0.23	1	0.23	0	0.00
4	0	0.00	1	0.23	0	0.00	0	0.00
5	0	0.00	1	0.23	1	0.00	0	0.00
6	0	0.00	0	0.00	1	0.00	1	0.23
7	1	0.23	13	3.00	4	0.90	14	3.20
8	1	0.23	8	1.84	2	0.45	12	2.75
9	1	0.23	0	0.00	1	0.23	4	0.92
10	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
12	0	0.00	0	0.00	1	0.23	0	0.00
13	0	0.00	0	0.00	1	0.23	0	0.00
14	3	0.68	0	0.00	4	0.90	0	0.00
15	9	2.04	0	0.00	6	1.36	0	0.00
16	13	2.94	2	0.26	11	2.49	2	0.46
17	22	4.98	24	5.53	18	4.07	22	5.03
18	33	7.47	56	12.90	32	7.24	68	15.56
19	73	16.52	84	19.35	65	14.71	95	21.74
20	98	22.17	98	22.58	95	21.49	97	22.20
21	98	22.17	83	19.12	101	22.85	68	15.56
22	66	14.93	51	11.75	63	14.25	42	9.61
23	22	4.98	8	1.84	25	5.66	10	2.29
24	2	0.45	2	0.46	7	1.58	1	0.23
Total	442	100.0	434	100.0	442	100.0	437	100.0

- This table shows the distribution of the top 10% of tight supply conditions hours by operating hour.
- As expected, the majority of tight supply cushion hours are around the evening ramp/peak- HE 18-22, averages 83.54% of hours. In Off Peak Months, we also see fewer hours that capture the morning ramp.
- Because fewer hours fall outside of the evening ramp, this would diminish the incentive to be available 24x7

Distribution top 10% UCAP assessment hours per day: October as peak

# of tight supply hours per day	Peak Months 2018		Off Peak Months 2018/2019		Peak Months 2019		Off Peak Months 2019/2020	
	# of Days	% of Days	# of Days	% of Days	# of Days	% of Days	# of Days	% of Days
0	75	40.76	72	39.78	77	41.85	73	40.11
1	13	7.07	11	6.08	9	4.89	5	2.75
2	16	8.70	15	8.29	19	10.33	25	13.74
3	27	14.67	22	12.15	30	16.30	24	13.19
4	18	9.78	15	8.29	16	8.70	17	9.24
5	11	5.98	22	12.15	8	4.35	15	8.24
6	6	3.26	16	8.84	10	5.43	11	6.04
7	5	2.72	4	2.21	3	1.63	4	2.20
8	3	1.63	3	1.66	5	2.72	5	2.75
9	7	3.80	1	0.55	2	1.09	1	0.55
10	2	1.09	0	0.00	1	0.54	1	0.55
11	1	0.54	0	0.00	3	1.63	0	0.00
12					0	0.00	0	0.00
13					0	0.00	0	0.00
14					0	0.00	1	0.55
15					0	0.00		
16					0	0.00		
17					0	0.00		
18					0	0.00		
19					1	0.54		
20								
21								
22								
23								
24								
Total	184	100.00	181	100.0	184	100.0	182	100.0

- Only covers 59% of days
- The median number of UCAP assessment hours per day is 2

- By selecting the top 20% of tightest supply cushion, we can capture a greater percentage of days, and more hours outside of the evening ramp which will increase the incentives to perform proper maintenance to avoid a UCAP reduction.