# Resource adequacy enhancements discussion

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

1. Determining 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 |
|---|---|
| September 15,17 | Working Group |
| Oct 1 | Stakeholder comments on Working Group due |
| Oct 9 | Market Surveillance Committee Meeting |
| Nov 3 | Draft final proposal |
| Nov 10-12 | Stakeholder meeting on draft final proposal |
| Nov 13 | Market Surveillance Committee Meeting |
| Dec 3 | Stakeholder comments on draft final proposal |
| Aug 2020 - Q1 2021 | Draft Business Requirements Specifications and Tariff |
| January 2021 | Final proposal |
| Q1 2021 | Present proposal to ISO Board |

# UNFORCED CAPACITY (UCAP) EVALUATIONS

# OUTAGE DEFINITIONS, PRIORITIES, AND UCAP IMPACTS

# 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

# Outage priorities and UCAP impacts

- 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
- Planned and opportunity outages will not be considered in the UCAP calculation

# ISO will not include a limited set of certain forced or urgent outages in the UCAP calculation

- ISO is evaluating the outage exemption proposal to ensure it:
  - Incentivizes resource maintenance and availability
  - Provides clear exemption criteria
- Considering updating the proposal such that if outage is caused by equipment failure that is not owned, operated, or maintained by generator, then the outage should be UCAP exempt
- ISO is evaluating existing forced outage nature of work categories for this purpose
  - Nature of work categories as currently defined can lead to ambiguity with respect to RAAIM exemptions

# UCAP METHODOLOGY: SEASONAL AVAILABILITY FACTORS

# ISO has updated seasonal availability factor proposal for UCAP evaluations

- ISO will develop and utilize a seasonal availability factor based approach for UCAP determinations during the tightest system conditions
- Resource availability factors will incorporate historical derates and forced and urgent outages
  - Excludes planned and approved opportunity outages
- ISO believes this updated UCAP determination proposal, based on seasonal availability factors, is best applied to the following resource types:
  - Thermal, hydro, and storage resources
  - For resources with QC values calculated using an ELCC methodology, ISO will use ELCC value as the UCAP value

# ISO proposes to calculate resource availability on a seasonal basis measured on tight supply cushion hours

- Considers different impacts of availability during seasons across the year to better reflect unit reliability
- A large supply cushion indicates less real-time system resource adequacy risk because more energy remains available to respond to unplanned market events
- A low 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
- Stakeholder comments generally support a seasonal approach

# Proposes to assess forced outages during 20% of tightest supply cushion hours

- Today we assess 5 RAAIM hours per day, which is roughly 20% of all hours
- Using RAAIM as inspiration, 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 really needed them
  - Unlike RAAIM, 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 the majority of days and covers a large enough sample size 800+ hours

# Defining top 20% tightest supply cushion hours

- **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
- Measured in MWs
- 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

# Defining peak and off peak months

- Proposal to calculate seasonal UCAP values for:
  - Peak Months- May- October
  - Off-Peak Months- November- April
- Appendix slide presents the monthly hourly supply cushion distribution, and evidence supports peak and off peak definition
- Next slide further provides evidence of the need for seasonal approach- which could lead to over sampling of hours in off-peak months, and thus may not capture resource availability during summer months when grid is known to be more stressed or when ambient derates tend to be higher

# Data analysis of supply cushion hours shows:

- Appendix shows analysis on supply cushion hours for May 2018-April 2020.
- Shows significant difference in top 20% supply cushion MW threshold- peak months tight supply cushion hours are ≤ 8800 MWs; Off-peak months tight supply cushion hours are ≤ 2800 MWs
- Majority UCAP assessment hours fall during evening net load ramp (70% of hours fall between HE 18-22), and morning ramp during off-peak months (10% of hours fall between HE 6-8)
- Median number of UCAP assessment hours are 4 hours during off-peak months and 5 hours during peak months
- Covers on average 82% of days

# Summary of UCAP process steps

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) for each UCAP assessment hours each season
3. Determine seasonal average availability factors (SAAF) using HUFs for each season of prior year
4. Determine weighted seasonal average availability factors (WSAAF) using proposed weighting approach
5. Apply WSAAFs for each season of the prior 3 annual periods to determine monthly UCAP (On-peak and Off-peak) values for each resource

