Flexible Capacity Requirement Methodology for 2025 through 2027

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Housekeeping reminders

- This call is being recorded for informational and convenience purposes only. Any related transcriptions should not be reprinted without ISO's permission.
- Meeting is structured to stimulate dialogue and engage different perspectives.
- Please keep comments professional and respectful.
- Please try and be brief and refrain from repeating what has already been said so that we can manage the time efficiently.

Instructions for raising your hand to ask a question

- If you are connected to audio through your computer or used the “call me” option, select the raise hand icon  at the bottom of the screen. **Note**: #2 only works if you dialed into the meeting.
  - Please remember to state your name and affiliation before making your comment.
- If you need technical assistance during the meeting, please send a chat to the event producer.
- You may also send your question via chat to either Yelena Kopylov-Alford or to all panelists.

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 2025 and advisory flexible capacity requirements for compliance years 2026 and 2027
- 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 2023 and expected profiles for 2025-2027
  - 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 2023 actual production data based on the expected installed capacity in subsequent years
- Generate net-load profiles for 2025 through 2027
  - Generate load profiles for 2025 through 2027
  - Generate solar profiles for 2025 through 2027
  - Generate wind profiles for 2025 through 2027
- 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.

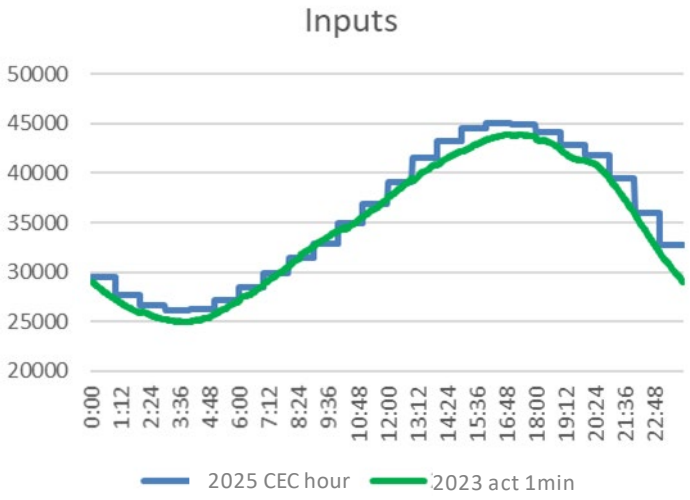
- CEC IEPR Load Forecast
  - California Energy Commission : Docket Log

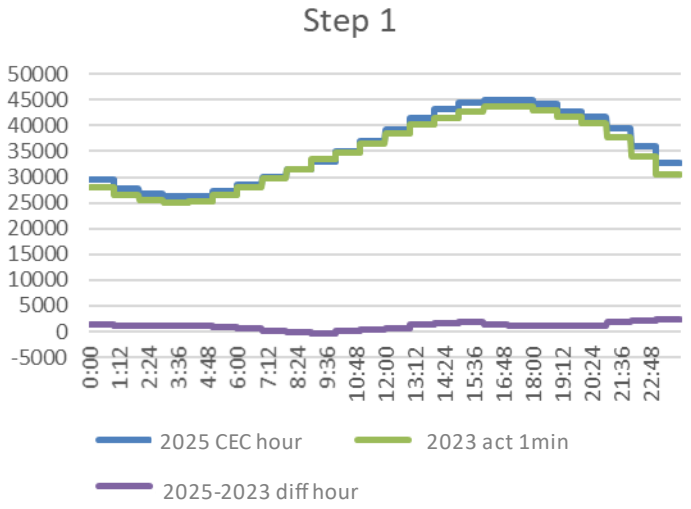
The ISO will use the CEC's 1-in-2 IEPR forecast to develop the monthly flexible capacity

- CEC IEPR Load Forecast
  - California Energy Commission : Docket Log
  - Title of File: "CED 2023 Hourly Forecast – CAISO – Planning Scenario"
    - CAISO will be using Managed Net Load (column T) within the spreadsheet
      - **Managed Net Load (col T)** = Baseline Net Load (col O)
        + AAEE (col P)
        + AAFS (col Q)
        + AATE_LDV (col R)
        + AATE_MDHD (col S)
      - Baseline Net Load (col O) = Baseline Consumption (col K)
        - BTM PV (col L)
        - BTM Storage Res (col M)
        - BTM Storage NonRes (col N)
      - Baseline Consumption (col K) = unadjusted consumption (col E)
        + Pumping (col F)
        + climate change (col G)
        + light EV (col H)
        + medium heavy EV (col I)
        + other adjustments (col J)

Building expected 1-minute load profile requires actual 2023 hourly and 1-minute data and CEC's hourly forecast

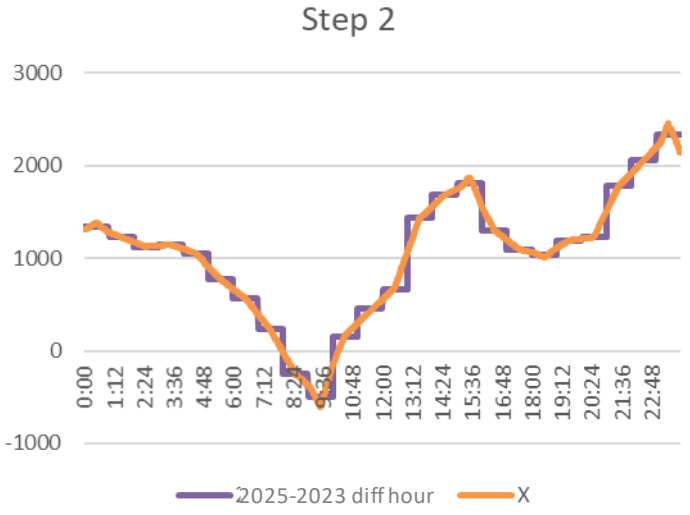
Using the 2025 CEC hourly forecast and the 2023 1-minute actuals, we will create the estimated 2025 1-minute forecast

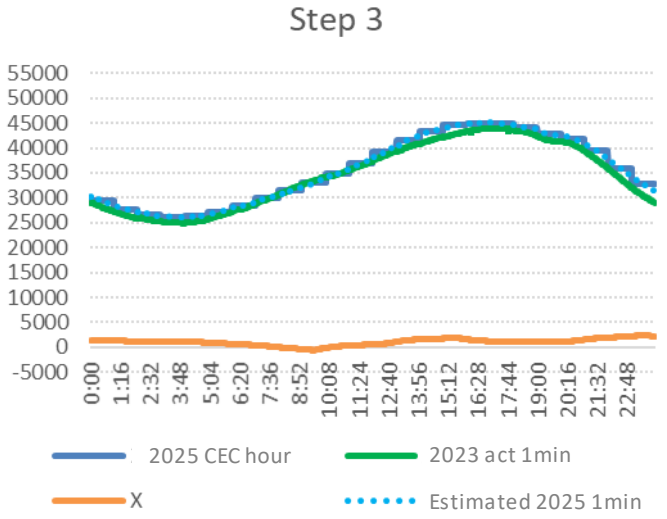




Take the hourly average of the 1-minute data and find the difference between the hourly 2023 actuals and 2025 forecast

Smooth the hourly 2025-2023 difference from Step 1 to a 1-minute granularity





Add the 1-minute data from Step 1 to the 2023 1-minute actuals to get a smoothed 2025 forecast

Hourly load forecast to 1-minute load forecast

- Used 2023 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 2023 1-minute actuals.

