Flexible Capacity Requirements for 2022 through 2024

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What's the purpose of this call?

- Discuss the criteria, methodology, and assumptions used in calculating monthly flexible capacity requirement.
- Calculate requirements for all LRAs within the ISO footprint for RA compliance year 2022 and advisory flexible capacity requirements for compliance years 2023 and 2024
- Discuss the input assumptions and methodology of the annual CAISO's Availability Assessment Hour (AAH).

Agenda / Overview

- Background
- Process review
  - Expected build out from all LSEs (CPUC jurisdictional and non-Jurisdictional)
  - Actual load, wind and solar 1-minute profiles for 2020 and expected profiles for 2022-2024
  - Calculate 3-hour net-load ramps
  - Expected monthly maximum contingency reserve requirements
  - Calculate monthly Flexible Capacity requirement
  - Allocation Methodology
  - Availability Assessment Hours (AAH)
  - Next steps

Each LSE's SC shall make a year-ahead and month-ahead showing of flexible capacity for each month of the compliance year

Resource Adequacy (RA)

- Ensure LSEs contract for adequate capacity to meet expected flexible needs
- Year ahead timeframe: LSEs need to secure a minimum of 90% of the next years monthly needs
- Month ahead timeframe: LSEs need to secure adequate net qualified capacity to serve their monthly peak load including a planning reserve margin and flexible capacity to address largest three hour net load ramps plus contingency reserves
- All resources participating in the ISO markets under an RA contract will have an RA must-offer-obligation
- Required to submit economic bids into the ISO's real-time market consistent with the category of flexible capacity for which it is shown

The ISO flexibility capacity assessment is based on current LSE's RPS expected build-out data

- Uses the most current data available for renewable build-out obtained from all LSE SCs
- For new renewable installation scale 2020 actual production data based on the expected installed capacity in subsequent years
- Generate net-load profiles for 2022 through 2024
  - Generate load profiles for 2022 through 2024
  - Generate solar profiles for 2022 through 2024
  - Generate wind profiles for 2022 through 2024
- CAISO will look into impacts of curtailments when running draft requirement values

The ISO will use the CEC's 1-in-2 IEPR forecast to develop the load forecast

- ISO uses 1-in-2 IEPR forecast; the IEPR forecast has both an hourly view and a monthly view.
  - The forecast is correlated such that the peak of the month can be seen in the hourly profile.

- CEC IEPR Load Forecast
  - https://www.energy.ca.gov/data-reports/planning-and-forecasting *

* Links will be updated when the 2020 IEPR Load Forecast is released by the CEC

The ISO will use the CEC's 1-in-2 IEPR forecast to develop the monthly flexible capacity

- CEC IEPR Load Forecast
  - https://www.energy.ca.gov/data-reports/planning-and-forecasting *
  - Title of File for last years analysis: "CED 2020 Hourly Results - CAISO - MID-MID" *
    - CAISO will be using Managed Net Load (column S)* within the spreadsheet
      - **Managed Net Load (col S)** = Baseline Net Load (col R)

        - AAEE (col Q)
      - Baseline Net Load (col R) = Baseline Consumption (col M)

        - BTM PV (col N)

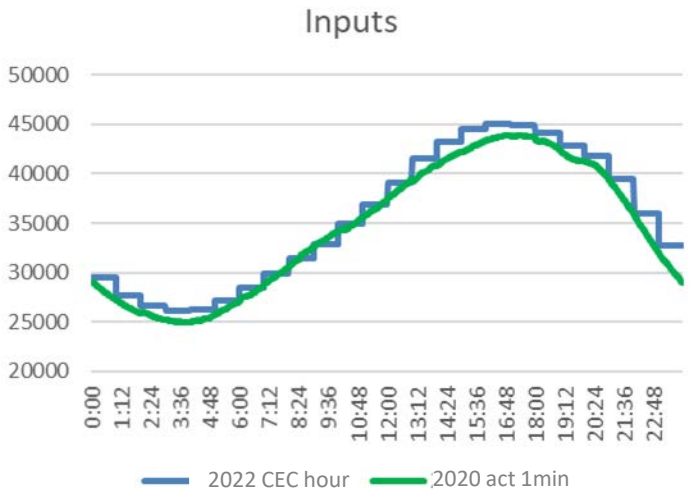
        - BTM Storage Res (col O)

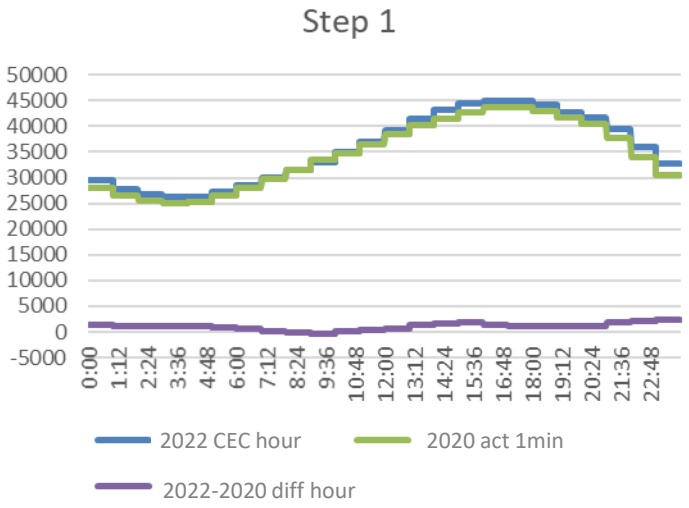
        - BTM Storage NonRes (col P)
      - Baseline Consumption (col M) = unadjusted consumption (col E)
        + Pumping (col F)
        + climate change (col H)
        + light duty EV (col I)
        + mdhd EV (col J)
        + TOU impacts (col K)
        + other adjustments (col L)