# Proposed UCAP calculation steps

- ISO will determine each resource's hourly unavailability factor (HUF) for each of the 20% tightest supply cushion hours per season

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

- ISO is considering additional multiplier for outages during staged emergencies

- ISO will 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

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

# Proposed UCAP calculation steps (continued)

- ISO also proposes a weighting method for determining a resource's UCAP values over three year period
- ISO proposes 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

# Proposed UCAP calculation steps (continued)

- Seasonal average availability factors (SAAF) will be calculated for each of the 3 prior historical years (for both on-peak and off-peak seasons)
- SAAFs will based on each hourly unavailability factor (HUF) derived by assessing forced and urgent outages compared to the Pmax value for each resource
- ISO will 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)

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

# Proposed UCAP calculation steps (continued)

- Once the weighted seasonal average availability factors (WSAAF) are established for each season of each of prior 3 years, ISO will sum the factors and apply them to each resource's NQC to determine the resource's seasonal UCAP ratings

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

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

# ISO proposed the following UCAP methodologies for non-conventional generation

- Wind and Solar: Use ELCC values as UCAP
- Demand response: Use ELCC if adopted, otherwise use performance metric
- Hydro: Longer term historical year weighted average assessment
- Storage: Consider state of charge constraints in UCAP calculation
- Hybrids: Consider dynamic limits in UCAP calculation
- Imports: Consider transmission curtailments for non-frim transmission

# RA showings converted to UCAP

| Fuel Type | Peak Month WSAAF | June NQC Shown | June UCAP Estimate |
|---|---|---|---|
| **Battery** | 0.969 | 110.00 | 106.60 |
| **Biomass** | 0.832 | 540.00 | 449.30 |
| **Coal** | 0.950 | 18.00 | 17.10 |
| **Demand Response*** | 0.977 | 235.00 | 229.60 |
| **Gas** | 0.877 | 27,002.00 | 23,680.80 |
| **Geothermal** | 0.869 | 984.00 | 855.10 |
| **Hydro*** | 0.863 | 5,544.00 | 4,784.50 |
| **Nuclear** | 0.992 | 1,640.00 | 1,626.90 |
| **Pump Hydro*** | 0.863 | 1,285.00 | 1,109.00 |
| **Interchange*** | | 4,118.00 | 4,118.00 |
| **Solar** | ELCC | 3,303.00 | 3,303.00 |
| **Wind** | ELCC | 1,688.0 | 1,688.00 |
| **HRCV** | 0.915 | 29.00 | 26.50 |
| **Other** | 0.977 | 0.13 | 0.13 |
| **Pumping Load** | | 59.00 | 59.00 |
| **Total** | | 46,555.13 | 42,053.53 |

