Flexible Capacity Needs and Availability Assessment Hours Technical Study for 2022

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What's the purpose of this call?

To discuss the assumptions, methodology, and draft results of the monthly flexible capacity requirement and Availability Assessment Hours Technical Study.

Specifically

Calculating requirements for all LRAs within the ISO footprint for RA compliance year 2022 and advisory flexible capacity requirements for compliance years 2023 and 2024

Agenda / Overview

- Background
- Process review
  - Expected build out from all LSEs (CPUC jurisdictional and non-jurisdictional)
  - Load, wind and solar profiles
  - Calculate 3-hour net load upward ramps
  - Add the larger of either the spinning reserve portion of contingency reserves or the most severe contingency
  - Calculate monthly Flexible Capacity requirement
- Overview of methodology used for system/local availability assessment hours
  - 2023 availability assessment hours
  - 2023-2024 draft availability assessment hours

Each LSE Scheduling Coordinator shall make a year-ahead and month-ahead showing of flexible capacity for each month of the compliance year

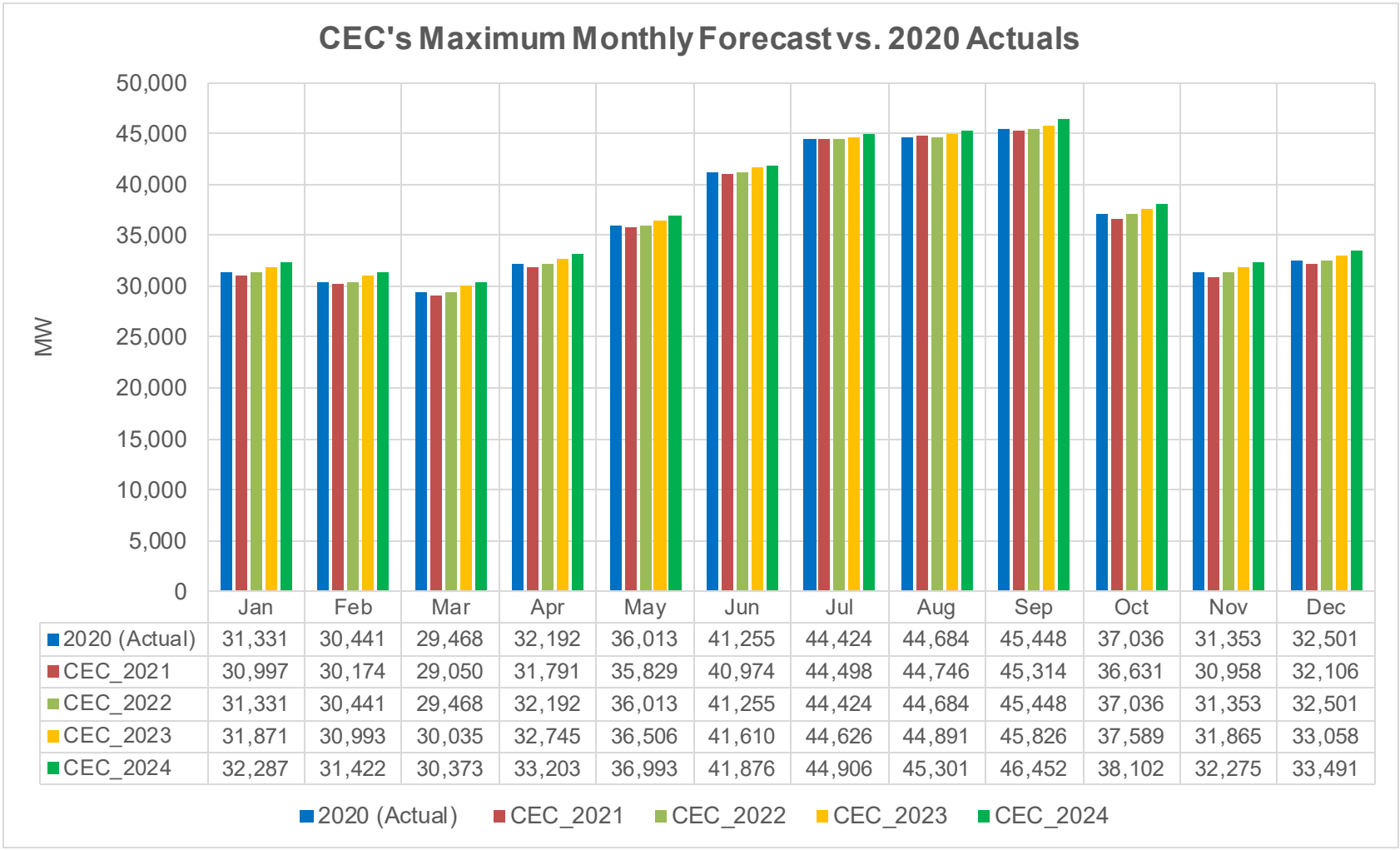
Resource Adequacy (RA)

- Ensure LSEs contract for adequate capacity to meet expected flexible capacity needs
- Year ahead: LSEs need to secure a minimum of 90% of the next years monthly needs
- Month ahead: LSEs need to secure adequate net qualified capacity to serve their peak load including a planning reserve margin and flexible capacity to address largest 3-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

The ISO used the following data to determine the flexible capacity needs

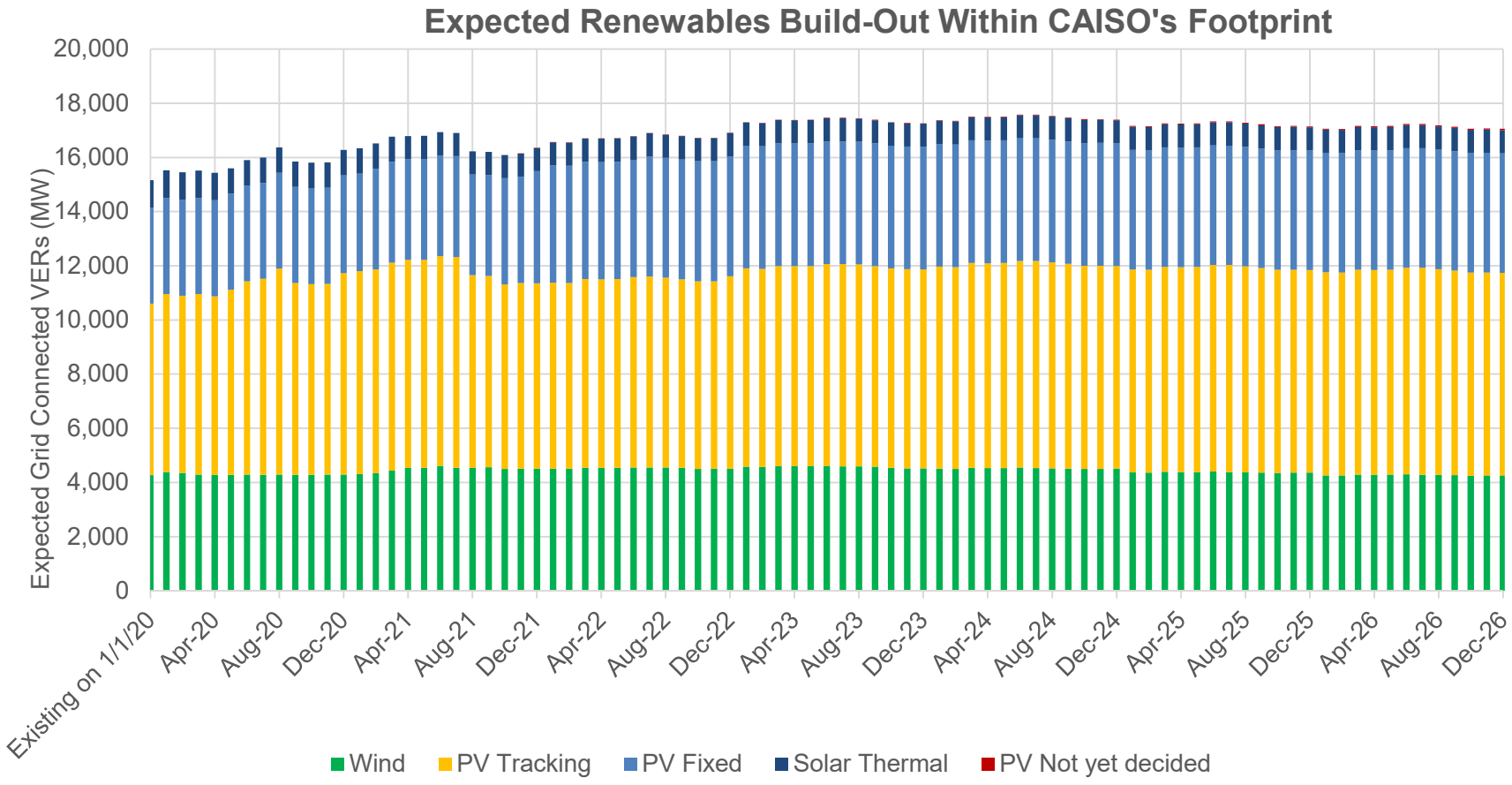
- CEC's IEPR demand forecast for 2022 through 2024
  - Behind-the-meter hourly solar PV production
  - Hourly AAEE
- LSE SCs updated renewable build-out for 2020 through 2024
- The Analysis of Flex Capacity Needs included:
  - Existing VERs capacity
  - Expected installed capacity by technology and expected operating date (e.g. Solar thermal, solar PV tracking, solar PV non-tracking, estimate of behind-the-meter solar PV, co-located) for all variable energy resources under contract
  - Operational date or expected on-line date
  - Dynamically scheduled resources located outside ISO's BAA