* Links and information will be updated when the 2020 IEPR Load Forecast is released by the CEC

Building expected 1-minute load profile requires actual 2020 hourly and 1-minute data and CEC's hourly forecast

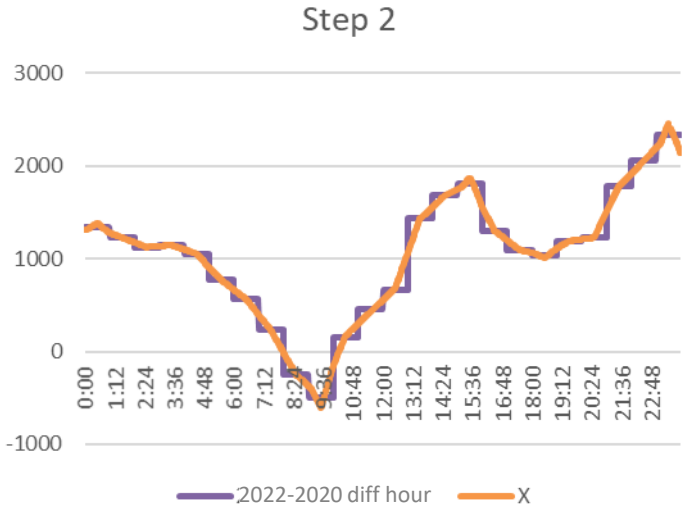
Using the 2022 CEC hourly forecast and the 2020 1-minute actuals, we will create the estimated 2022 1-minute forecast

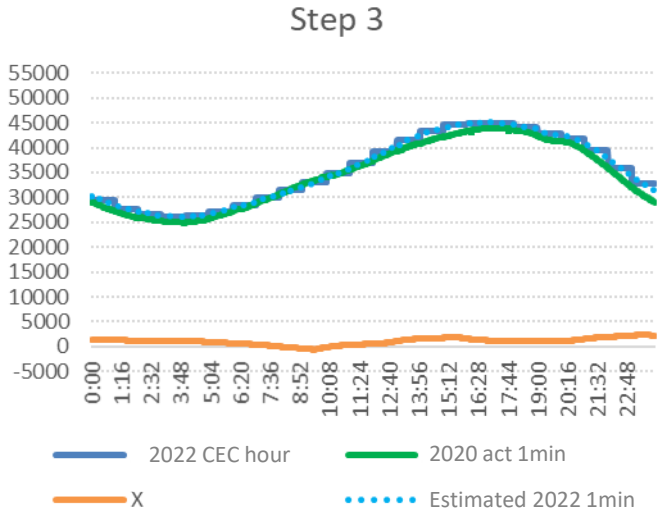




Take the hourly average of the 1-minute data and find the difference between the hourly 2020 actuals and 2022 forecast

Smooth the hourly 2022-2020 difference from Step 1 to a 1-minute granularity





Add the 1-minute data from Step 1 to the 2020 1-minute actuals to get a smoothed 2022 forecast

Hourly load forecast to 1-minute load forecast

- Used 2020 actual 1-minute load data to build 1-minute load profiles for subsequent years
- Scaled the hourly CEC load forecast value of each hour into 1-minute forecast data using a smoothing equation looking at the differences between the forecasted year and the 2020 1-minute actuals.

2021 Load 1-Minute Forecast

- **2021 $L_{CECfcst\_1\text{-}min}$ = 2020 $L_{Act\_1\text{-}min}$ + X**
  - **Where X = Interpolated 1min profile from the difference**

    (2021 $L_{CECfcst\_hourly}$ - 2020 L_{actual_hourly})

2022 Load 1-Minute Forecast

- **2022 $L_{CECfcst\_1\text{-}min}$ = 2020 $L_{Act\_1\text{-}min}$ + X**
  - **Where X = Interpolated 1min profile from the difference**

    (2022 $L_{CECfcst\_hourly}$ - 2020 L_{actual_hourly})

*See slide 8 for more graphs showing steps to calculate **X**

Wind growth assumptions

- Use the actual 1-minute wind production data for the most recent year i.e. for 2021 wind forecast, use actual 1-minute data from 2020 (**$2020_{Act\_1\text{-}min}$**)
- Projects installed in 2020 would be modeled in 2021 for the months the projects were not yet in-service (e.g. projects installed in May 2020 would be included in January through April of 2020)
- Scale 1-minute data using expected capacity for the new plants scheduled to be operational in 2021
- Repeat the above steps for 2022

$$\text{2021 } W_{Mth\_Sim\_1\text{-}min} = \text{2020 } W_{Act\_1\text{-}min} * \text{2021 } W_{Mth\ Capacity} / \text{2020 } W_{Mth\ Capacity}$$

$$\text{2022 } W_{Mth\_Sim\_1\text{-}min} = \text{2020 } W_{Act\_1\text{-}min} * \text{2022 } W_{Mth\ Capacity} / \text{2020 } W_{Mth\ Capacity}$$

Note: This approach maintains load/wind, load/solar and wind/solar correlations

Solar growth assumptions

Existing solar

- Use the actual solar 1-minute production data for the most recent year

  i.e. for 2021 forecast, use 2020 actual 1-minute data (**$2020_{Act\_1\text{-}min}$**)