2024 Load 1-Minute Forecast

- **2024 $L_{CECfcst\_1\text{-}min}$ = 2023 $L_{Act\_1\text{-}min}$ + X**
  - **Where X = Interpolated 1min profile from the difference**

    (2024 $L_{CECfcst\_hourly}$ - 2023 L_{actual_hourly})

2025 Load 1-Minute Forecast

- **2025 $L_{CECfcst\_1\text{-}min}$ = 2023 $L_{Act\_1\text{-}min}$ + X**
  - **Where X = Interpolated 1min profile from the difference**

    (2025 $L_{CECfcst\_hourly}$ - 2023 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 2024 wind forecast, use actual 1-minute data from 2023 (**$2023_{Act\_1\text{-}min}$**)
  - Wind actual data utilized includes dynamic resources
- Projects installed in 2023 would be modeled in 2024 for the months the projects were not yet in-service (e.g. projects installed in May 2023 would be included in January through April of 2023)
- Scale 1-minute data using expected capacity for the new plants scheduled to be operational in 2024
- Repeat the above steps for 2025

$$\text{2024 } W_{Mth\_Sim\_1\text{-}min} = \text{2023 } W_{Act\_1\text{-}min} * \text{2024 } W_{Mth\ Capacity} / \text{2023 } W_{Mth\ Capacity}$$

$$\text{2025 } W_{Mth\_Sim\_1\text{-}min} = \text{2023 } W_{Act\_1\text{-}min} * \text{2025 } W_{Mth\ Capacity} / \text{2023 } W_{Mth\ Capacity}$$

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
  - Solar actual data utilized includes dynamic resources
  - i.e. for 2024 forecast, use 2023 actual 1-minute data (**$2023_{Act\_1\text{-}min}$**)

New solar installation

- Develop 1-minute solar production profiles by scaling actual 2023 1-minute data by the expected monthly installed capacity in 2024 divided by the monthly installed capacity in 2023

- Projects installed in 2023 will be modeled in 2024 for the months the projects were not yet in-service in 2023

$$2024\ S_{Mth\_Sim\_1\text{-}min} = 2023\ S_{Act\_1\text{-}min} * 2024\ S_{Mth\ Capacity} / 2023\ S_{Mth\ Capacity}$$

$$2025\ S_{Mth\_Sim\_1\text{-}min} = 2023\ S_{Act\_1\text{-}min} * 2025\ S_{Mth\ Capacity} / 2023\ S_{Mth\ Capacity}$$

$$2026\ S_{Mth\_Sim\_1\text{-}min} = 2023\ S_{Act\_1\text{-}min} * 2026\ S_{Mth\ Capacity} / 2023\ S_{Mth\ Capacity}$$

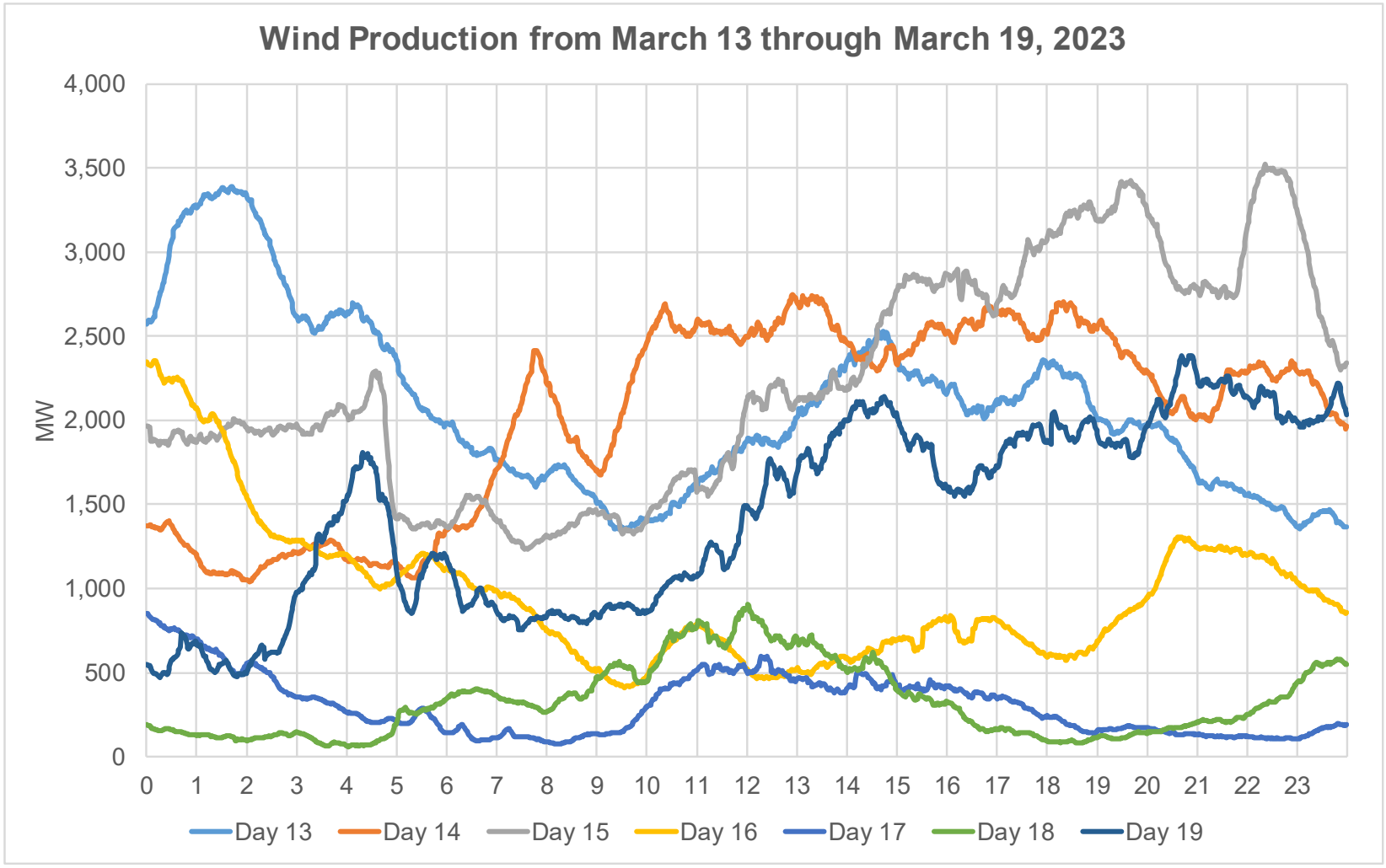
$$2027\ S_{Mth\_Sim\_1\text{-}min} = 2023\ S_{Act\_1\text{-}min} * 2027\ S_{Mth\ Capacity} / 2023\ S_{Mth\ Capacity}$$