CEC's (1-in-2) ISO monthly coincident peak forecast

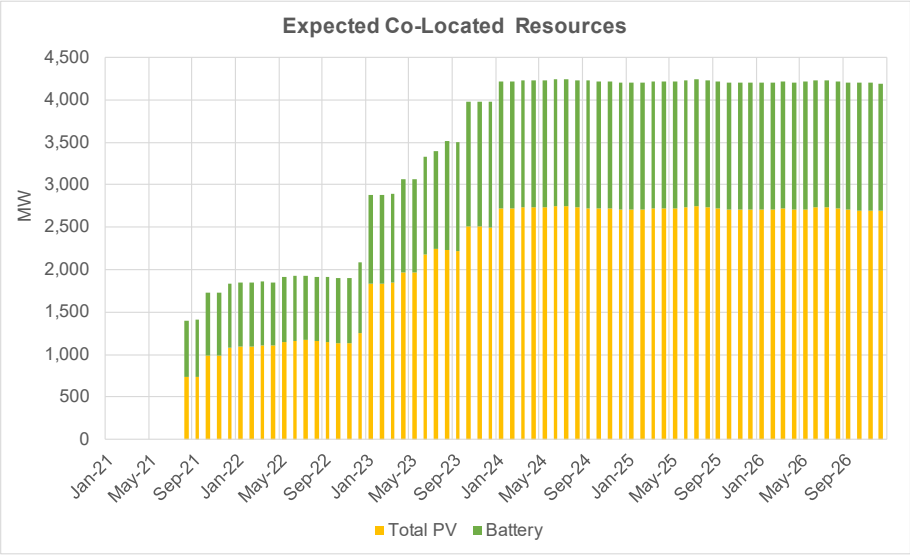


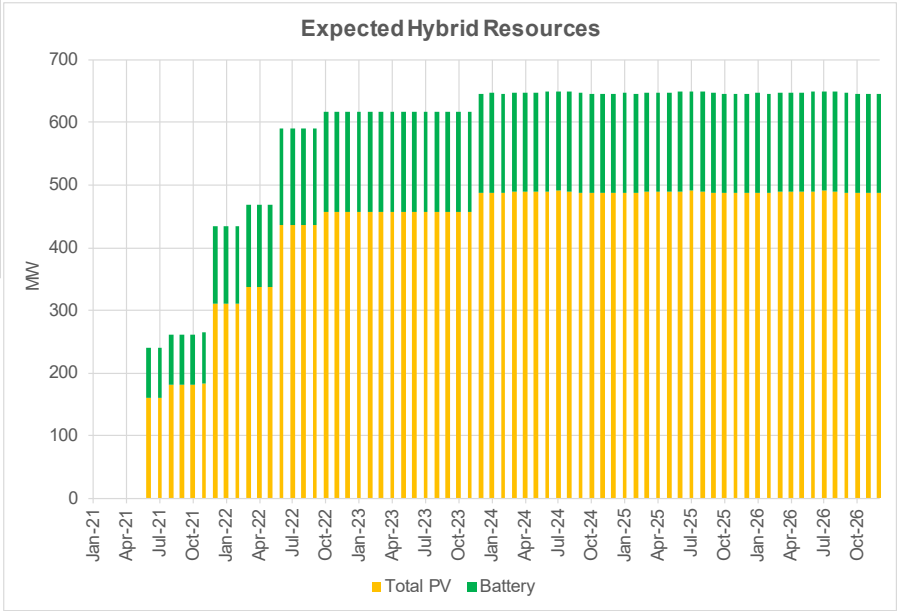
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020 (Actual)	31,331	30,441	29,468	32,192	36,013	41,255	44,424	44,684	45,448	37,036	31,353	32,501
CEC_2021	30,997	30,174	29,050	31,791	35,829	40,974	44,498	44,746	45,314	36,631	30,958	32,106
CEC_2022	31,331	30,441	29,468	32,192	36,013	41,255	44,424	44,684	45,448	37,036	31,353	32,501
CEC_2023	31,871	30,993	30,035	32,745	36,506	41,610	44,626	44,891	45,826	37,589	31,865	33,058
CEC_2024	32,287	31,422	30,373	33,203	36,993	41,876	44,906	45,301	46,452	38,102	32,275	33,491

Expected renewable buildout through December 2026 based on LSE's submittal



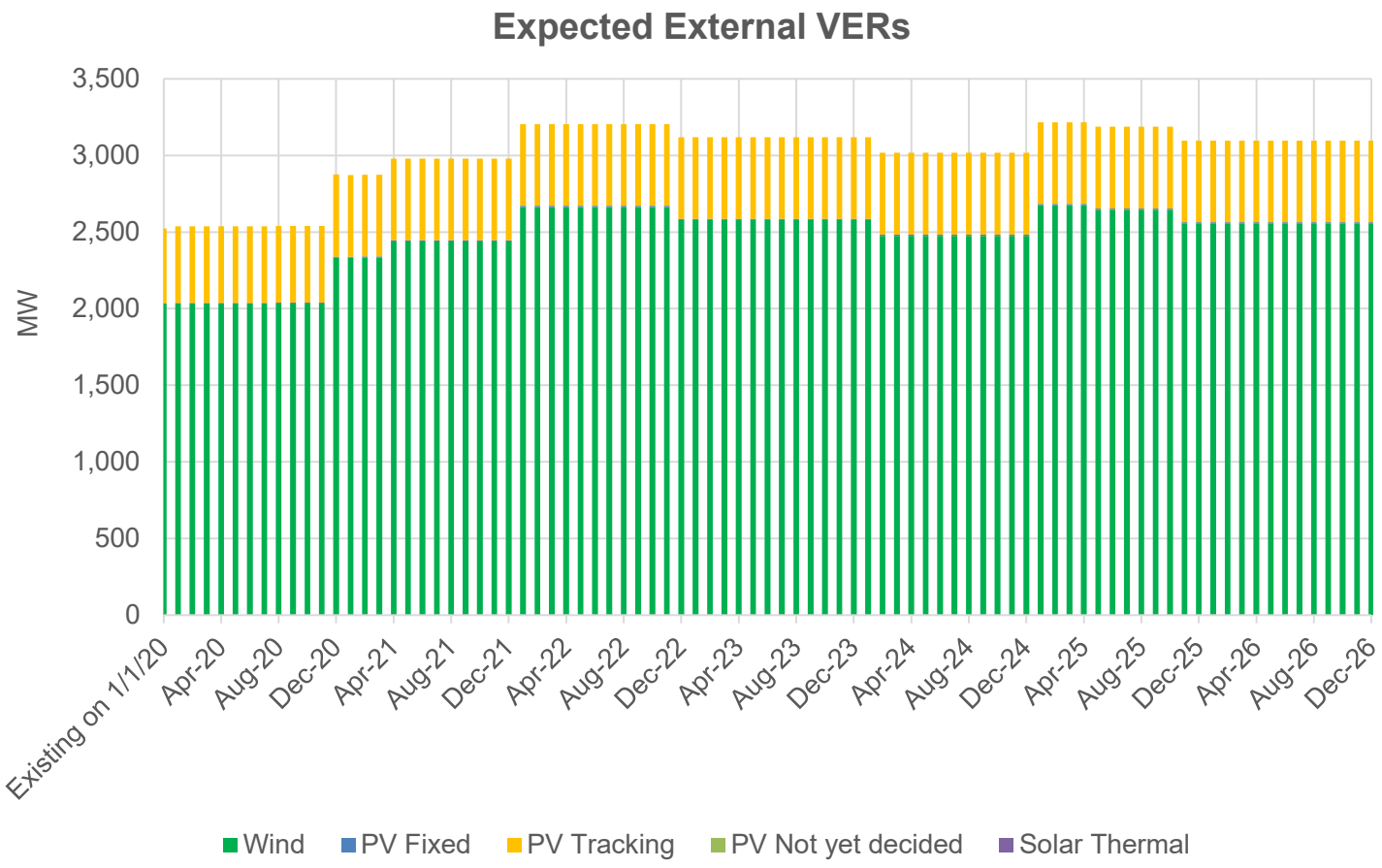
Expected co-located and hybrid renewable buildout through December 2026 based on LSE's submittal