New solar installation

- Develop 1-minute solar production profiles by scaling actual 2020 1-minute data by the expected monthly installed capacity in 2021 divided by the monthly installed capacity in 2020
- Projects installed in 2020 will be modeled in 2021 for the months the projects were not yet in-service in 2020

$$2021\ S_{Mth\_Sim\_1\text{-}min} = 2020\ S_{Act\_1\text{-}min} * 2021\ S_{Mth\ Capacity} / 2020\ S_{Mth\ Capacity}$$

$$2022\ S_{Mth\_Sim\_1\text{-}min} = 2020\ S_{Act\_1\text{-}min} * 2022\ S_{Mth\ Capacity} / 2020\ S_{Mth\ Capacity}$$

$$2023\ S_{Mth\_Sim\_1\text{-}min} = 2020\ S_{Act\_1\text{-}min} * 2023\ S_{Mth\ Capacity} / 2020\ S_{Mth\ Capacity}$$

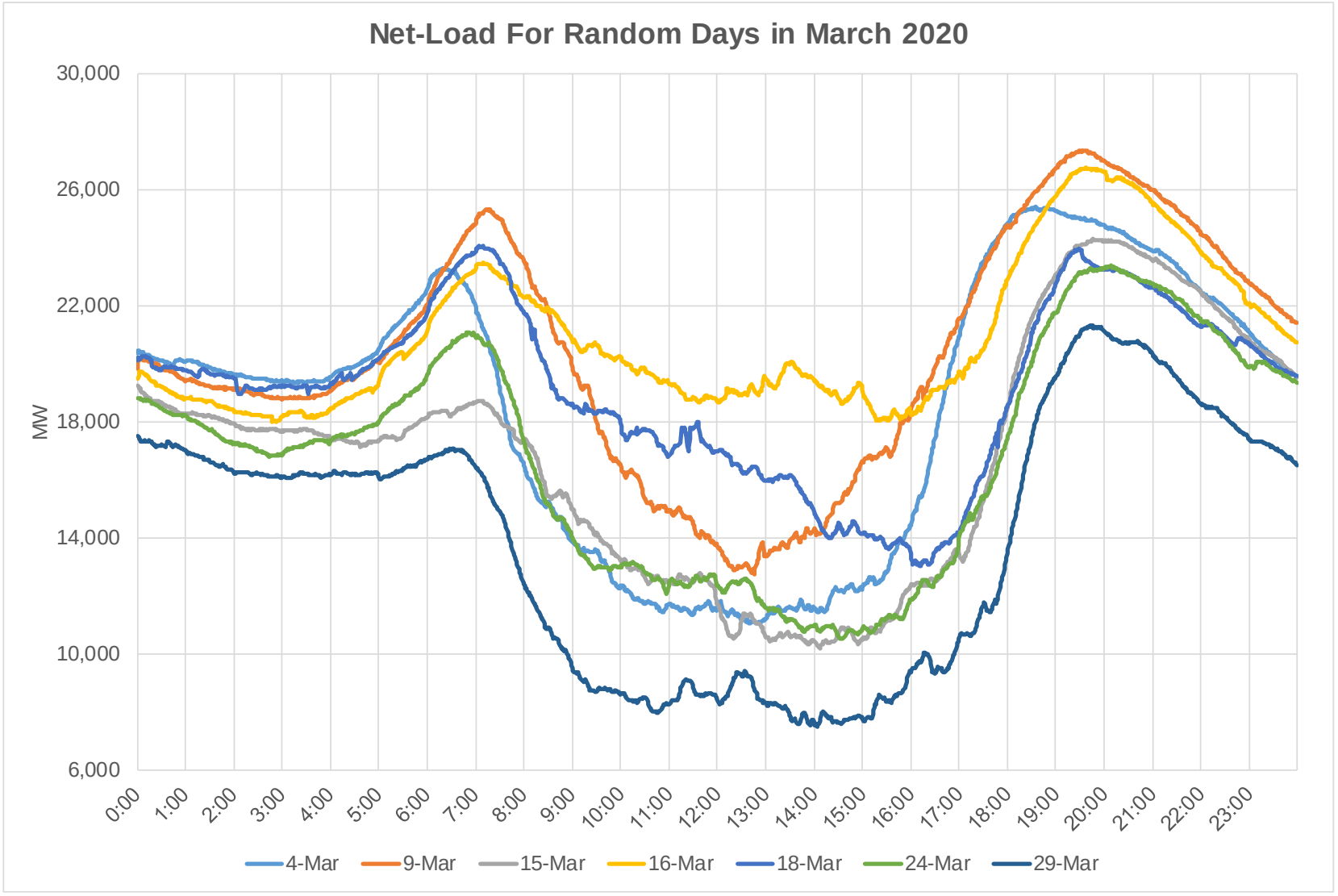
$$2024\ S_{Mth\_Sim\_1\text{-}min} = 2020\ S_{Act\_1\text{-}min} * 2024\ S_{Mth\ Capacity} / 2020\ S_{Mth\ Capacity}$$

Net-load is a NERC accepted metric[1] for evaluating additional flexibility needs to accommodate VERs