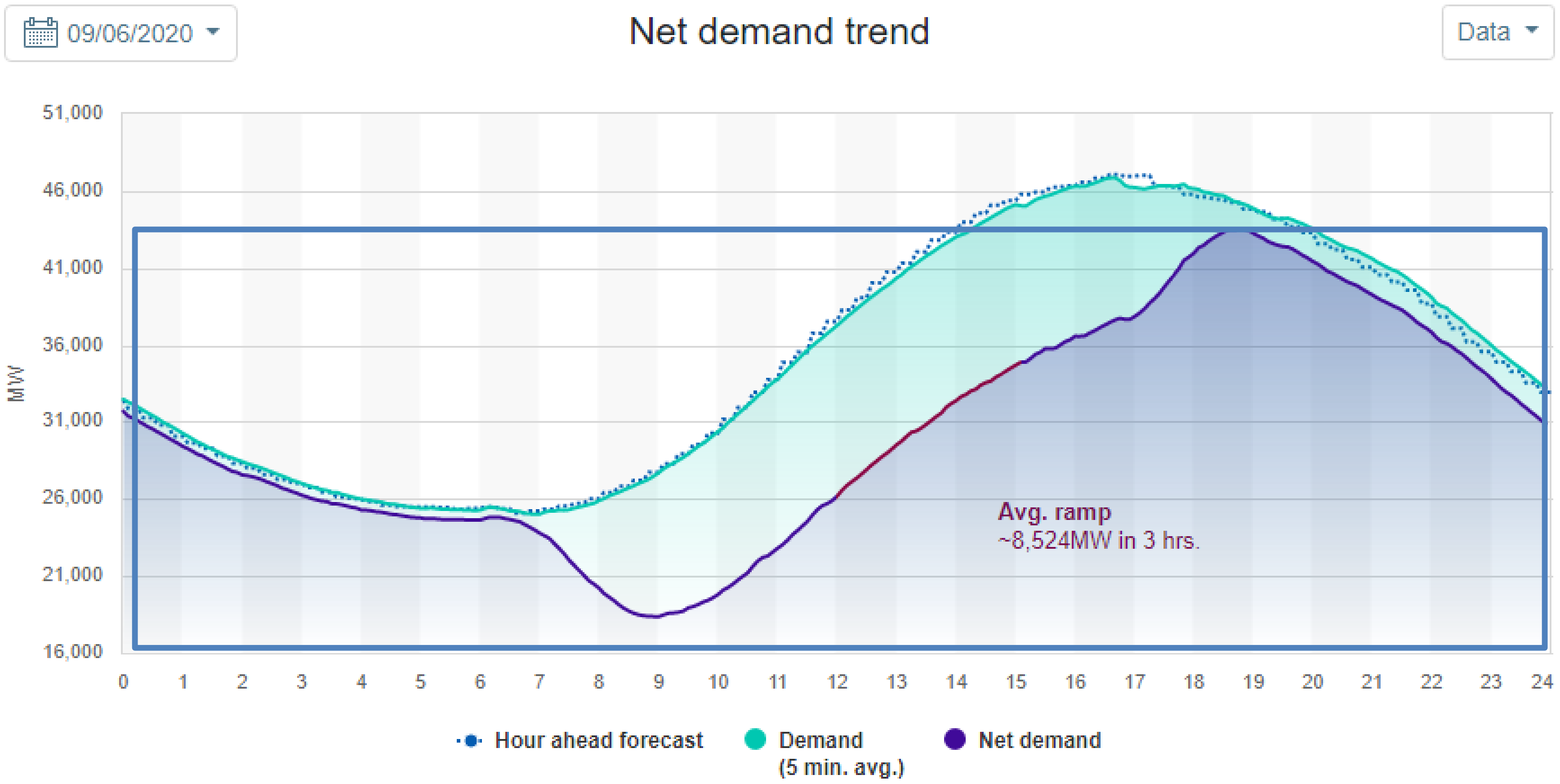
- Taking the RA showings for June 2020, we applied the Peak Month WSAAF to estimate the UCAP value of the June 2020 Showings
- Shows a 9.66% reduction, which matches the roughly 10% force outage rate of the system.
- Note DR, Hydro, and interchange resources are estimates based on forced outage rates, which differs from the methodologies covered in the 5th RSP
- Appendix slides provides more details on WSAAF calculations by Fuel Type