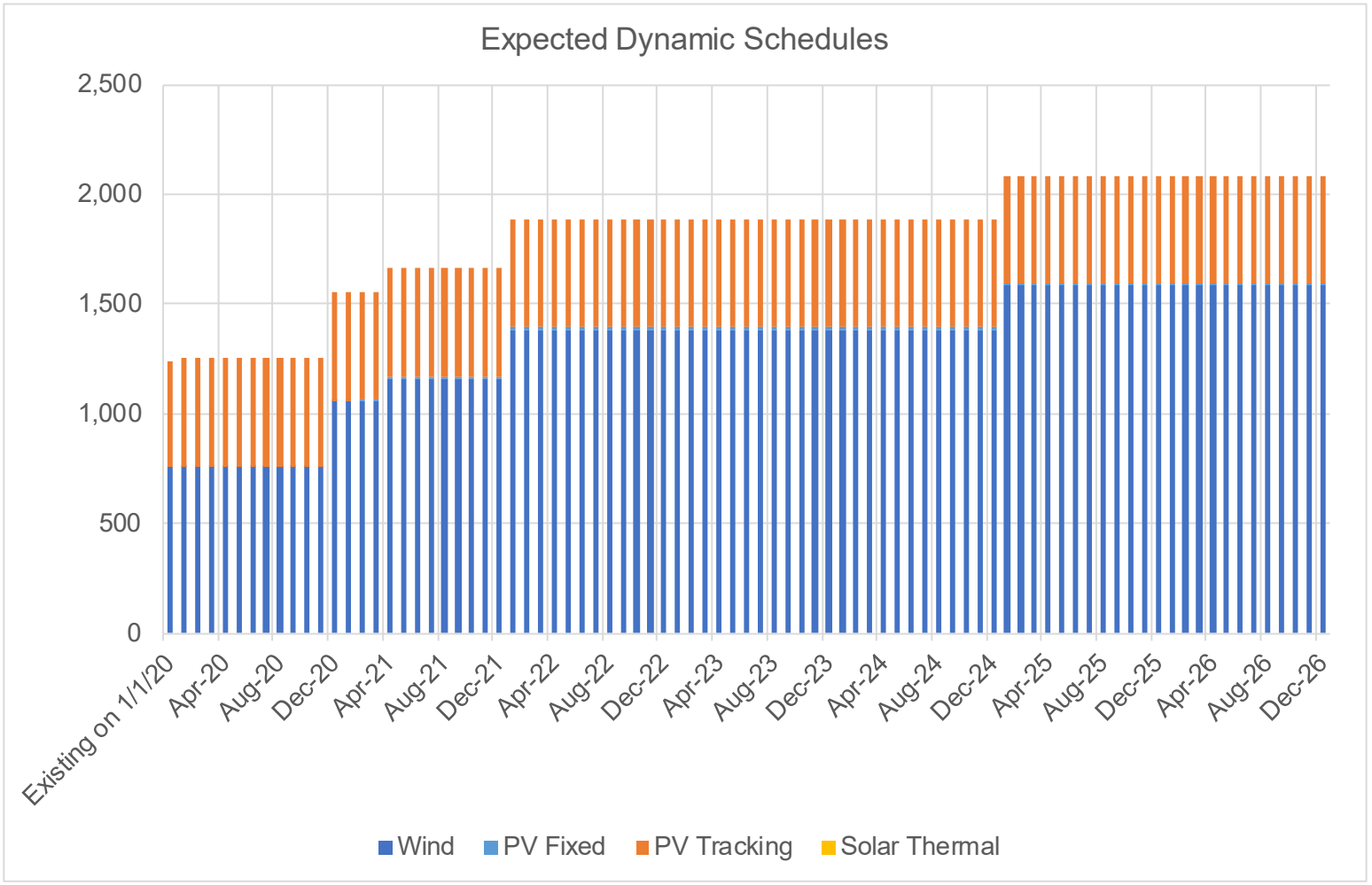


- Co-Located resources were included in the flexible needs assessment
- Hybrid resources were not included in the flexible needs assessment
- Hybrid resources would be reevaluated for inclusion in future studies

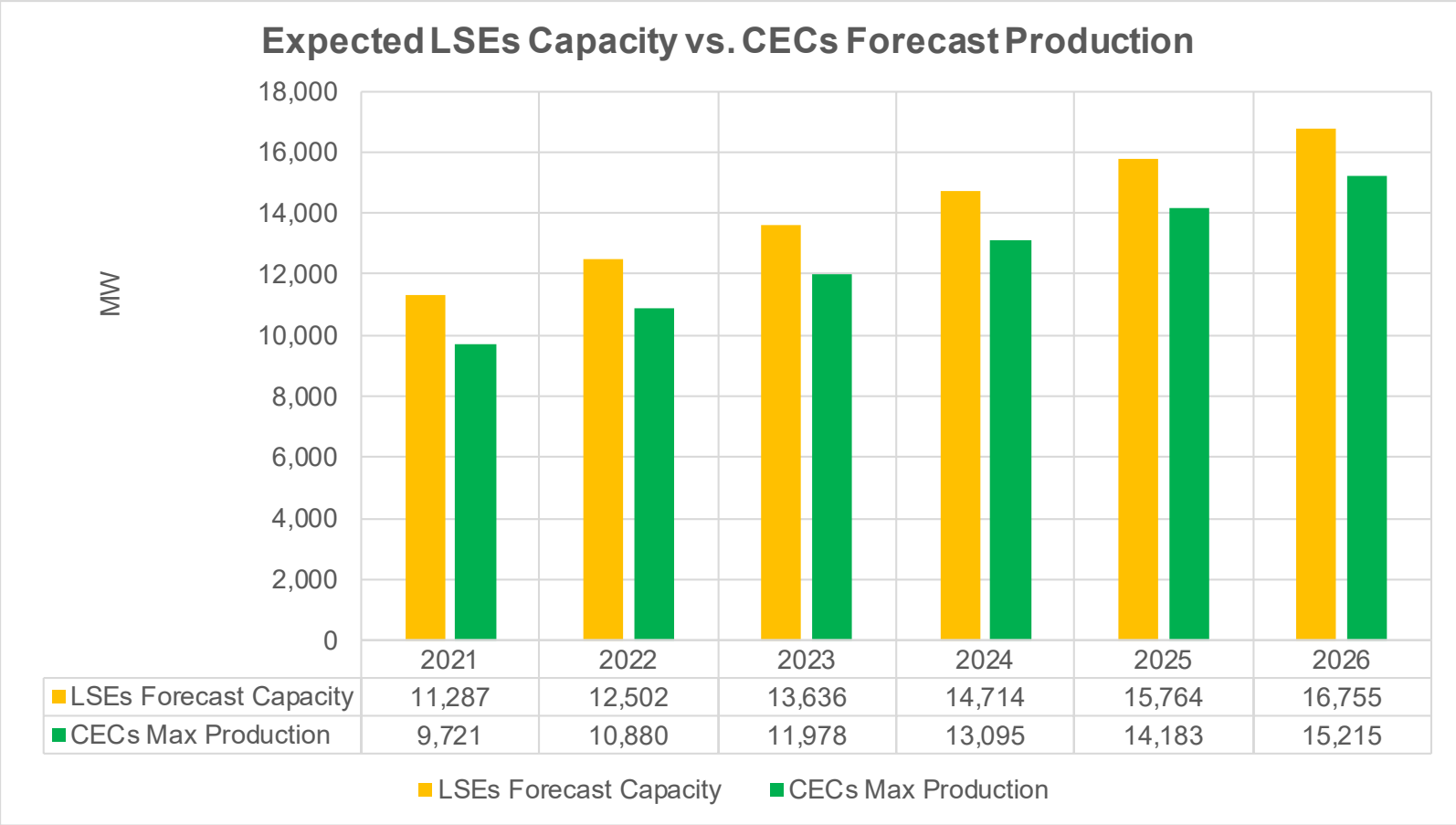
Expected wind/solar resources located outside the ISO which are contracted by LSE within the ISO