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

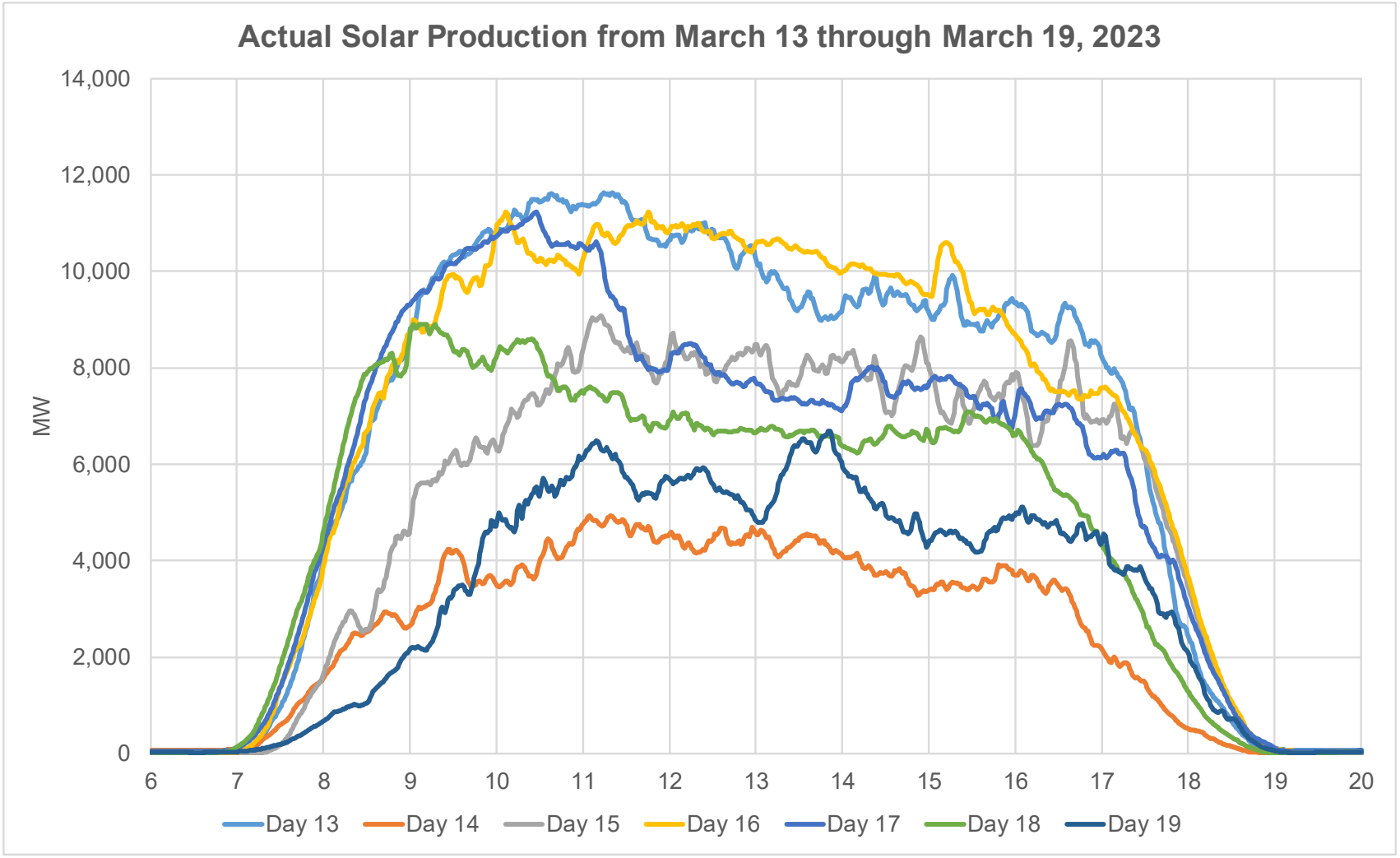
- Net-load is the aggregate of customer demand reduced by variable generation power output
- Net-load is more variable than load itself and it increases as VER production increases
- The monthly three-hour flexible capacity need equates to the largest expected up-ward change in net-load when looking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

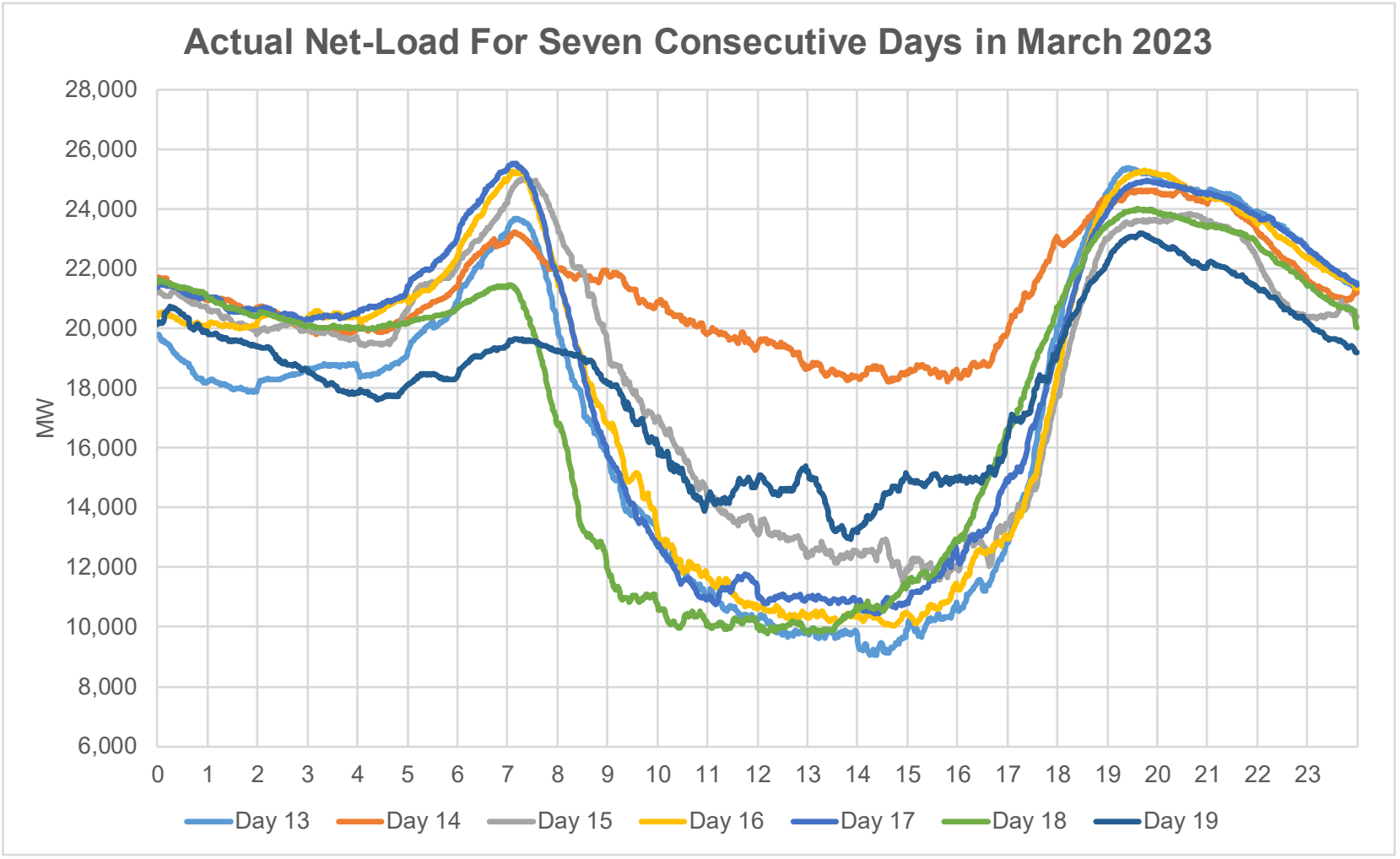
Example of actual wind variability for seven consecutive days in March 2023