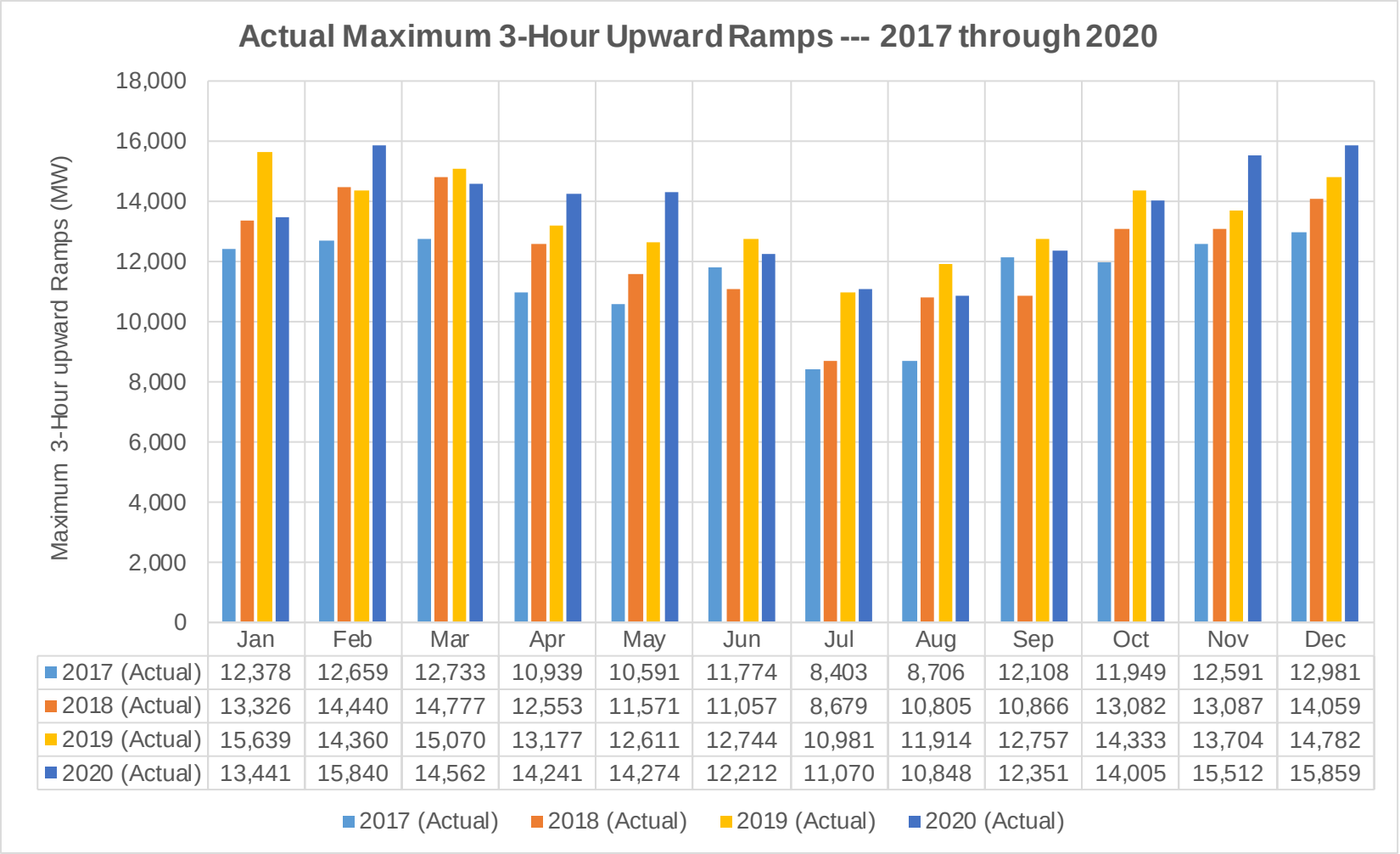
- Net-load is the aggregate of customer demand reduced by variable generation power output
- Net-load is more variable than load itself and it increases as VER production increases
- The monthly three-hour flexible capacity need equates to the largest expected up-ward change in net-load when looking across a rolling three-hour evaluation window
- The ISO dispatches flexible resources to meet net-load

[1]NERC Special Report - Flexibility Report Requirements and metrics for Variable Generation: Implications for System Planning Studies, August 2010 . http://www.nerc.com/files/IVGTF_Task_1_4_Final.pdf