Expected dynamically scheduled wind/solar resources from external resources shown in the previous slide



Expected LSEs rooftop solar PV capacity vs. CEC's estimated production



Summary of LSEs submittal showing the expected capacity at the end of each year

Resource Type	*Existing VERs 2020 (MW)*	*Expected 2021 (MW)*	*Expected 2022 (MW)*
ISO Solar PV	11,050	10,985	11,535
ISO Solar Thermal	938	858	858
ISO Wind	4,294	4,513	4,515
Total Variable Energy Resource Capacity in the 2022 Flexible Capacity Needs Assessment	***16,282***	***16,356***	***16,908***
Non ISO Solar Resources that's Dynamically Scheduled into the ISO	503	501	501
Non ISO Wind Resources that's Dynamically Scheduled into the ISO	1,055	1,160	1,385
Co-Located Resources		1,090	1,255
Total Internal and dynamically scheduled VERs in 2021 Flexible Capacity Needs Assessment	***17,840***	***19,107***	***20,049***
Incremental New Additions Each Year		1,267	942
Incremental behind-the-meter Solar PV Capacity submitted by LSEs*		1,336	1,215

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

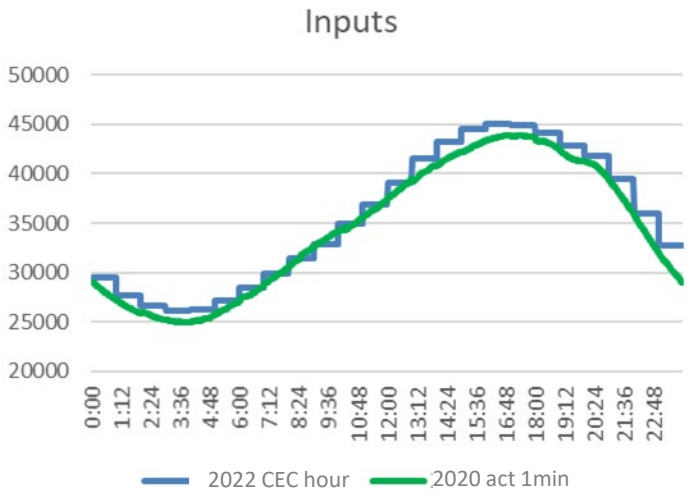
- Uses the most current data available for renewable build-out obtained from all LSE SCs
- For new renewable installation scale 2020 actual production data based on the expected installed capacity in subsequent years
- Generate net-load profiles for 2022 through 2024
  - Generate load profiles for 2022 through 2024
  - Generate solar profiles for 2022 through 2024
  - Generate wind profiles for 2022 through 2024

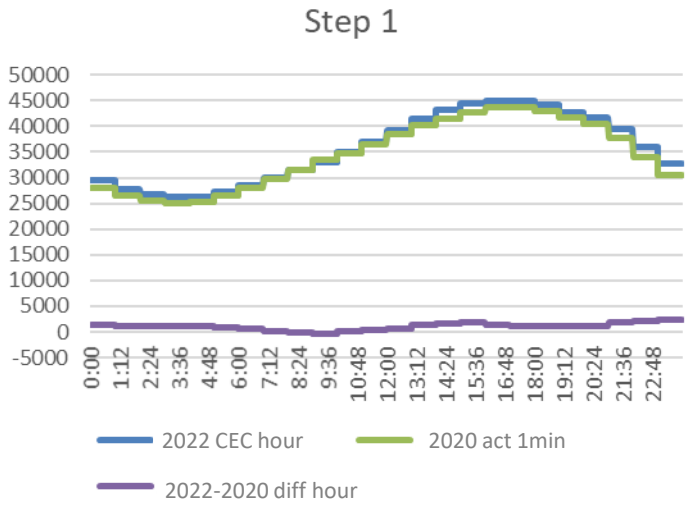
The ISO used the CEC's 1-in-2 IEPR forecast to develop the load forecast

- CEC IEPR Load Forecast
  - https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2020-integrated-energy-policy-report-update-0
  - Title of File: "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)

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

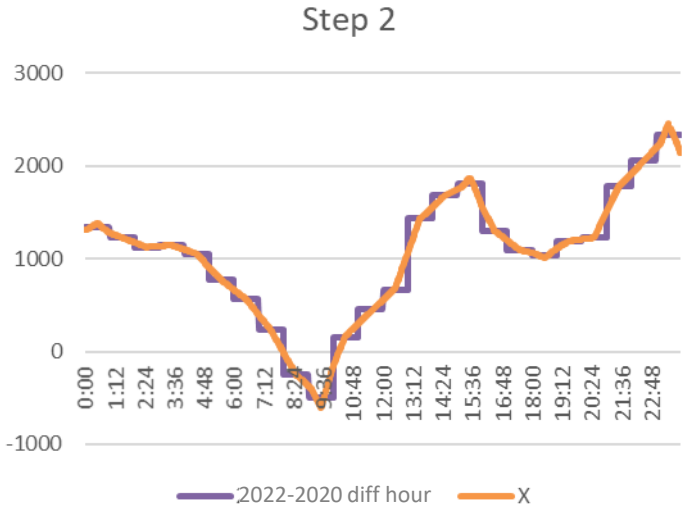
Using the 2022 CEC hourly forecast and the 2020 1-minute actuals, we will create the estimated 2022 1-minute forecast

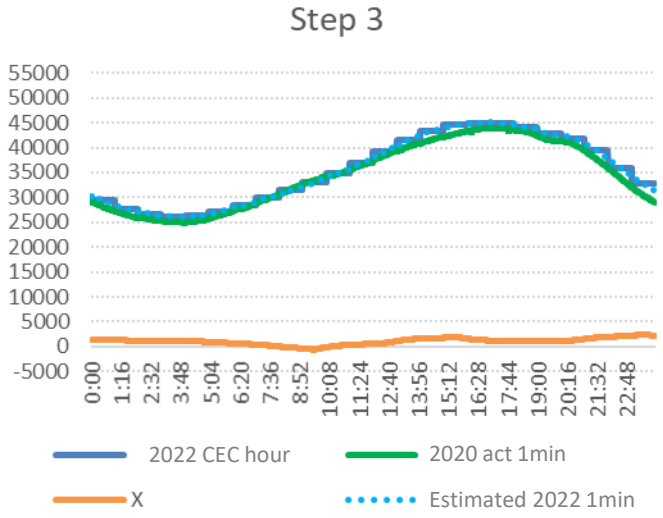




Take the hourly average of the 1-minute data and find the difference between the hourly 2020 actuals and 2022 forecast

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

Converting 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

2022 Load 1-Minute Forecast

- **2022 $L_{CECfcst\_1min}$ = 2020 L_{Act_1min} + X**
  - **Where X = Interpolated 1min profile from the difference (2022 $L_{CECfcst\_hourly}$ - 2020 L_{actual_hourly})**

2023 Load 1-Minute Forecast

- **2023 $L_{CECfcst\_1min}$ = 2020 L_{Act_1min} + X**
  - **Where X = Interpolated 1min profile from the difference (2023 $L_{CECfcst\_hourly}$ - 2020 L_{actual_hourly})**

Solar growth assumptions through 2024

- Used the actual solar 1-minute solar production data for 2020 to develop the 1-minute solar profiles for 2021 through 2024
- Scaled 1-minute solar data using the forecast monthly solar capacity for the new plants scheduled to be operational in 2020
- Repeated the above steps for 2022, 2023 & 2024

$$2021\ S_{Mth\_Sim\_1min} = 2020\ S_{Act\_1min} * \frac{2021\ S_{Mth\ Capacity}}{2020\ S_{Mth\ Capacity}}$$

$$2022\ S_{Mth\_Sim\_1min} = 2020\ S_{Act\_1min} * \frac{2022\ S_{Mth\ Capacity}}{2020\ S_{Mth\ Capacity}}$$

$$2023\ S_{Mth\_Sim\_1min} = 2020\ S_{Act\_1min} * \frac{2023\ S_{Mth\ Capacity}}{2020\ S_{Mth\ Capacity}}$$

$$2024\ S_{Mth\_Sim\_1min} = 2020\ S_{Act\_1min} * \frac{2024\ S_{Mth\ Capacity}}{2020\ S_{Mth\ Capacity}}$$

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

- Net load is defined as load minus wind and solar power production
- Net load variability increases as more and more wind and solar resources are integrated into the system
- The monthly 3-hour flexible capacity need equates to the largest upward change in net load when looking across a rolling 3-hour evaluation window
- The ISO dispatches flexible resources (including renewable resources with energy bids) to meet net load