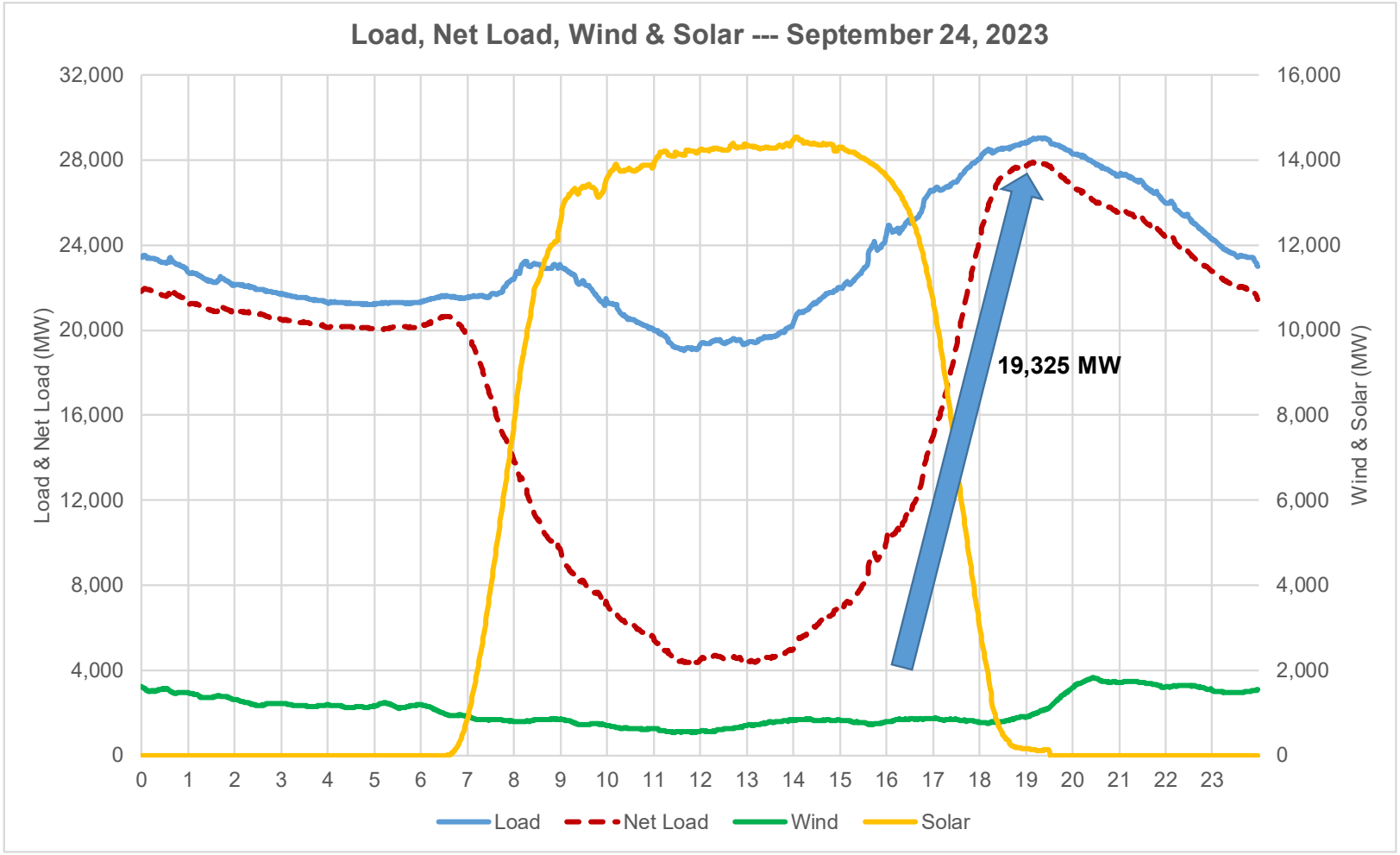
Example of actual solar variability for seven consecutive days in March 2023