Example of net-load variability for one week in March 2020

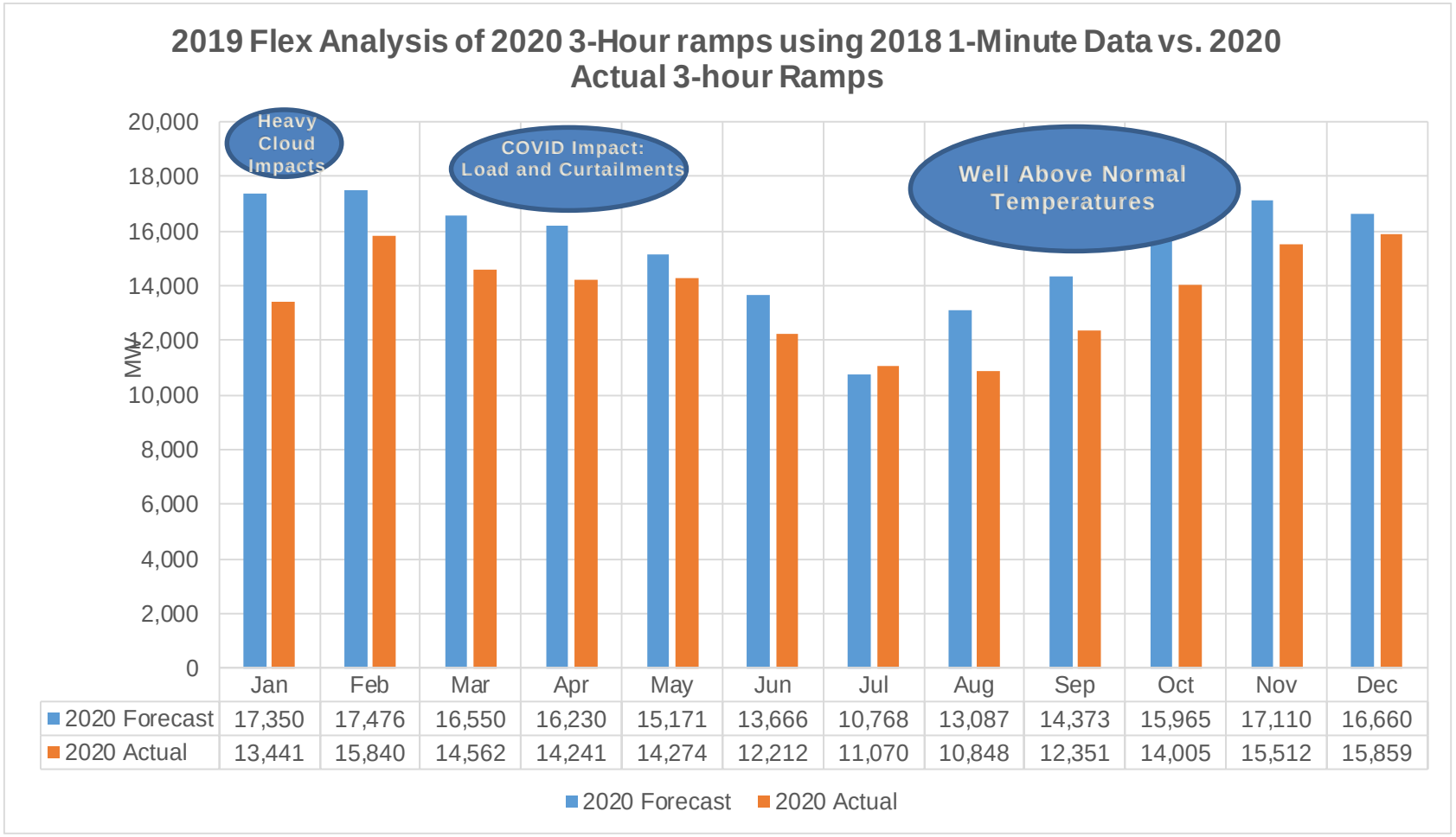


Actual 3-hour ramps with curtailments



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017 (Actual)	12,378	12,659	12,733	10,939	10,591	11,774	8,403	8,706	12,108	11,949	12,591	12,981
2018 (Actual)	13,326	14,440	14,777	12,553	11,571	11,057	8,679	10,805	10,866	13,082	13,087	14,059
2019 (Actual)	15,639	14,360	15,070	13,177	12,611	12,744	10,981	11,914	12,757	14,333	13,704	14,782
2020 (Actual)	13,441	15,840	14,562	14,241	14,274	12,212	11,070	10,848	12,351	14,005	15,512	15,859

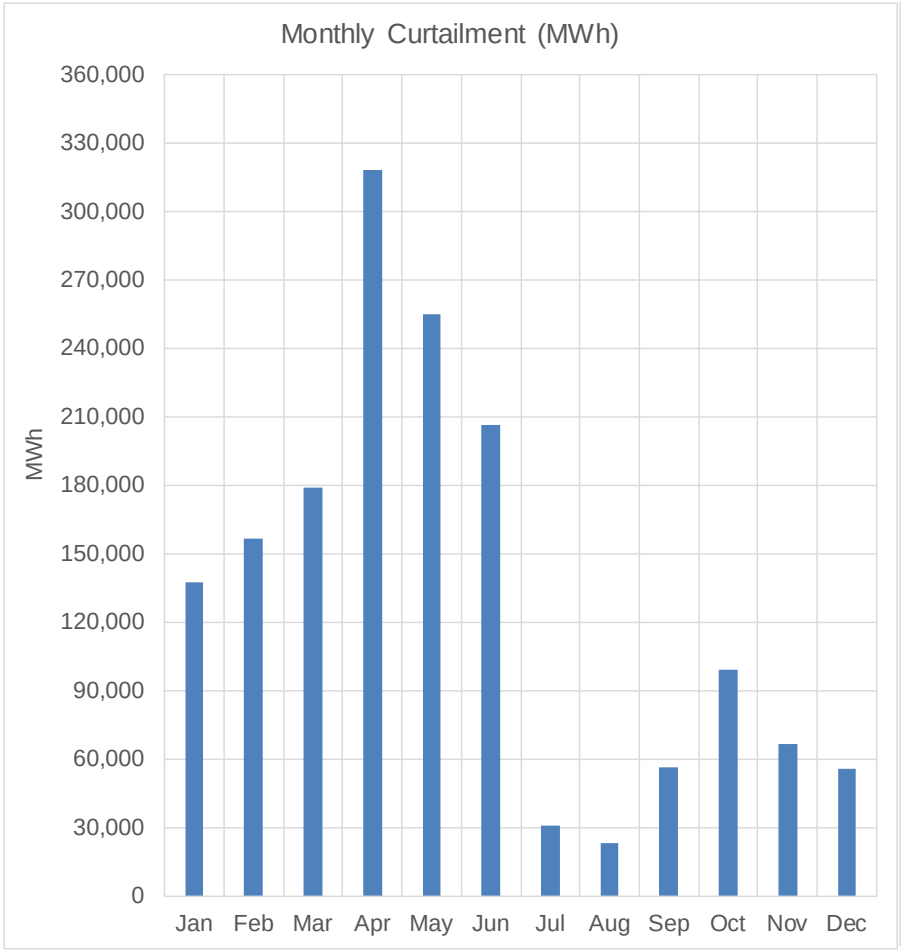
2020 forecast data* vs. actual 2020 3-hour ramps with curtailments