1 NERC Special Report
Flexibility Requirements and Metrics for Variable Generation: Implications for System Planning Studies, August 2010. https://www.nerc.com/files/IVGTF_Task_1_4_Final.pdf

The flexible capacity methodology is expected to 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 3-hour contiguous ramp starting in hour x for month y

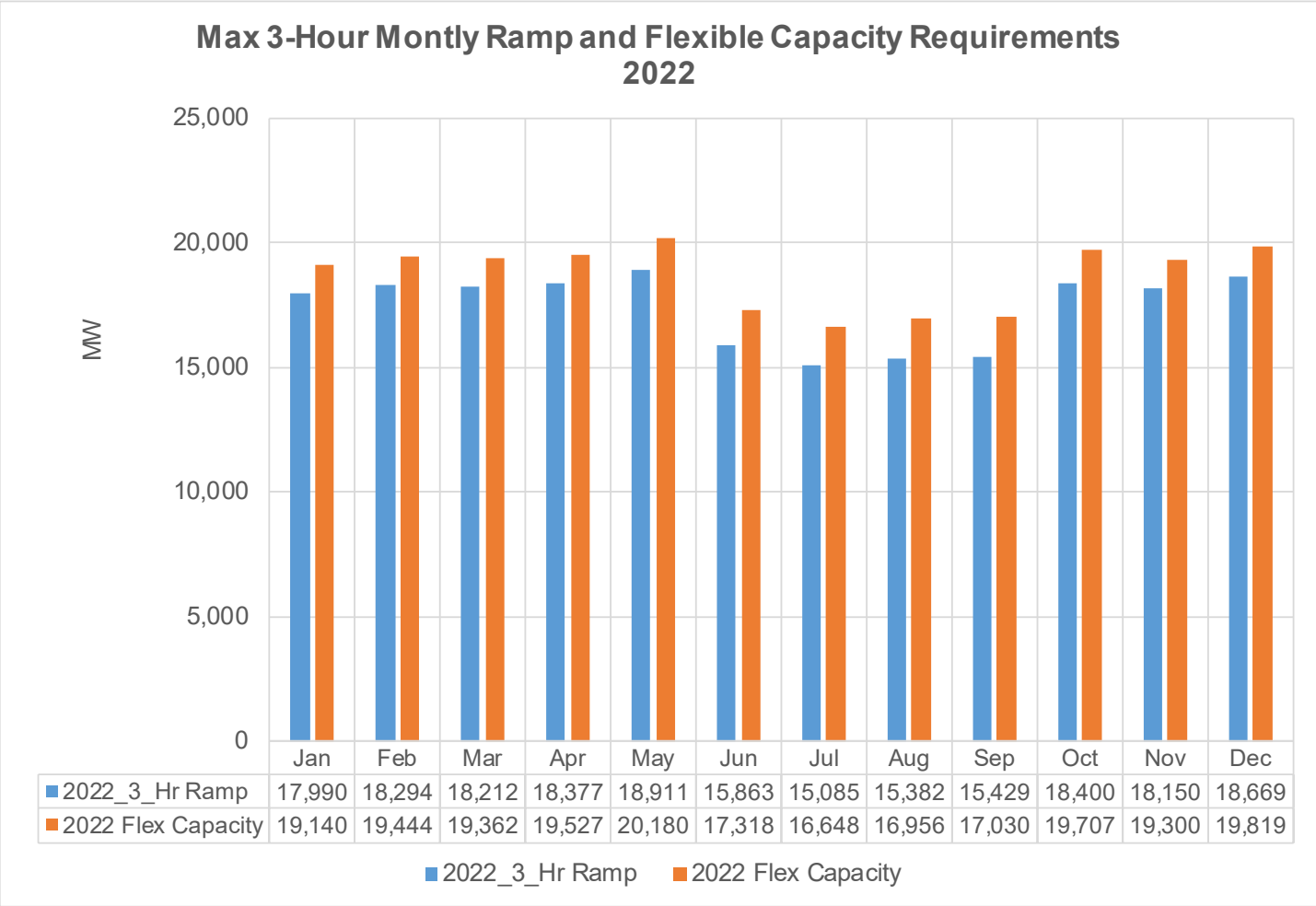
E(PL) = Expected peak load

MTH_y = Month $_y$

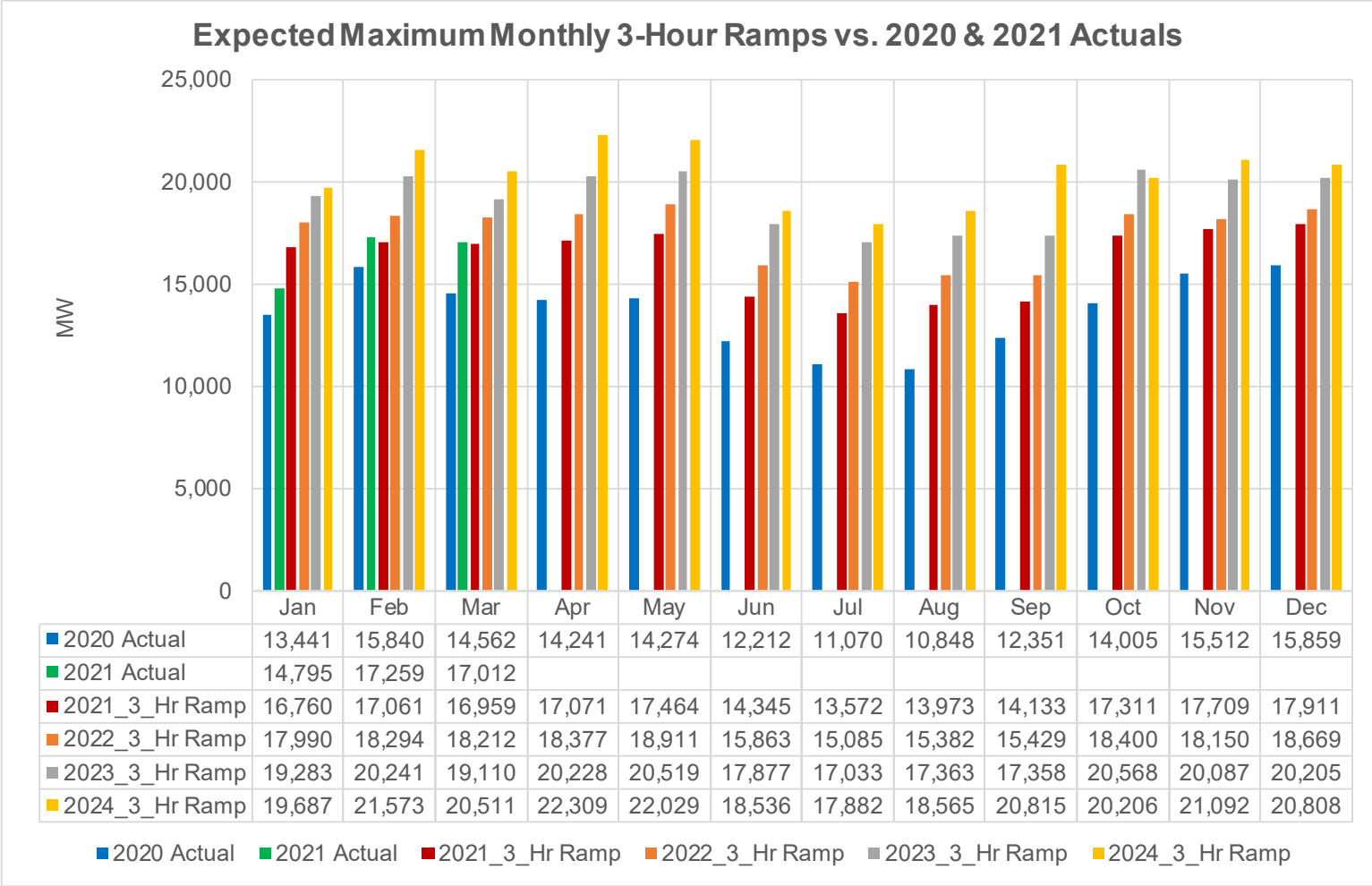
MSSC = Most Severe Single Contingency

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

Monthly 3-Hour upward ramps and total flexible capacity requirements for 2022

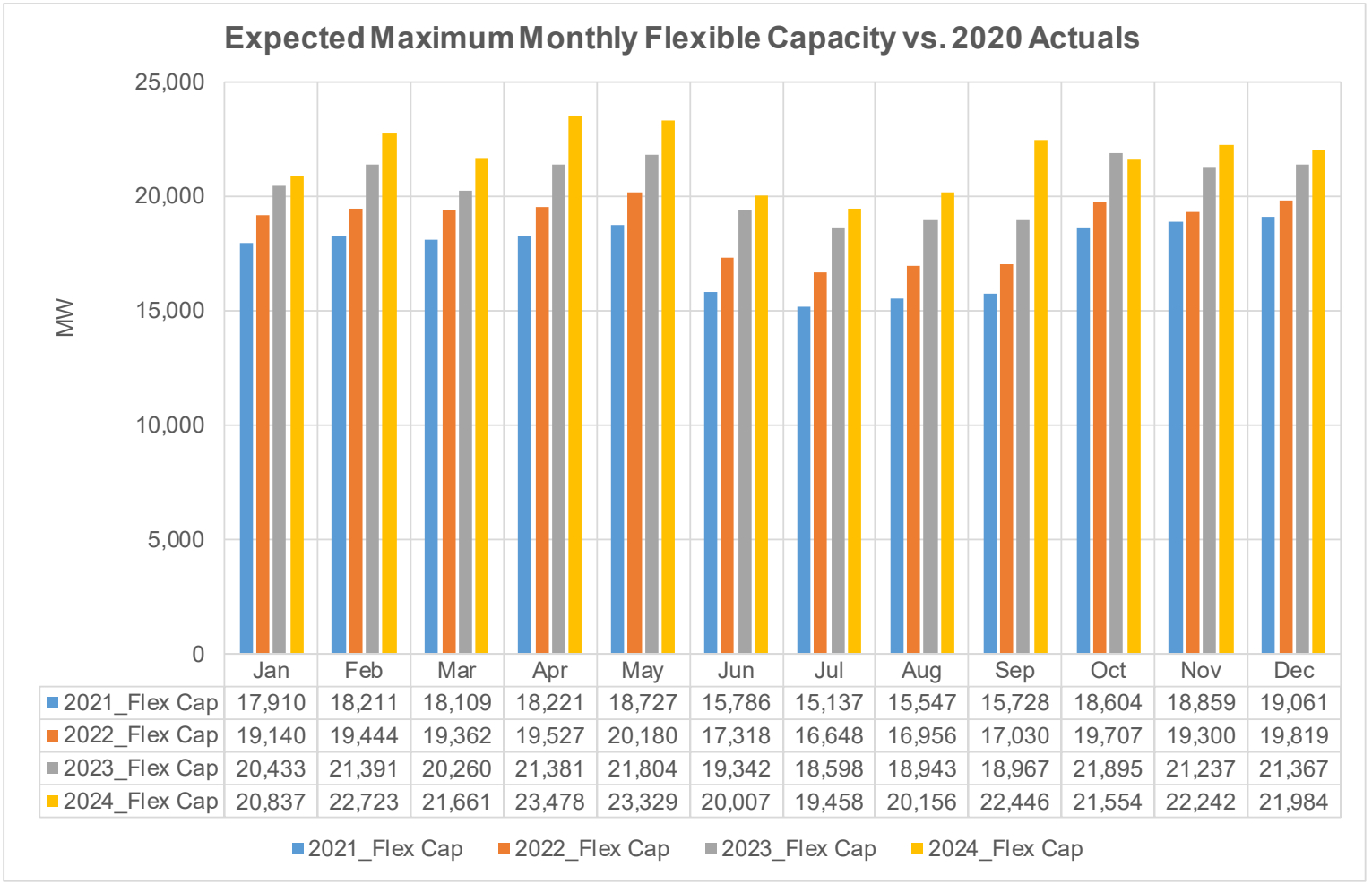


Expected maximum monthly 3-hour upward ramps vs. 2020 and 2021 actuals