Example of actual net-load variability for seven consecutive days in March 2023

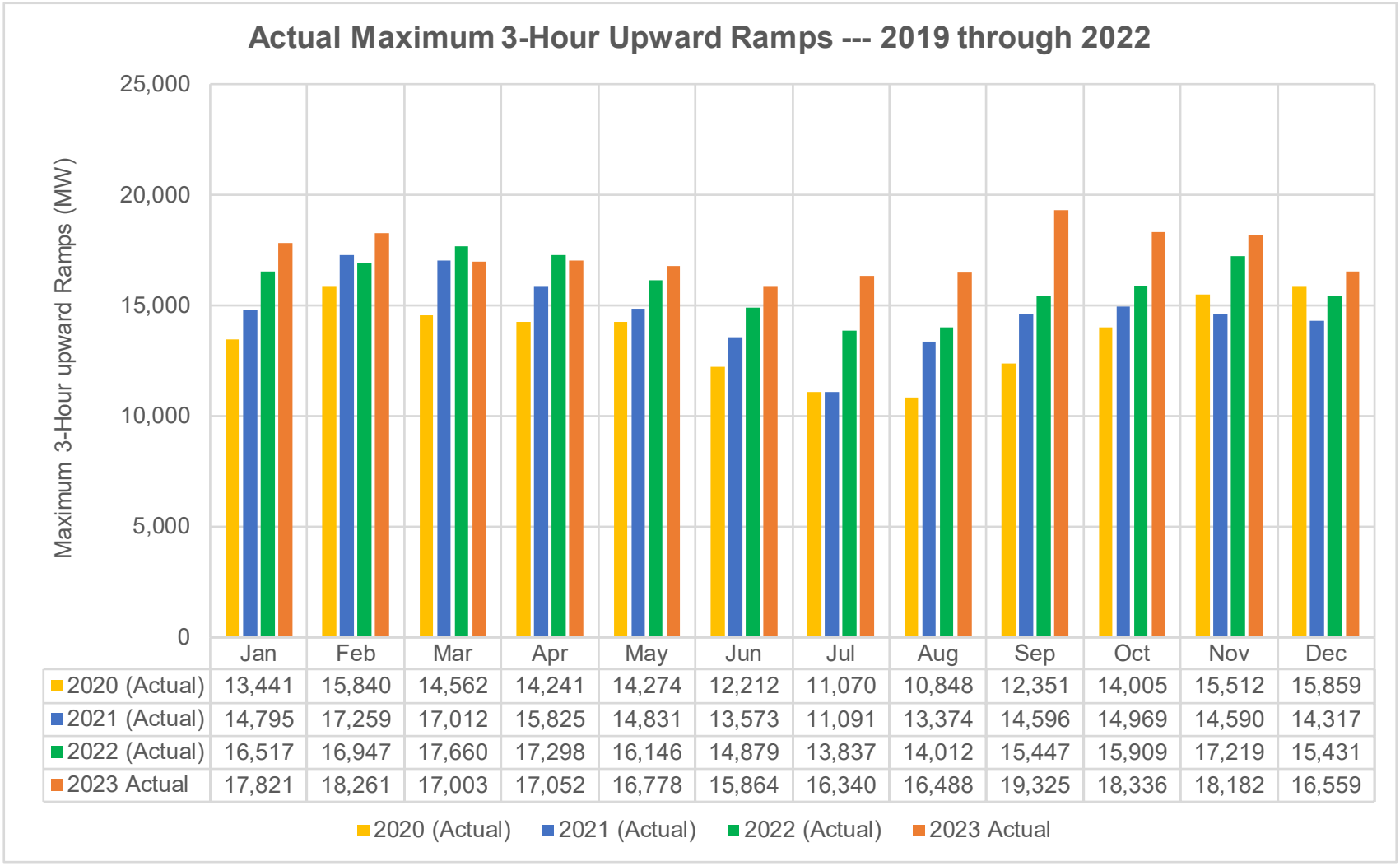


Maximum net-load 3-hour upward ramp in 2023 occurred on Sunday, September 24



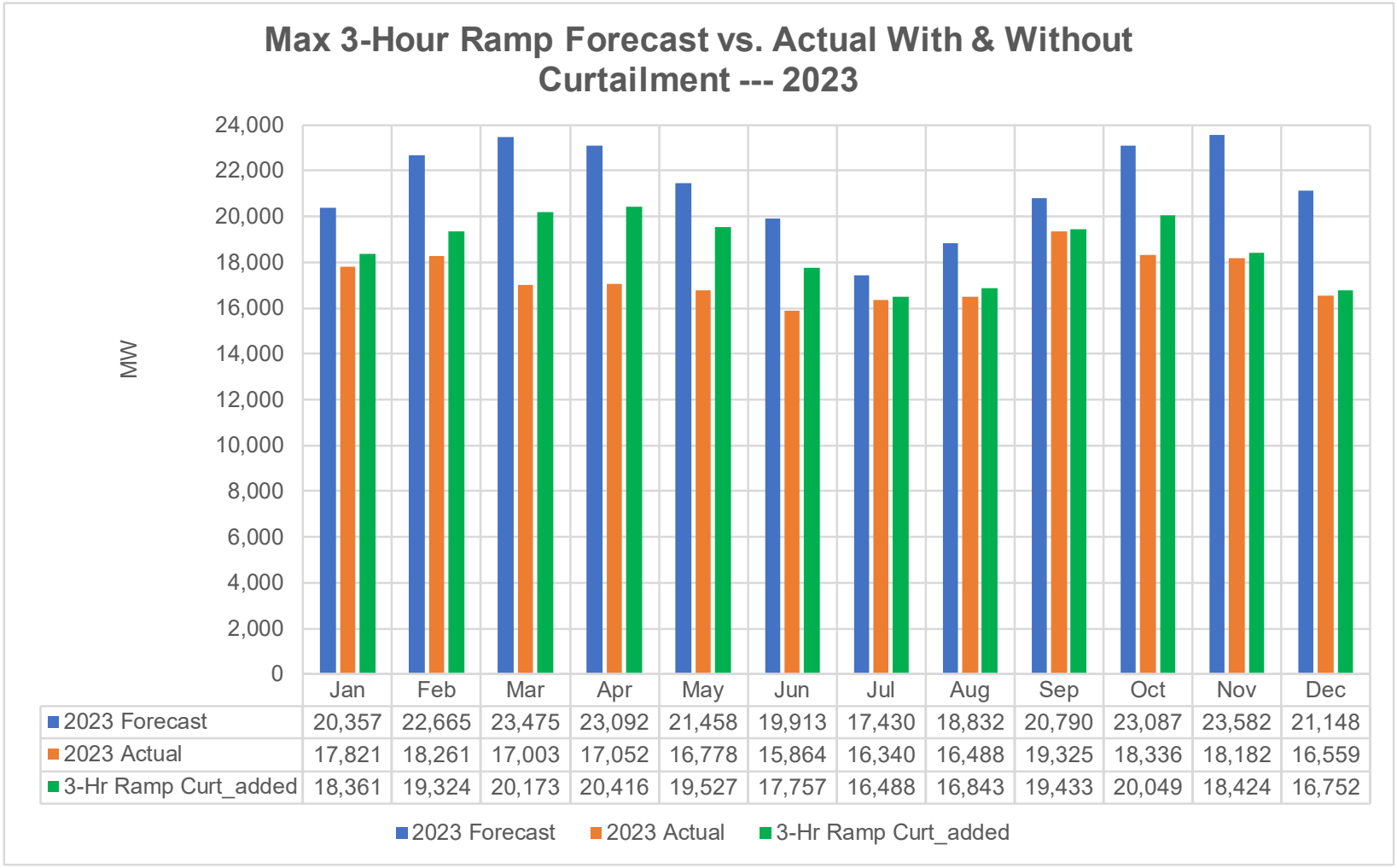
3-hour net load ramp values reported may vary based on resolution of the data and resources used in the calculation

Actual 3-hour ramps with curtailments --- 2020 through 2023



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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
2021 (Actual)	14,795	17,259	17,012	15,825	14,831	13,573	11,091	13,374	14,596	14,969	14,590	14,317
2022 (Actual)	16,517	16,947	17,660	17,298	16,146	14,879	13,837	14,012	15,447	15,909	17,219	15,431
2023 Actual	17,821	18,261	17,003	17,052	16,778	15,864	16,340	16,488	19,325	18,336	18,182	16,559