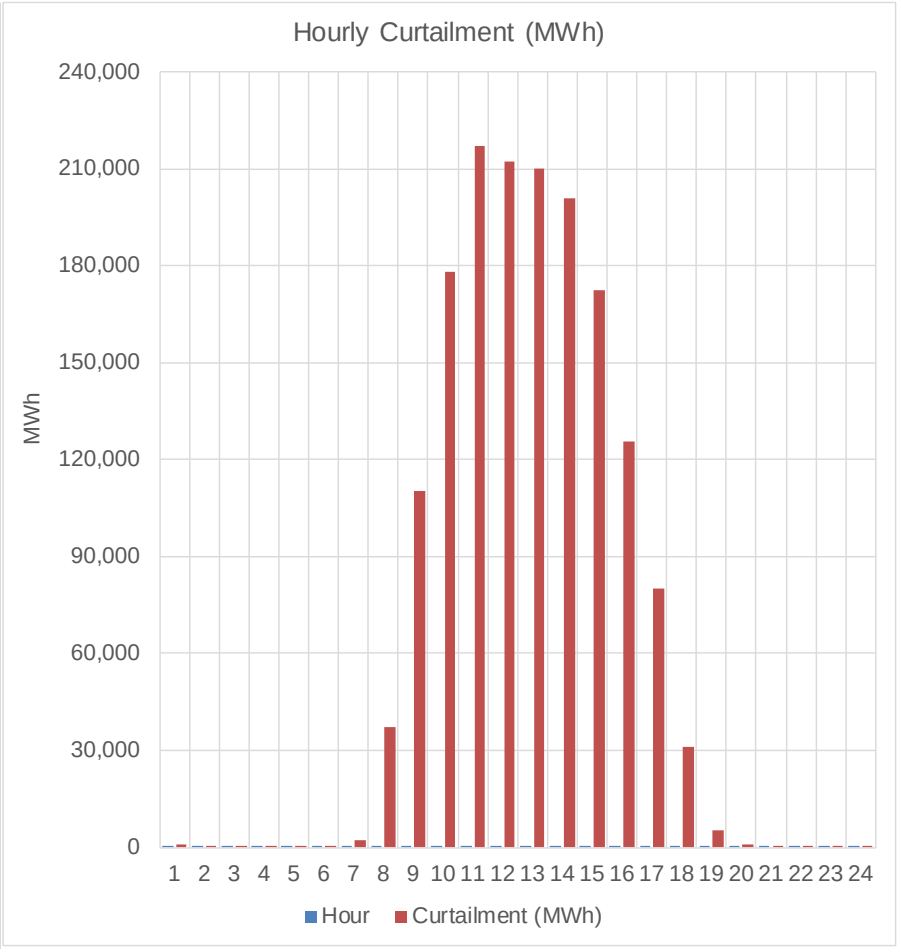


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020 Forecast	17,350	17,476	16,550	16,230	15,171	13,666	10,768	13,087	14,373	15,965	17,110	16,660
2020 Actual	13,441	15,840	14,562	14,241	14,274	12,212	11,070	10,848	12,351	14,005	15,512	15,859

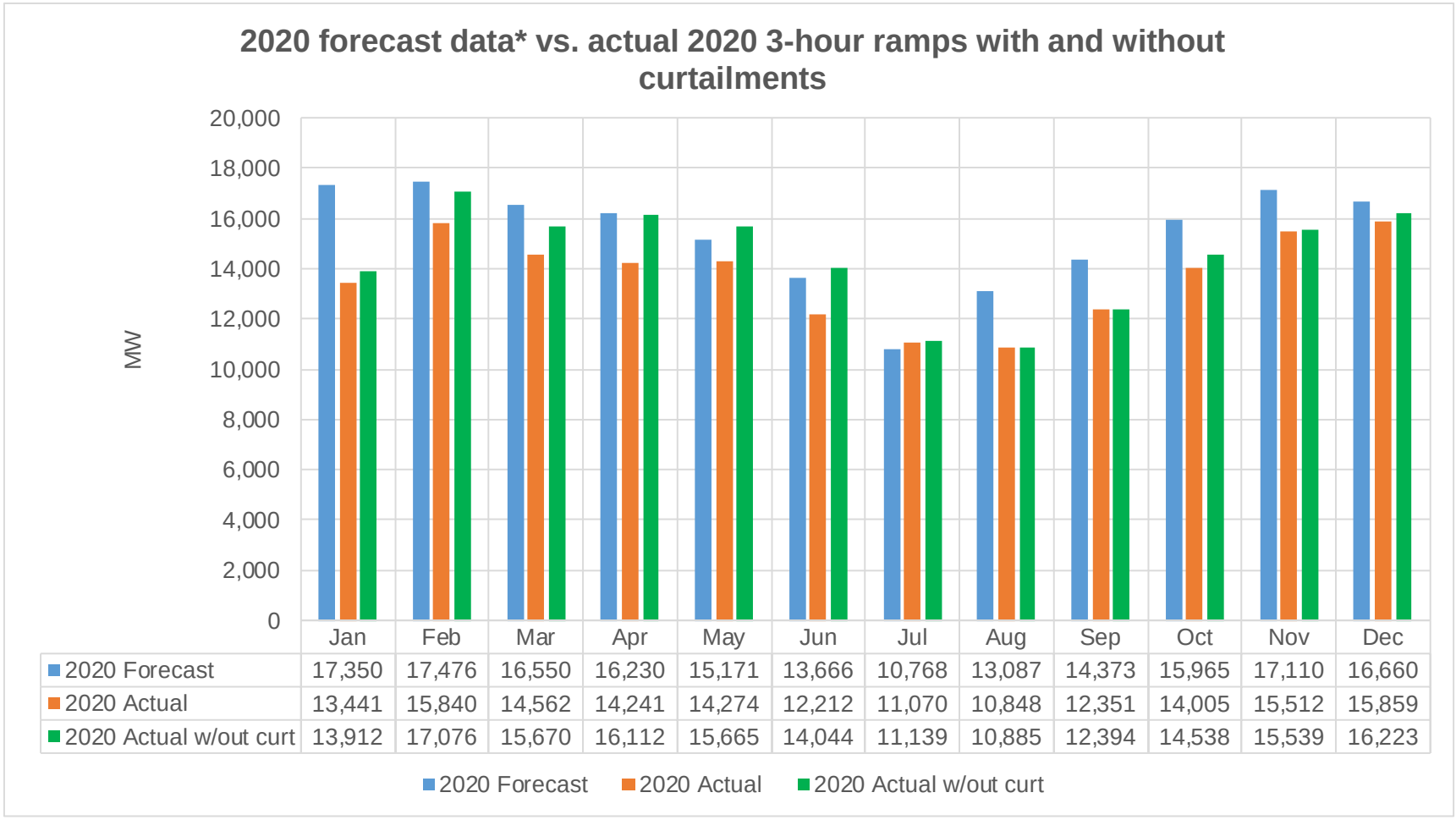
*2020 forecast data from 2019 flex-analysis of 2020 3-hour ramps using 2018 1-minute