# OPERATIONALIZING STORAGE

# Battery storage is a rapidly growing segment of California's resource mix

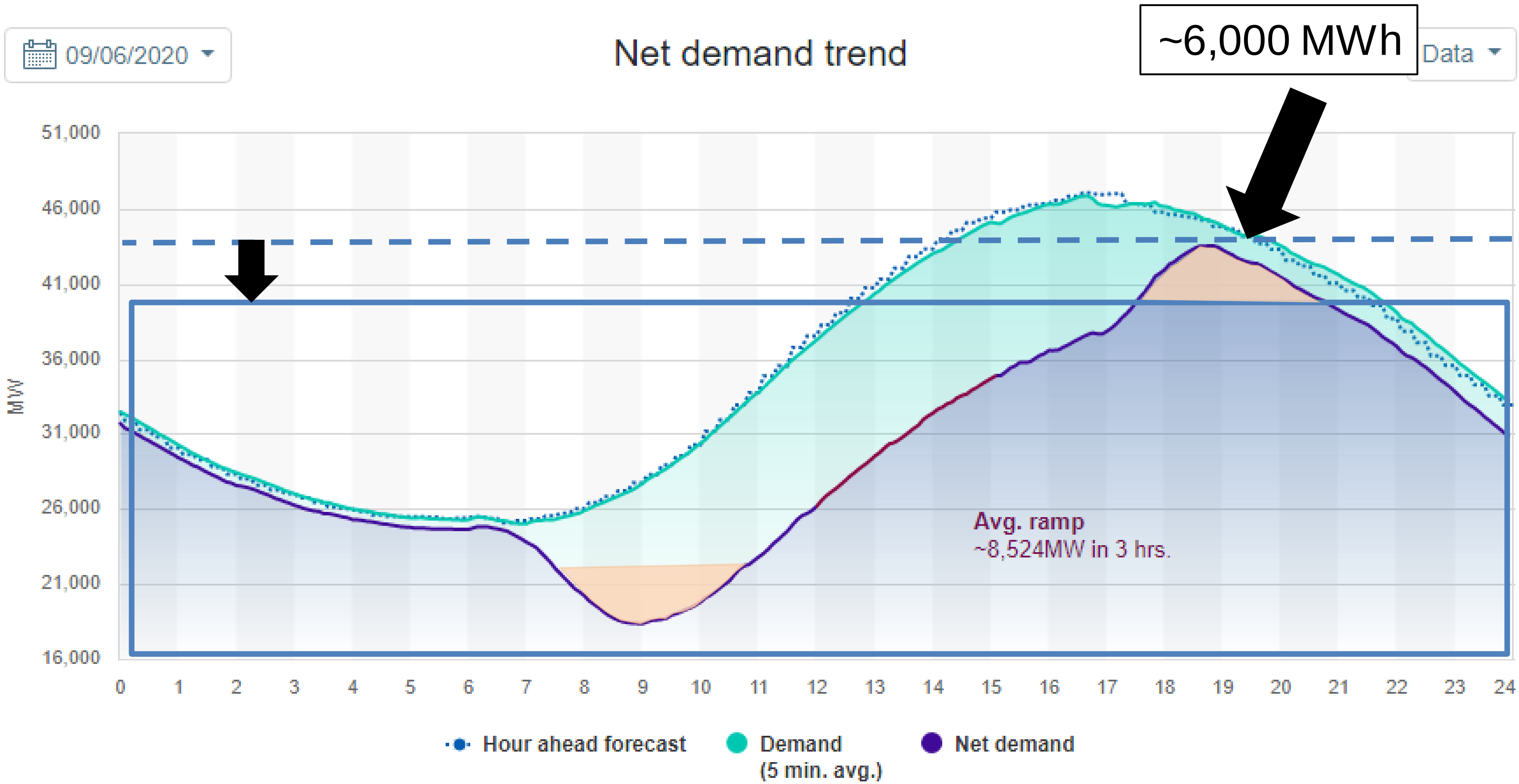
- The CPUC authorized new resource procurement for 3,300 MW of resource adequacy capacity
- Retirement over next few years includes older steam resources and Diablo Canyon nuclear facility in 2024
- Today there are about 550 MW of storage online, but the ISO may be dispatching thousands of MW shortly
- Much of the new procurement may come in the form of battery storage and hybrid (solar + storage) resources
- These resources bring new integration challenges
- The minimum charge requirement (MCR) will work with other RA tools to ensure storage is charged

# Today the ISO has about enough (traditional) resources to meet peak net-demand




California ISO

# After traditional generation partial retirement the ISO will rely on storage to meet net peaks




California ISO

# Storage resources will be critical to meet peak net demand in the future

- The ISO will rely on storage resources to meet peak load in the future
- The day-ahead market will schedule storage resources to charge during the lowest priced hours and discharge during the highest hours
  - Storage 'moves energy' but does not produce additional energy
  - Imposes additional cost to the grid to move this energy
- In the event that these resources are not charged the ISO may not be able to serve load
  - Resources may not charge in the real-time market if 'low prices' do not materialize
  - Resources may discharge 'too soon' if there are spikey or volatile prices in the real-time market

# There are a number of potential ways to solve the reliability issue in the real-time market

1. Impose a heavy charge on resources if they are not available (i.e. charged) in the real-time market
2. Institute high penalty prices for market infeasibilities
3. Increase look-ahead of real-time market to 12+ hours
4. Use a ‘STUC like’ tool to commit batteries in the real-time market if insufficient SOC detected
5. Require resources maintain certain state of charge values from the day-ahead market
6. Impose system and local requirements on gross SOC
7. Copy day-ahead schedules explicitly into real-time