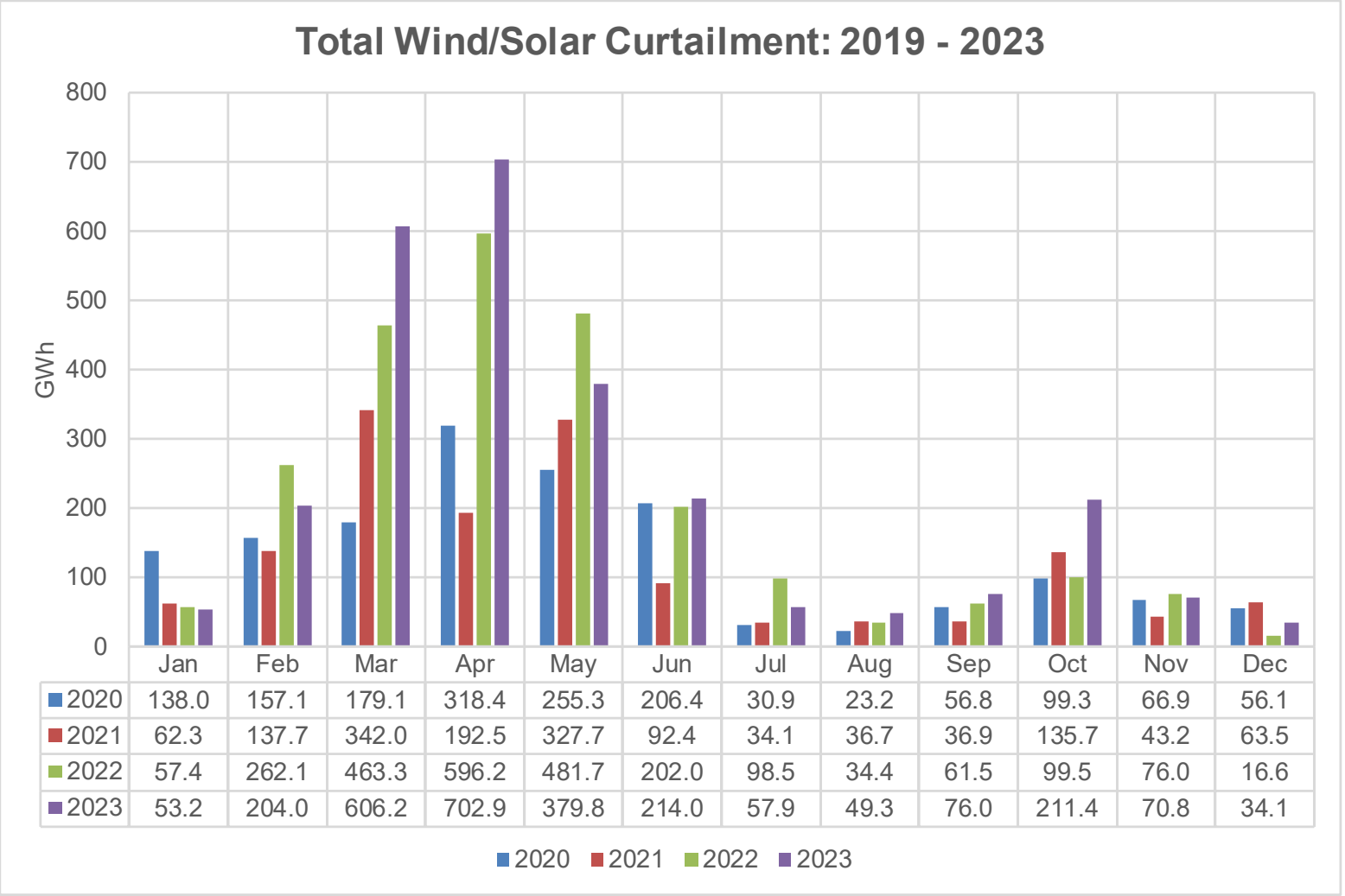
ISO continues to consider how we account for curtailments in Flex RA Study



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2023 Forecast	20,357	22,665	23,475	23,092	21,458	19,913	17,430	18,832	20,790	23,087	23,582	21,148
2023 Actual	17,821	18,261	17,003	17,052	16,778	15,864	16,340	16,488	19,325	18,336	18,182	16,559
3-Hr Ramp Curt_added	18,361	19,324	20,173	20,416	19,527	17,757	16,488	16,843	19,433	20,049	18,424	16,752

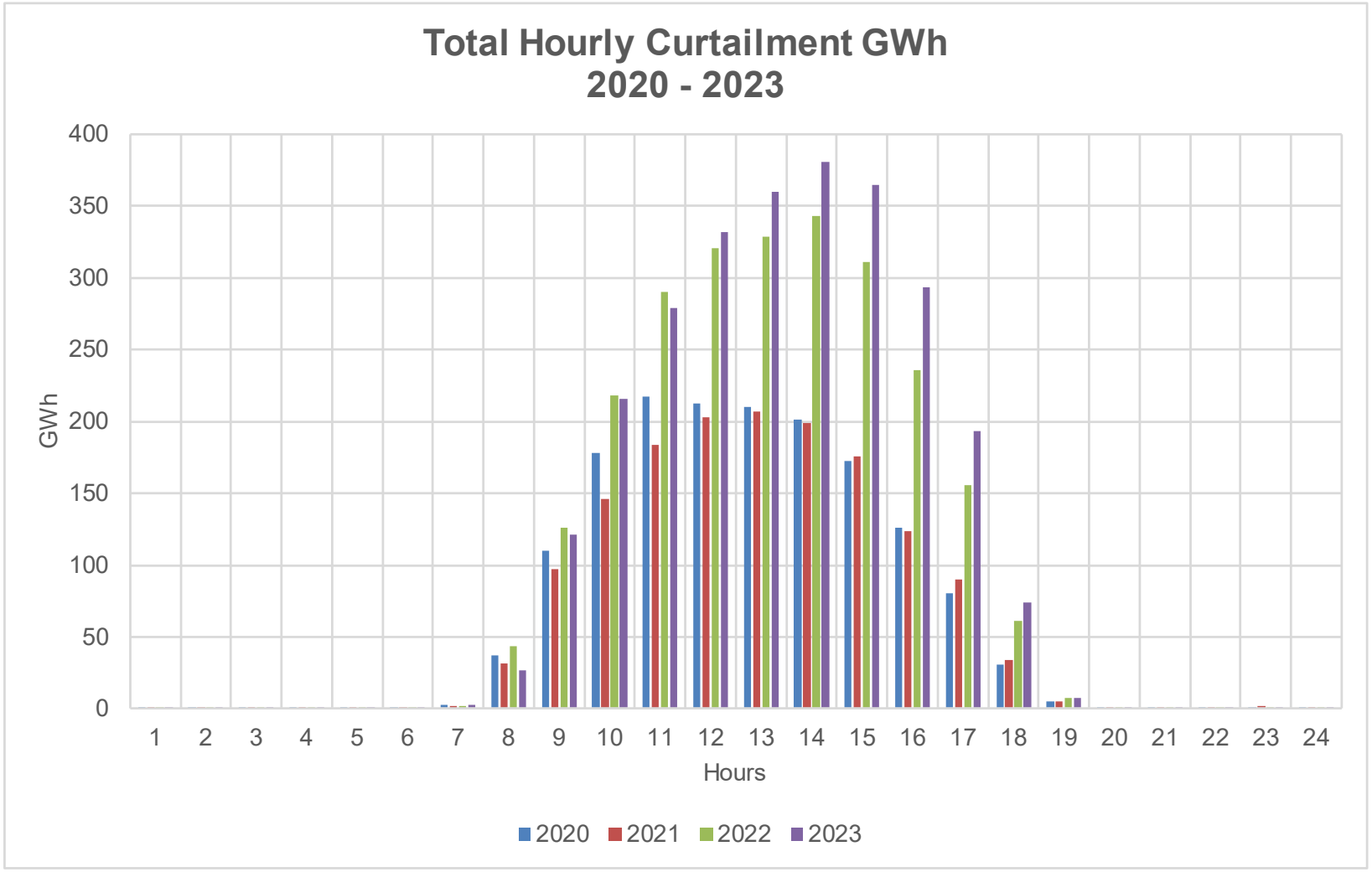
Forecast 2023 3-Hour ramps were derived from the 2022 flex-analysis study using 2021 actual 1-minute data

Highest levels of curtailments typically occur during the spring months --- 2020 through 2023