2020: Higher levels of curtailments typically occur during the spring months between sunrise and sunset (MWh)





ISO continues to consider how we account for curtailments in Flex RA Study



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020 Forecast	17,350	17,476	16,550	16,230	15,171	13,666	10,768	13,087	14,373	15,965	17,110	16,660
2020 Actual	13,441	15,840	14,562	14,241	14,274	12,212	11,070	10,848	12,351	14,005	15,512	15,859
2020 Actual w/out curt	13,912	17,076	15,670	16,112	15,665	14,044	11,139	10,885	12,394	14,538	15,539	16,223

*2020 forecast data from 2019 flex-analysis of 2020 3-hour ramps using 2018 1-minute

Contingency reserves is a NERC/WECC requirement all BAs must comply with in real-time

- Each Balancing Authority and each Reserve Sharing Group shall maintain a minimum amount of Contingency Reserve, except within the first sixty minutes following an event requiring the activation of Contingency Reserve.
- To meet WECC and NERC reliability criteria, the ISO must have contingency reserves.
- Contingencies can occur during the three hour ramps and the ISO must be prepared to dispatch contingency reserve to recover its Area Control Error (ACE) within 15-minutes following a disturbance.
- Contingency reserves are held for contingency events and cannot be dispatched to meet day-to-day net-load ramps.

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The proposed interim flexible capacity methodology should provide the ISO with sufficient flexible capacity

Methodology

Flexible $Req_{MTHy} = Max[(3RR_{HRx})_{MTHy}] + Max(MSSC, 3.5\%*E(PL_{MTHy})) + \varepsilon$

Where:

$Max[(3RR_{HRx})_{MTHy}]$ = Largest three hour contiguous ramp starting in hour x for month y

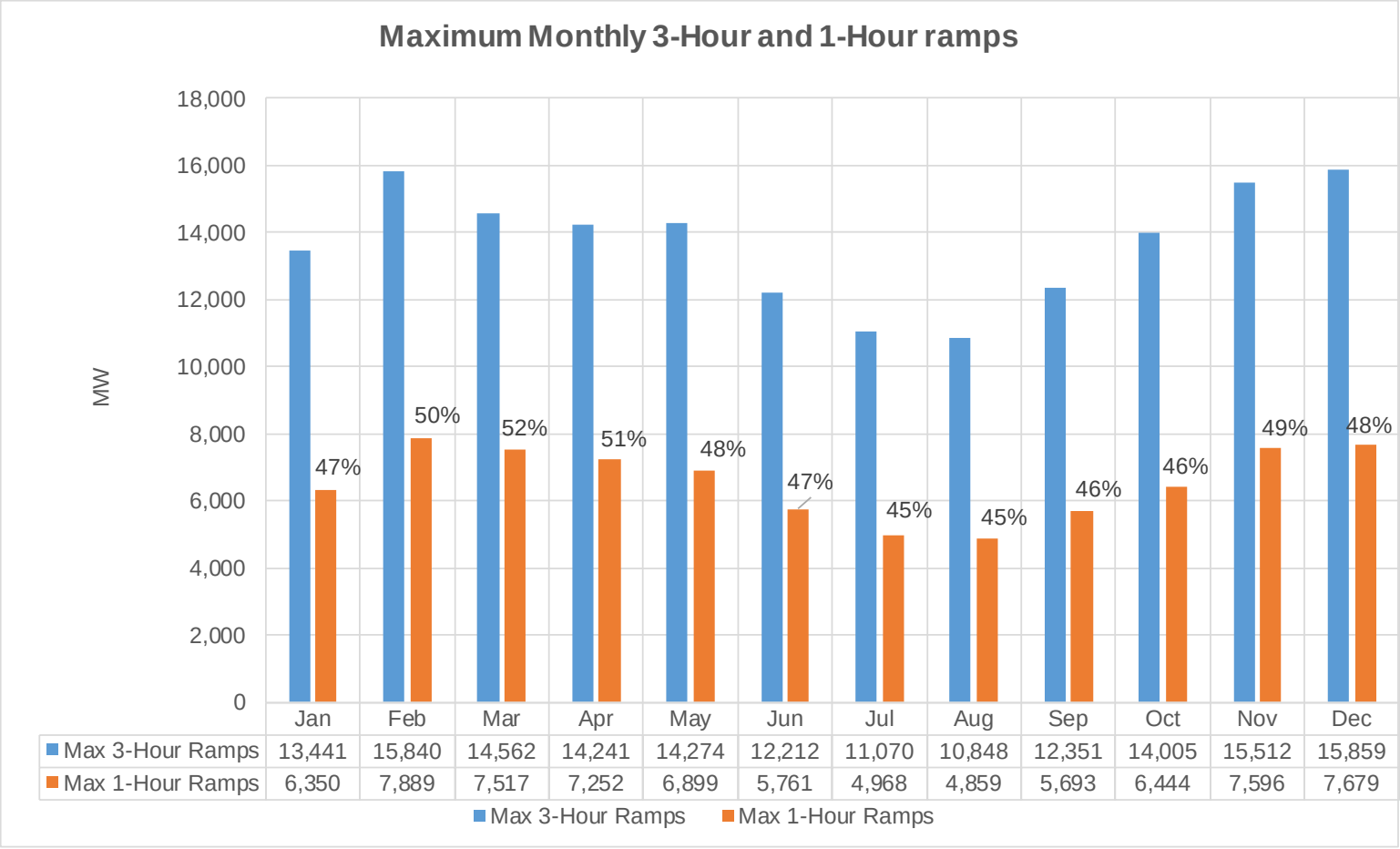
E(PL) = Expected peak load

MTH_y = Month $_y$

MSSC = Most Severe Single Contingency

ε = Annually adjustable error term to account for load forecast errors and variability. ε is currently set at zero