# ISO proposes a solution to this problem with a new tool called the minimum charge requirement (MCR)

- The MCR uses individual day-ahead discharge schedules to set a minimum amount of state of charge that a resource must carry until the discharge hours
- The MCR is imposed as a market constraint that may be relaxed, similar to other constraints
- Storage resources will be ‘guaranteed’ of meeting their day-ahead schedules in the real-time market
  - Reduces risk that a resource without energy will have to buy back day-ahead schedules
- Storage resources will not have an MCR imposed if they do not receive a discharge schedule in the day-ahead market
- The MCR does not bind if resources bid in such a way to charge above the minimum requirements

# Stakeholders asked if there are considerations for not imposing the minimum charge requirement each day

- Some stakeholders have asked that the ISO only impose the MCR on the 20 peak load days
- The ISO may consider only imposing requirements on days when batteries are nearly ‘critical’
  - Use CEC 1-in-2 year daily forecasts prior to the start of each month
  - Determine non-storage capacity
  - Flag days when load exceeds 90% of non-storage capacity as days when the minimum charge requirement is imposed
- Seeking MSC guidance on other potential exceptions that could be offered and would not jeopardize grid reliability
- Also discuss relaxation of constraint with high prices and imposing the constraint either at the later of day-charging hours or lowest priced energy hour

# APPENDIX: EXISTING PLANNED OUTAGE STUDY WINDOWS AND EXAMPLES

# 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 CAISO 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

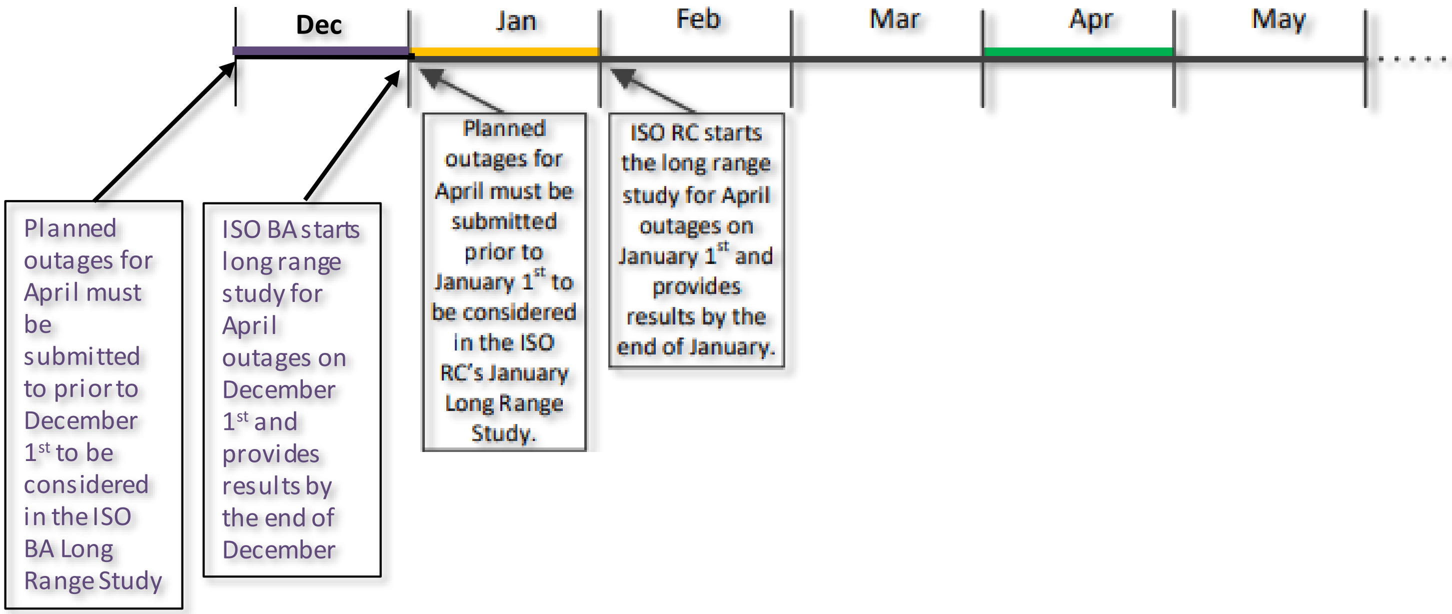
# Purpose of outage definition proposal

- Align ISO BA outage definitions with existing RC 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 provides study results no later than the end of the month after outage submittal