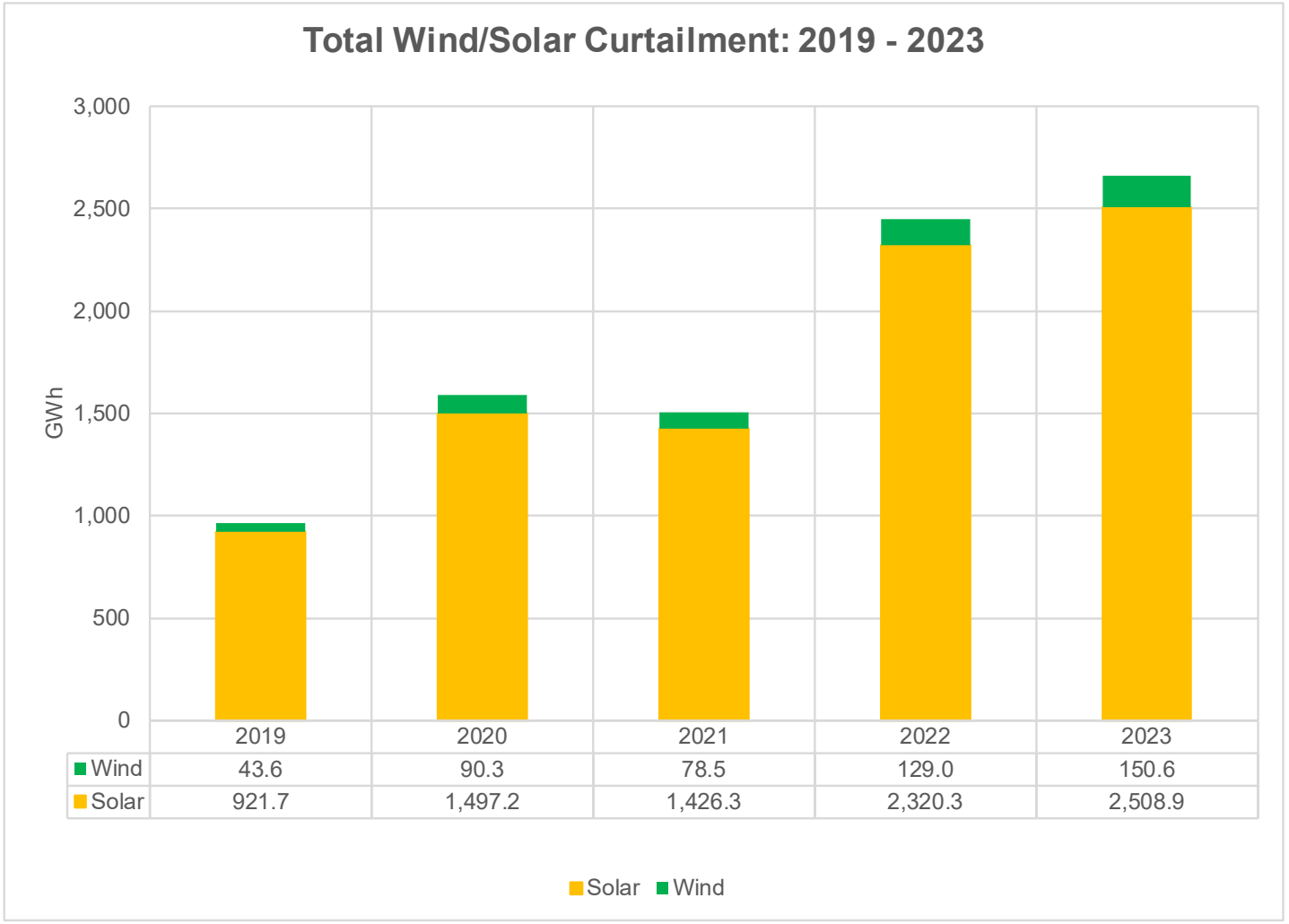


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020	138.0	157.1	179.1	318.4	255.3	206.4	30.9	23.2	56.8	99.3	66.9	56.1
2021	62.3	137.7	342.0	192.5	327.7	92.4	34.1	36.7	36.9	135.7	43.2	63.5
2022	57.4	262.1	463.3	596.2	481.7	202.0	98.5	34.4	61.5	99.5	76.0	16.6
2023	53.2	204.0	606.2	702.9	379.8	214.0	57.9	49.3	76.0	211.4	70.8	34.1

Highest levels of curtailments occur between sunrise and sunset --- 2020 through 2023



Level of curtailment has been increasing over the years --- 2019 through 2023



	2019	2020	2021	2022	2023
Wind	43.6	90.3	78.5	129.0	150.6
Solar	921.7	1,497.2	1,426.3	2,320.3	2,508.9

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 flexible capacity methodology should provide the ISO with sufficient flexible capacity

Methodology

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

Where:

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

E(PL) = Expected peak load

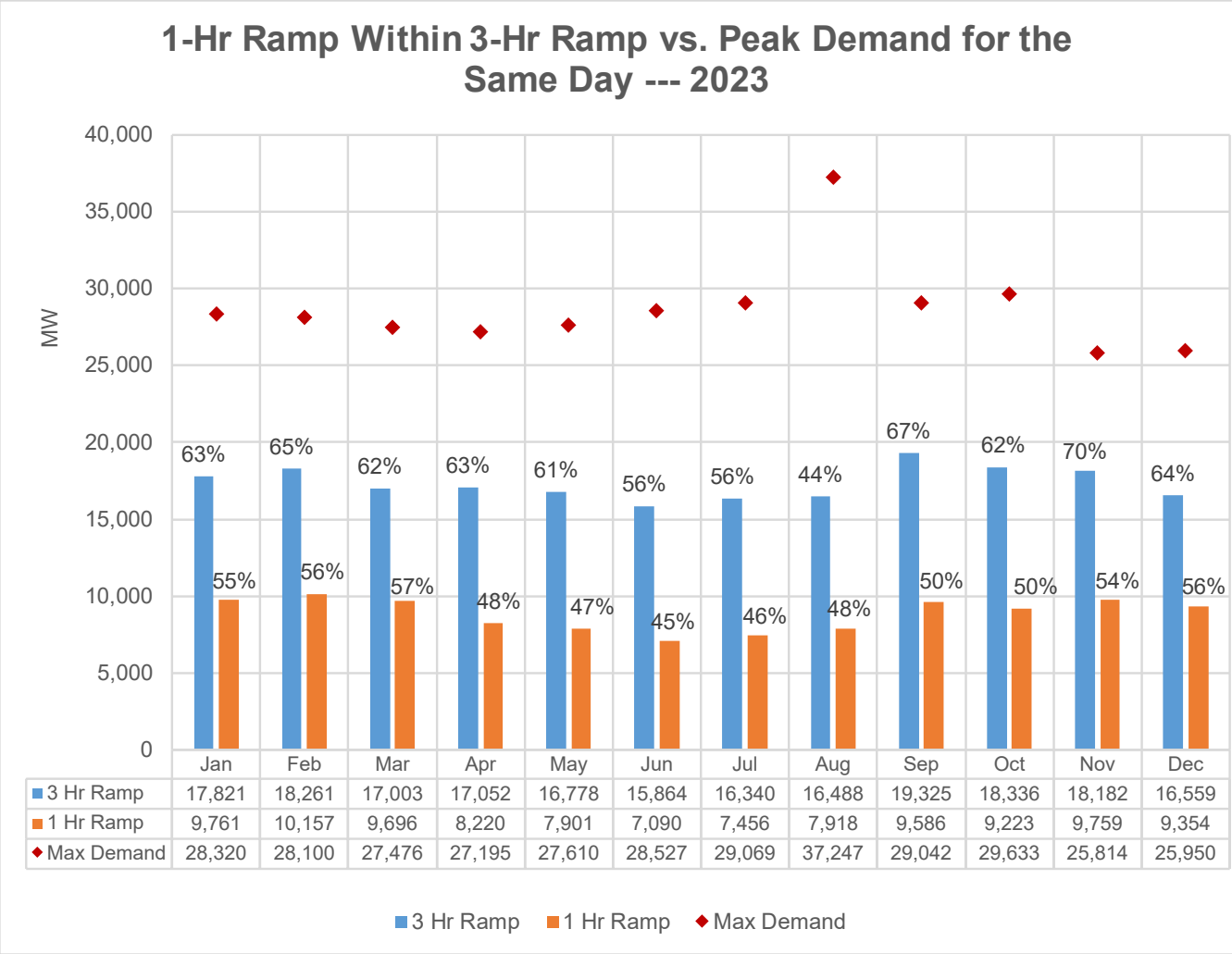
MTH_y = Month $_y$

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, demonstrating the need for faster ramping capability