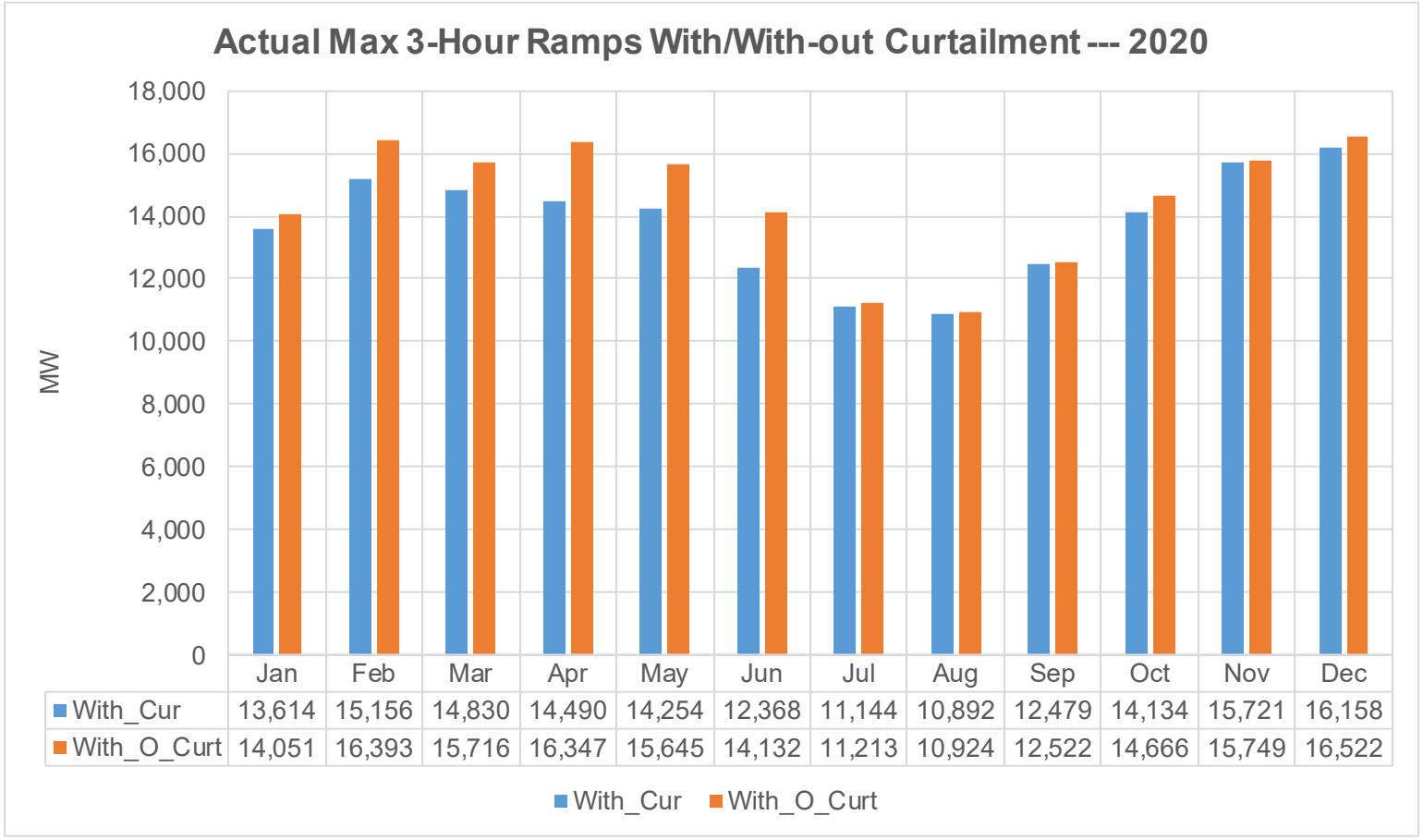
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020 Actual	13,441	15,840	14,562	14,241	14,274	12,212	11,070	10,848	12,351	14,005	15,512	15,859
2021 Actual	14,795	17,259	17,012									
2021_3_Hr Ramp	16,760	17,061	16,959	17,071	17,464	14,345	13,572	13,973	14,133	17,311	17,709	17,911
2022_3_Hr Ramp	17,990	18,294	18,212	18,377	18,911	15,863	15,085	15,382	15,429	18,400	18,150	18,669
2023_3_Hr Ramp	19,283	20,241	19,110	20,228	20,519	17,877	17,033	17,363	17,358	20,568	20,087	20,205
2024_3_Hr Ramp	19,687	21,573	20,511	22,309	22,029	18,536	17,882	18,565	20,815	20,206	21,092	20,808

Maximum monthly total flexible capacity requirement using CEC's load forecast for 2021 through 2024