# Long range study window example



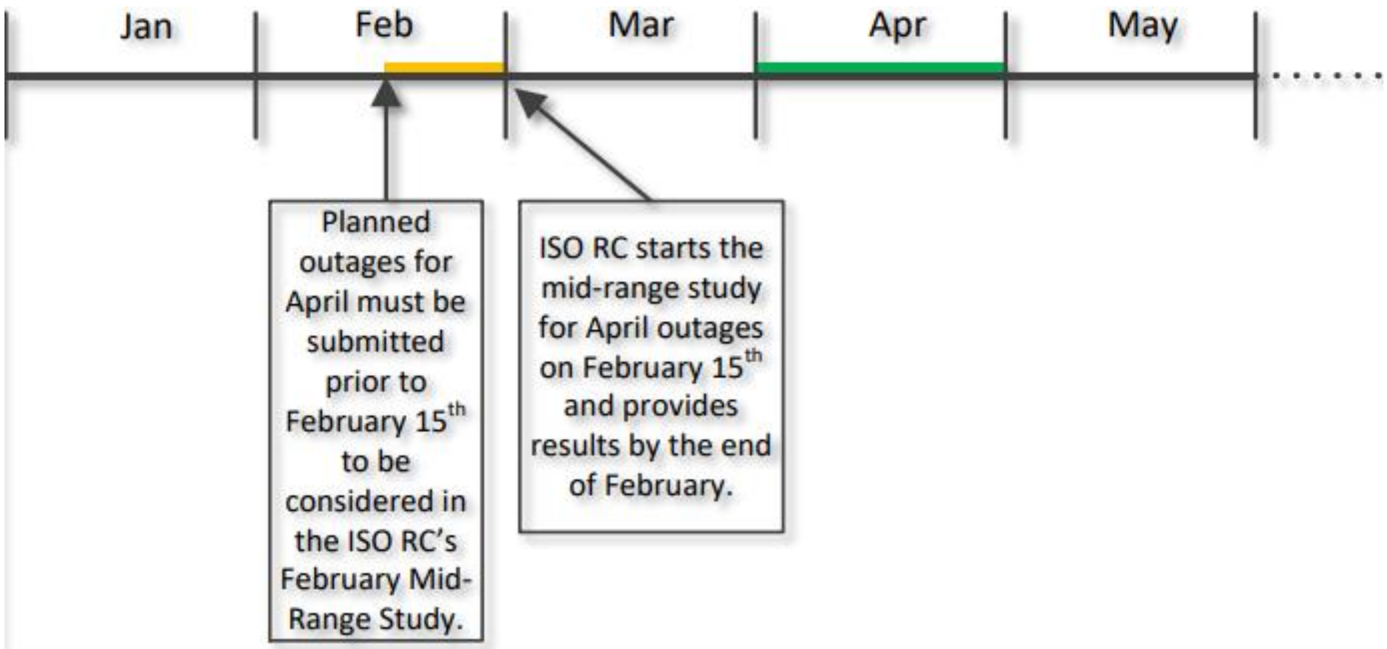

CAISO BA outage submission (GOs and PTOs submit to CAISO BA)

RC outage submission (TOPs and BAs submit to RC)

# Existing mid range study window

- Mid range study window process is optional
- RC and 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 15$^{th}$)
    - ISO BA and RC 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 outage submission (TOPs and BAs submit to RC)

# 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 an 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: SUPPLY CUSHION ANALYSIS

California ISO

# 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 |
|---|---|---|---|---|
| 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 |