- Three-hour upward ramps have been steadily increasing over the years
- Ramps are not evenly distributed across three hours
- One hour upward ramp is over 50% of the three hour ramp in some months



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3 Hr Ramp	17,821	18,261	17,003	17,052	16,778	15,864	16,340	16,488	19,325	18,336	18,182	16,559
1 Hr Ramp	9,761	10,157	9,696	8,220	7,901	7,090	7,456	7,918	9,586	9,223	9,759	9,354
Max Demand	28,320	28,100	27,476	27,195	27,610	28,527	29,069	37,247	29,042	29,633	25,814	25,950

What data does the ISO need?

- CEC's IEPR demand forecast (e.g. 2024 – 2027 demand forecast)
- LSE SCs to update renewable build-out for 2024 through 2027 by CREZ by January 15, 2024 (Beyond 2027 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_{2025}	Net Load Ramp Requirement for 2025
$\Delta NL_{sc,2025}$	Net Load Ramp Requirement of SC Allocation for 2025
R	Reserve = max(MSSC, 3.5* peak load)
pl_r_{sc}	CEC peak load ratio
Σ	Summation of all SCs

- 2025 load (L) forecast is from the CEC IEPR forecast
- Wind (W) and solar (S) are from survey results
- 2023 L is 5-minute observed data

Allocation: Formula

- Flex Requirement $= \Delta NL_{2025} + R_{2025}$
$= \Delta NL_{2025} + \Sigma pl\_r_{sc} * R_{2025}$

- $\Delta NL_{2025} = \Delta L_{2025} - \Delta W_{2025} - \Delta S_{2025}$
$= \Delta L_{2025} - \frac{\Sigma W_{sc,2025}}{W_{2025}} * \Delta W_{2025} - \frac{\Sigma S_{sc,2025}}{S_{2025}} * \Delta S_{2025}$

Allocation: Load Proportion

- $\Delta L_{2025} = \Delta L_{2023} + (\Delta L_{2025} - \Delta L_{2023})$

$$= \Sigma \Delta L_{sc,2023} + \frac{\Sigma L^{M}_{sc,2023}}{L^{M}_{2023}} * (\Delta L_{2025} - \Delta L_{2023})$$

ΔL_{2023} is the average load portion of top 5 maximum 2023 3h ramps while matching 2025 maximum 3h ramp on month and time, and L^{M}_{2023} is the average load at the middle point of those top 5 ramps.

- Therefore, each SC will receive:

$$\Delta L_{sc,2023} + \frac{L^{M}_{sc,2023}}{L^{M}_{2023}} * (\Delta L_{2025} - \Delta L_{2023})$$

The ISO accounts for renewables on the grid to determine flexibility needs

- The ISO uses the maximum ramping needs across a 3-hour period to set requirements for flexible capacity
- Renewable resources contribute to this requirement and the ISO incorporates forecasts to estimate these needs
- Resources Included:
  - EIR Wind and Solar Resources
  - Co-located EIRs
  - Hybrid Renewable Components
- Renewable components of hybrid resource must be considered in flexible need assessment because all renewable resources contributes 3-hour net load ramp
- The ISO allows the storage component for co-located and hybrid resources to count for flexible capacity

Other considerations in the Flex RA study

Item	Consideration
Treatment of Hybrid Resources	Full Hybrid capability went live February 1, 2023. How are they performing during the 3-hour ramp?
Load, wind, and solar forecast errors	Within the 2024 study, the CAISO made a correction based on CEC IEPR demand forecast. The CAISO will evaluate if any forecast errors need to be accounted for within the 2025 study
Net load minimum cap	Due to the rapid growth and not accounting for curtailments, the current net load goes to values that would not actually materialize.
Treatment of curtailments	The ISO does not have a process to account for how curtailment impacts the 3-hour net load ramp, other than using renewable one minute actual profiles. As a result the hourly forecast profiles may not accurately reflect ramping needs

ANNUAL REVIEW OF AVAILABILITY ASSESSMENT HOURS

Methodology Overview of System/Local Availability Assessment Hours

- Used CEC IEPR data described in previous slides (slide 7) to obtain:
  - Hourly Average Load
    - By Hour
    - By Month
    - Years 2023-2025
- Calculated:
  - Top 5% of Load Hours within each month using an hourly load distribution
  - Years 2025 - 2027

Key information already requested and obtained

- ISO published a market notice for survey data in December 2023 and January 2024
- LSE Survey Data was due on January 15, 2024
- CEC Hourly IEPR Forecast was posted January 31

Next Steps

Item	Date
February 12, 2024	ISO Flex RA methodology and criteria stakeholder call
February 26, 2024	Stakeholder comments on Flex RA methodology, criteria and data used for 2025 flexible requirements due
April 10, 2024*	Stakeholder call on preliminary Flexible Capacity and Availability Assessment Hours (AAH) requirements for 2024, 2025, and 2026
April 24, 2024*	Stakeholder comments on preliminary requirements due
May 2024*	Publish preliminary Flexible Capacity and AAH requirements for 2025, 2026 & 2027
May 2024*	Issue final Flexible Capacity and AAH requirements for 2025 and projected requirements for 2026 & 2027

*We are evaluating our Flex RA schedule based on delay of CEC IEPR forecast publication. The above information is subject to change accordingly.

Questions?

Please submit comments on the assumptions to initiativecomments@caiso.com by February 23, 2024

Thank you for your participation.

Annual Policy Initiatives Roadmap Process 2024

Please submit potential discretionary initiatives to the 2024 annual policy catalog.

Submission deadline is Wednesday, **February 28, 2024**

- comment template here
- information on this process here.

Any questions or concerns email us at ISOStakeholderaffairs@caiso.com

Save the Date: 2024 Stakeholder Symposium

- The California ISO Stakeholder Symposium to be held Oct. 29-30, 2024
- The Symposium will be held at the Safe Credit Union Convention Center in Sacramento, California
- Welcome reception for all attendees the evening of Oct. 29. Additional information, including event registration and sponsorship opportunities, will be provided in a future notice and on the ISO's website.

Welcome reception:	**Stakeholder symposium:**
Date: Oct. 29, 2024 Time: 5:30 p.m. - 7:30 p.m. Location: To be announced	Date: Oct. 30, 2024 Time: 8:00 a.m. - 4:30 p.m. Location: **Safe Credit Union Convention Center**, 1400 J St., Sacramento, CA 95814

Please contact Symposium Registration at **symposiumreg@caiso.com** with any questions.