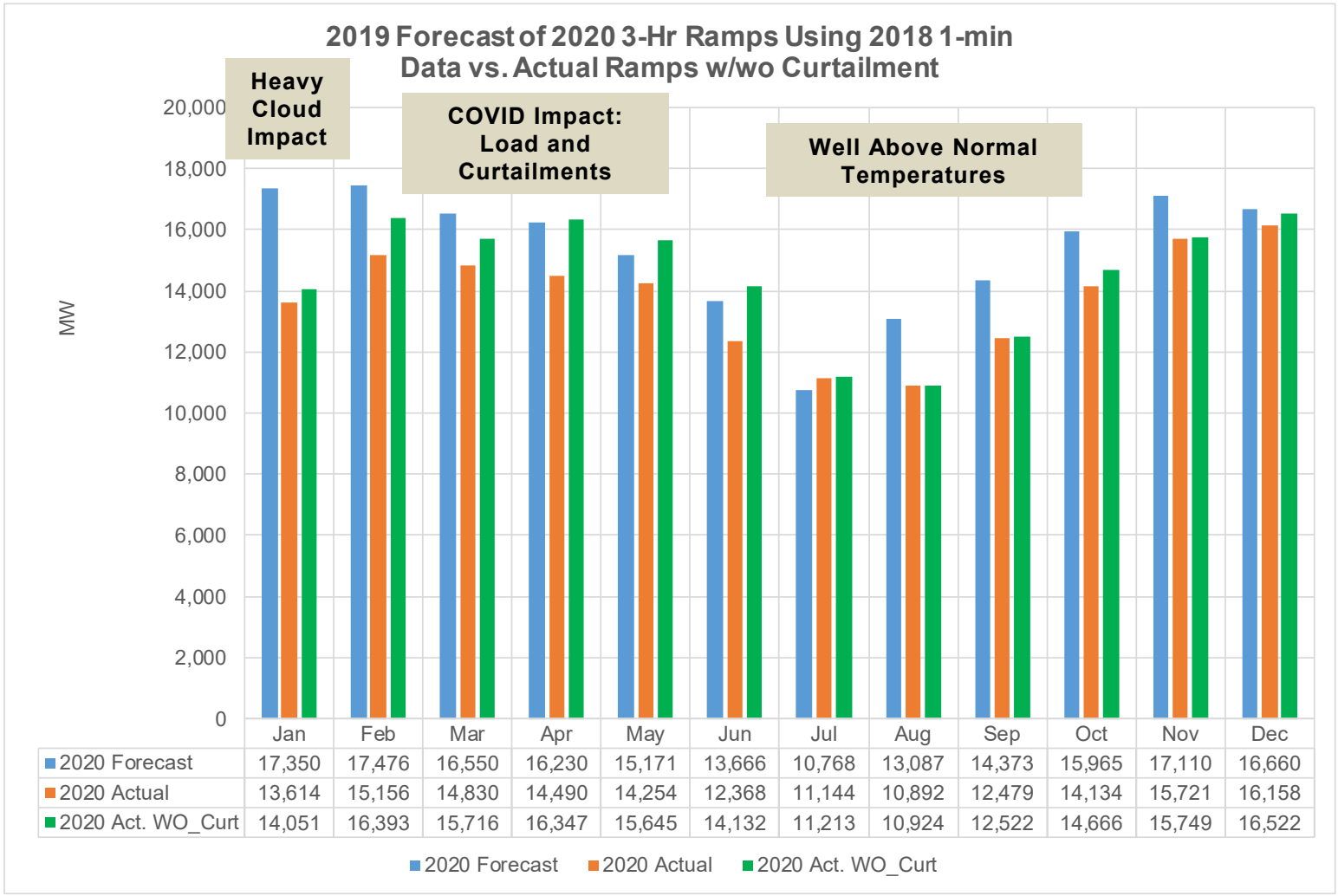
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2021_Flex Cap	17,910	18,211	18,109	18,221	18,727	15,786	15,137	15,547	15,728	18,604	18,859	19,061
2022_Flex Cap	19,140	19,444	19,362	19,527	20,180	17,318	16,648	16,956	17,030	19,707	19,300	19,819
2023_Flex Cap	20,433	21,391	20,260	21,381	21,804	19,342	18,598	18,943	18,967	21,895	21,237	21,367
2024_Flex Cap	20,837	22,723	21,661	23,478	23,329	20,007	19,458	20,156	22,446	21,554	22,242	21,984

Maximum monthly 3-hour upward ramps with and without curtailments in 2020



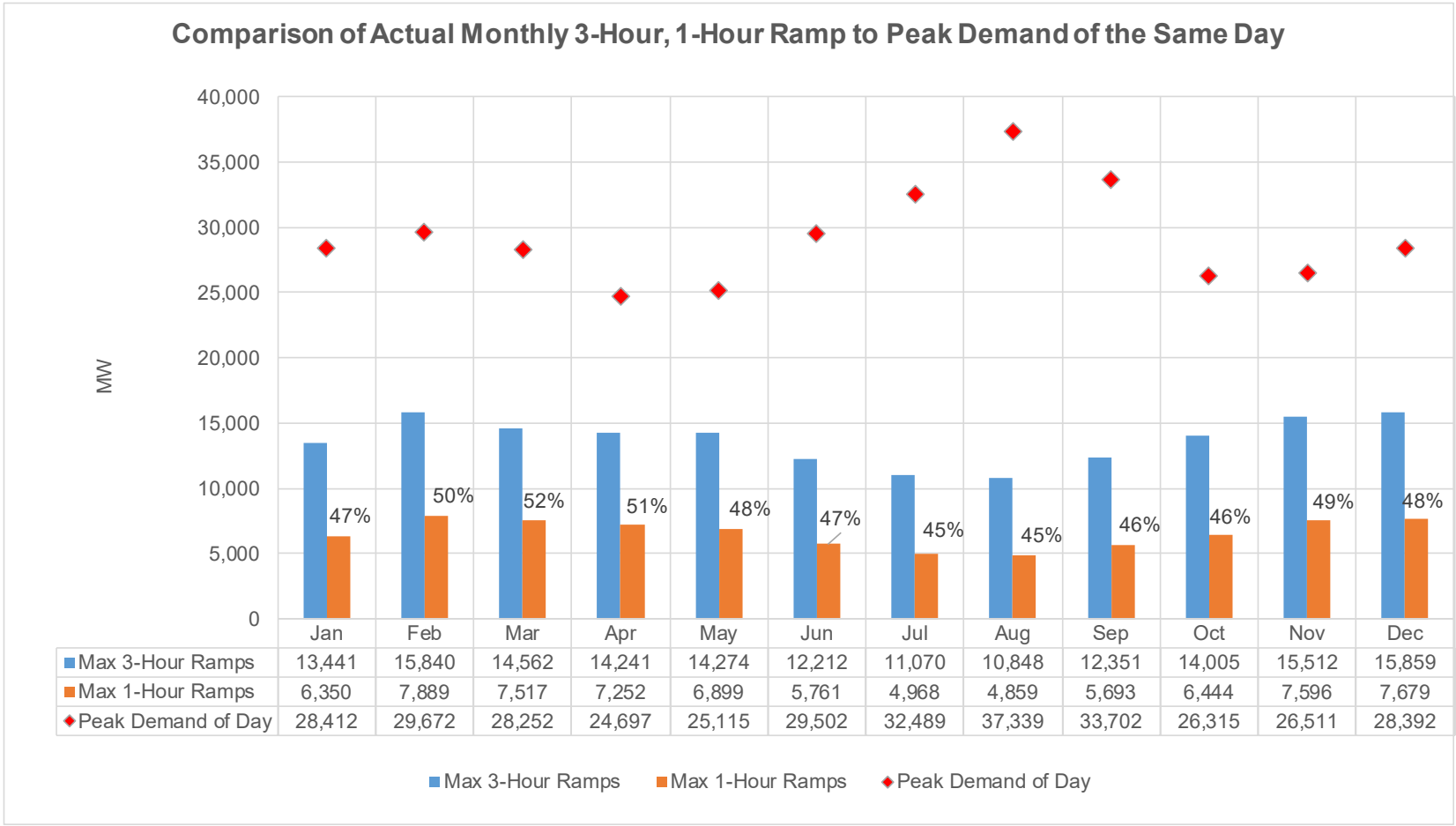
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
With_Cur	13,614	15,156	14,830	14,490	14,254	12,368	11,144	10,892	12,479	14,134	15,721	16,158
With_O_Curt	14,051	16,393	15,716	16,347	15,645	14,132	11,213	10,924	12,522	14,666	15,749	16,522

2019 forecast of 2020 3-hour ramps using 2018 actual data are higher than actual ramps with/without curtailments