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:

| 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 | 3 | 0.34 | 4 | 0.46 | 18 | 2.04 | 5 | 0.57 |
| 2 | 1 | 0.11 | 2 | 0.23 | 7 | 0.79 | 2 | 0.23 |
| 3 | 0 | 0.00 | 1 | 0.12 | 4 | 0.45 | 1 | 0.11 |
| 4 | 0 | 0.00 | 1 | 0.12 | 4 | 0.45 | 1 | 0.11 |
| 5 | 0 | 0.00 | 2 | 0.23 | 5 | 0.57 | 1 | 0.11 |
| 6 | 2 | 0.23 | 8 | 0.92 | 17 | 1.93 | 9 | 1.03 |
| 7 | 12 | 1.36 | 54 | 6.21 | 26 | 2.94 | 51 | 5.84 |
| 8 | 9 | 1.02 | 38 | 4.37 | 17 | 1.93 | 34 | 3.89 |
| 9 | 2 | 0.23 | 8 | 0.92 | 5 | 0.57 | 10 | 1.15 |
| 10 | 2 | 0.23 | 2 | 0.23 | 4 | 0.45 | 5 | 0.57 |
| 11 | 1 | 0.11 | 0 | 0.00 | 3 | 0.34 | 3 | 0.34 |
| 12 | 1 | 0.11 | 0 | 0.00 | 5 | 0.45 | 0 | 0.00 |
| 13 | 7 | 0.79 | 0 | 0.00 | 6 | 0.68 | 0 | 0.00 |
| 14 | 14 | 1.59 | 1 | 0.12 | 8 | 0.91 | 1 | 0.11 |
| 15 | 24 | 2.72 | 4 | 0.46 | 13 | 1.47 | 2 | 0.23 |
| 16 | 33 | 3.74 | 8 | 0.92 | 23 | 2.60 | 12 | 1.37 |
| 17 | 40 | 4.52 | 40 | 4.60 | 32 | 3.62 | 54 | 6.19 |
| 18 | 78 | 8.83 | 95 | 10.93 | 61 | 6.91 | 106 | 12.14 |
| 19 | 119 | 13.48 | 127 | 14.61 | 106 | 12.00 | 127 | 14.55 |
| 20 | 152 | 17.21 | 147 | 16.92 | 129 | 15.74 | 133 | 15.23 |
| 21 | 151 | 17.10 | 143 | 16.46 | 143 | 16.19 | 129 | 14.78 |
| 22 | 125 | 14.16 | 114 | 13.12 | 125 | 14.16 | 112 | 12.83 |
| 23 | 78 | 8.83 | 56 | 6.44 | 79 | 8.95 | 56 | 6.41 |
| 24 | 29 | 3.28 | 14 | 1.61 | 34 | 3.85 | 19 | 2.18 |
| Total | 883 | 100.0 | 869 | 100.0 | 883 | 100.0 | 873 | 100.0 |

- This 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 69.34% 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 82%)

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

# Distribution UCAP assessment hours per day: October as peak

- This 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.

# 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- April 2020.
- 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.
- Appendix slides provide estimates for bio-gas, bio-mass, coal, natural gas, geothermal, and storage (doesn't take into account EOH SOC impacts)

# Estimating fleet UCAP by fuel type: Bio Gas

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

| Year | Peak Months SAAF | Annual Weight | Weighted SAAF (Summer / On-Peak) |
|---|---|---|---|
| 3 | 0.850 | 20% | 0.170 |
| 2 | 0.854 | 35% | 0.299 |
| 1 | 0.819 | 45% | 0.369 |
| | | Total = 100% | 0.838 |
| **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 NQC of Bio-gas resource | On-Peak UCAP | Off-Peak UCAP |
|---|---|---|---|---|
| 0.838 | 0.851 | 30 MW | 25.14 MW | 45.53 MW |

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

# Estimating fleet UCAP by fuel type: Bio Mass

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

| Year | Peak Months SAAF | Annual Weight | Weighted SAAF (Summer / On-Peak) |
|---|---|---|---|
| 3 | 0.834 | 20% | 0.167 |
| 2 | 0.848 | 35% | 0.297 |
| 1 | 0.846 | 45% | 0.381 |
| | | Total = 100% | 0.850 |
| **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 NQC of Bio-mass resource | On-Peak UCAP | Off-Peak UCAP |
|---|---|---|---|---|
| 0.850 | 0.891 | 50 MW | 42.5 MW | 44.55 MW |

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

# Estimating fleet UCAP by fuel type: Coal

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

| Year | Peak Months SAAF | Annual Weight | Weighted SAAF (Summer / On-Peak) |
|---|---|---|---|
| 3 | 0.947 | 20% | 0.189 |
| 2 | 0.915 | 35% | 0.320 |
| 1 | 0.979 | 45% | 0.441 |
| | | Total = 100% | 0.950 |
| **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 NQC of Coal resource | On-Peak UCAP | Off-Peak UCAP |
|---|---|---|---|---|
| 0.950 | 0.946 | 10 MW | 9.5 MW | 9.46 MW |