Maximum 3-Hour upward ramps are not evenly distributed each hour which demonstrates the need for faster ramping capability



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max 3-Hour Ramps	13,441	15,840	14,562	14,241	14,274	12,212	11,070	10,848	12,351	14,005	15,512	15,859
Max 1-Hour Ramps	6,350	7,889	7,517	7,252	6,899	5,761	4,968	4,859	5,693	6,444	7,596	7,679

What data does the ISO need?

- CEC's IEPR demand forecast (e.g. 2021 – 2024 demand forecast)
- LSE SCs to update renewable build-out for 2020 through 2024 by CREZ by January 15, 2021 (Beyond 2024 if data is available)
- The data should include:
  - Installed capacity by technology and expected operating date (e.g. Solar thermal, solar PV tracking, solar PV non-tracking, estimate of behind-the-meter solar PV, hybrid, co-located, etc.) for all variable energy resources under contract
  - Operational date or expected on-line date
  - Interconnecting substation, closes substation or switching station
  - Resources located outside ISO's BAA must indicate if the resources are dynamically scheduled or not
- All required LSE SCs have already provided this data
  - LSE SCs must submit data for all LSE for which they are the SC
  - ISO is in the process of reviewing the submitted data

Allocation: Notation

Symbol or Equation	Meaning
L, W, S, NL	Load, wind, solar, net load = load – wind – solar
Δ	Ramp
Δ NL = Δ L – ΔW – ΔS	Net load ramp = load ramp – wind ramp – solar ramp
ΔNL_{2022}	Net Load Ramp Requirement for 2022
$\Delta NL_{sc,2022}$	Net Load Ramp Requirement of SC Allocation for 2022
R	Reserve = max(MSSC, 3.5* peak load)
pl_r_{sc}	CEC peak load ratio
Σ	Summation of all SCs

- 2022 load (L) forecast is from the CEC IEPR forecast
- Wind (W) and solar (S) are from survey results
- 2020 L is 5-minute observed data

Allocation: Formula

- Flex Requirement $= \Delta NL_{2022} + R_{2022}$

$$= \Delta NL_{2022} + \Sigma pl\_r_{sc} * R_{2022}$$

- $\Delta NL_{2022} = \Delta L_{2022} - \Delta W_{2022} - \Delta S_{2022}$

$$= \Delta L_{2022} - \frac{\Sigma W_{sc,2022}}{W_{2022}} * \Delta W_{2022} - \frac{\Sigma S_{sc,2022}}{S_{2022}} * \Delta S_{2022}$$

Allocation: Load Proportion

- $\Delta L_{2022} = \Delta L_{2020} + (\Delta L_{2022} - \Delta L_{2020})$

$$= \Sigma \Delta L_{sc,2020} + \frac{\Sigma L^{M}_{sc,2020}}{L^{M}_{2020}} * (\Delta L_{2022} - \Delta L_{2020})$$

ΔL_{2020} is the average load portion of top 5 maximum 2020 3h ramps while matching 2022 maximum 3h ramp on month and time, and L^{M}_{2020} is the average load at the middle point of those top 5 ramps.

- Therefore, each SC will receive:

$$\Delta L_{sc,2020} + \frac{L^{M}_{sc,2020}}{L^{M}_{2020}} * (\Delta L_{2022} - \Delta L_{2020})$$

ANNUAL REVIEW OF AVAILABILITY ASSESSMENT HOURS

Methodology Overview of System/Local Availability Assessment Hours

- Used CEC IEPR data described in previous slides to obtain:
  - Hourly Average Load
    - By Hour
    - By Month
    - Years 2020-2024
- Calculated:
  - Top 5% of Load Hours within each month using an hourly load distribution
  - Years 2022 - 2024

Key information already requested and obtained

- ISO published a market notice for survey data in December 2020 and January 2021
- LSE Survey Data was due on January 15, 2021
- CEC Hourly IEPR Forecast is anticipated to be finalized and published on January 28, 2021

Next Steps

Item	Date
January 27, 2021	ISO Flex RA methodology and criteria stakeholder call
February 10, 2021	Stakeholder comments on Flex RA methodology, criteria and data used for 2022 flexible requirements due
March 31, 2021*	Stakeholder call on preliminary Flexible Capacity and Availability Assessment Hours (AAH) requirements for 2021, 2022, and 2023
April 2021	Publish preliminary Flexible Capacity and AAH requirements for 2022, 2023 & 2024
April 14, 2021*	Stakeholder comments on preliminary requirements due
May 2021	Issue final Flexible Capacity and AAH requirements for 2022 and projected requirements for 2023 & 2024

*We are evaluating our Flex RA schedule based on delay of CEC IEPR forecast publication. At this time, we are expecting a two week delay. The above information is subject to change accordingly.

Questions?

Please submit comments on the assumptions to

initiativecomments@caiso.com

by February 10, 2021

Thank you for your participation.