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

# Estimating fleet UCAP by fuel type: Natural Gas

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

| Year | Peak Months SAAF | Annual Weight | Weighted SAAF (Summer / On-Peak) |
|---|---|---|---|
| 3 | 0.877 | 20% | 0.175 |
| 2 | 0.886 | 35% | 0.310 |
| 1 | 0.869 | 45% | 0.391 |
| | | Total = 100% | 0.877 |
| **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 NQC of Natural Gas resource | On-Peak UCAP | Off-Peak UCAP |
|---|---|---|---|---|
| 0.877 | 0.892 | 500 MW | 438.5 MW | 446 MW |

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

# Estimating fleet UCAP by fuel type: Geo-Thermal

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

| Year | Peak Months SAAF | Annual Weight | Weighted SAAF (Summer / On-Peak) |
|---|---|---|---|
| 3 | 0.871 | 20% | 0.174 |
| 2 | 0.893 | 35% | 0.313 |
| 1 | 0.848 | 45% | 0.382 |
| | | Total = 100% | 0.869 |
| **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 NQC of Geo-thermal resource | On-Peak UCAP | Off-Peak UCAP |
|---|---|---|---|---|
| 0.869 | 0.780 | 35 MW | 30.42 MW | 27.3 MW |

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

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

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

| Year | Peak Months SAAF | Annual Weight | Weighted SAAF (Summer / On-Peak) |
|---|---|---|---|
| 3 | 0.919 | 20% | 0.184 |
| 2 | 0.959 | 35% | 0.336 |
| 1 | 0.879 | 45% | 0.400 |
| | | Total = 100% | 0.920 |
| **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 NQC of HRCV resource | On-Peak UCAP | Off-Peak UCAP |
|---|---|---|---|---|
| 0.920 | 0.891 | 15 MW | 13.8 MW | 13.25 MW |

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

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

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

| Year | Peak Months SAAF | Annual Weight | Weighted SAAF (Summer / On-Peak) |
|---|---|---|---|
| 3 | 0.969 | 20% | 0.194 |
| 2 | 0.975 | 35% | 0.341 |
| 1 | 0.964 | 45% | 0.434 |
| | | Total = 100% | 0.969 |
| **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 NQC of Storage resource | On-Peak UCAP | Off-Peak UCAP |
|---|---|---|---|---|
| 0.969 | 0.946 | 25 MW | 24.23 MW | 23.65 MW |

Note: Based on daily outage rates weighted by the number of UCAP assessment hours, actual resource UCAP values will vary. Does not take into account impacts of EOH SOC parameter which hasn't been implemented yet

# Estimating fleet UCAP by fuel type: Nuclear

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

| Year | Peak Months SAAF | Annual Weight | Weighted SAAF (Summer / On-Peak) |
|---|---|---|---|
| 3 | 0.991 | 20% | 0.198 |
| 2 | 0.983 | 35% | 0.344 |
| 1 | 0.999 | 45% | 0.450 |
| | | Total = 100% | 0.992 |
| **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 NQC of Nuclear resource | On-Peak UCAP | Off-Peak UCAP |
|---|---|---|---|---|
| 0.992 | 0.958 | 800 MW | 793.6 MW | 766.4 MW |

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

# Estimating fleet UCAP by fuel type: Waste

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

| Year | Peak Months SAAF | Annual Weight | Weighted SAAF (Summer / On-Peak) |
|---|---|---|---|
| 3 | 0.907 | 20% | 0.181 |
| 2 | 0.957 | 35% | 0.335 |
| 1 | 0.857 | 45% | 0.386 |
| | | Total = 100% | 0.902 |
| **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 NQC of Waste resource | On-Peak UCAP | Off-Peak UCAP |
|---|---|---|---|---|
| 0.902 | 0.862 | 15 MW | 13.53 MW | 12.93 MW |

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

# APPENDIX: TOP 10% SUPPLY CUSHION, UCAP ASSESSMENT HOURS

# 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 less 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.