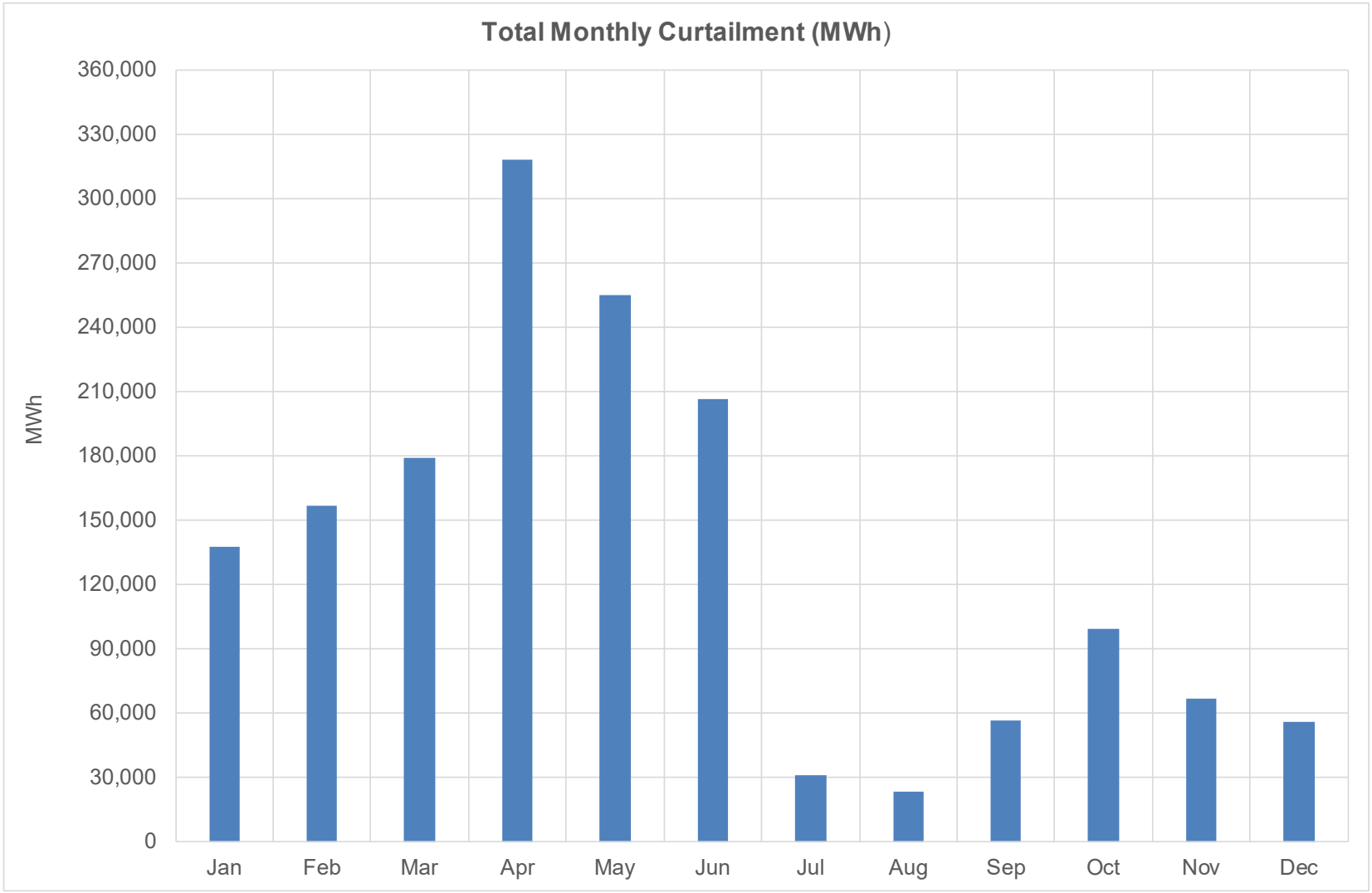
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020 Forecast	17,350	17,476	16,550	16,230	15,171	13,666	10,768	13,087	14,373	15,965	17,110	16,660
2020 Actual	13,614	15,156	14,830	14,490	14,254	12,368	11,144	10,892	12,479	14,134	15,721	16,158
2020 Act. WO_Curt	14,051	16,393	15,716	16,347	15,645	14,132	11,213	10,924	12,522	14,666	15,749	16,522

The 3-hour upward ramps can be more than 50% of the daily peak demand, which indicates the need for faster ramping resources

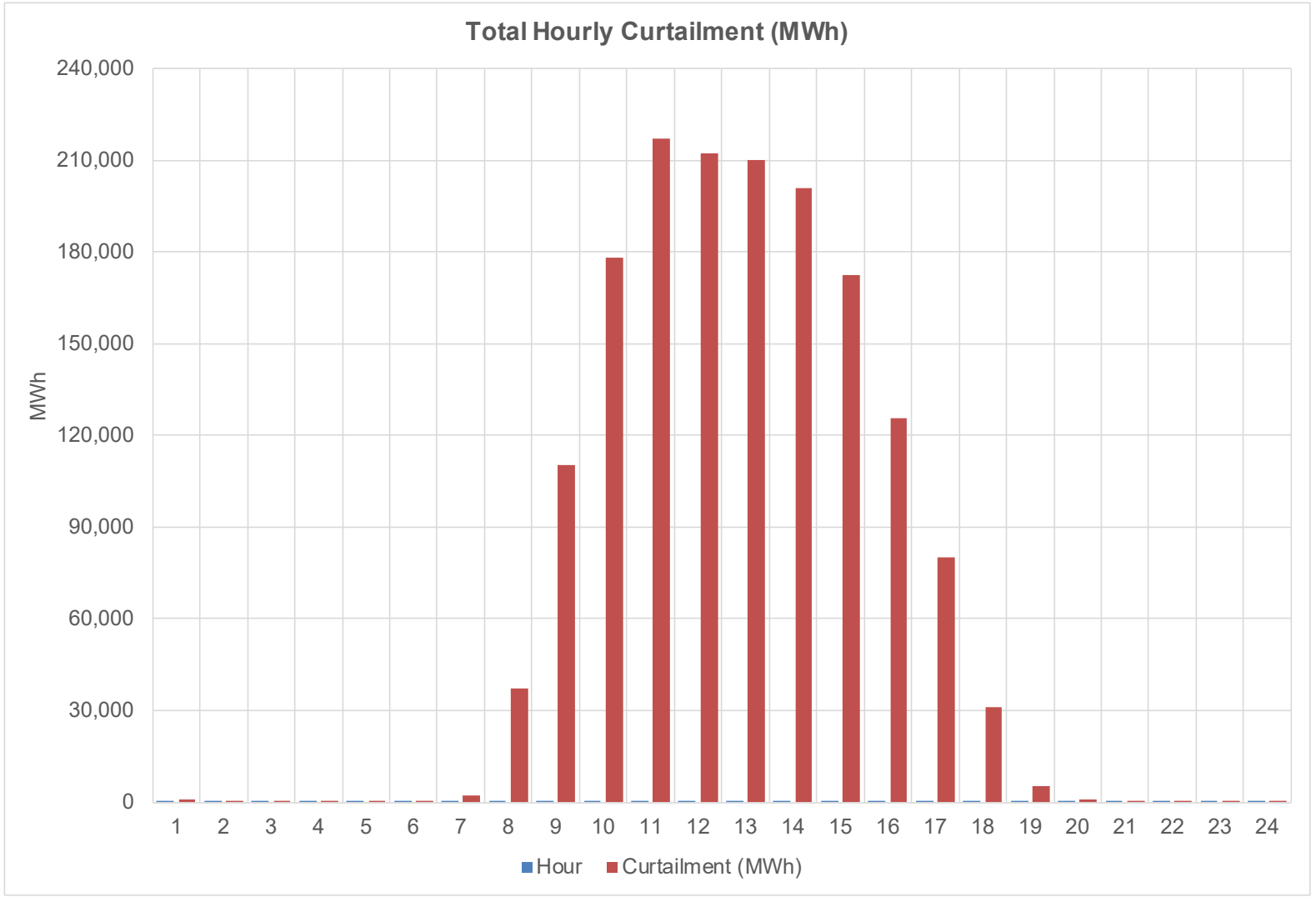


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max 3-Hour Ramps	13,441	15,840	14,562	14,241	14,274	12,212	11,070	10,848	12,351	14,005	15,512	15,859
Max 1-Hour Ramps	6,350	7,889	7,517	7,252	6,899	5,761	4,968	4,859	5,693	6,444	7,596	7,679
Peak Demand of Day	28,412	29,672	28,252	24,697	25,115	29,502	32,489	37,339	33,702	26,315	26,511	28,392

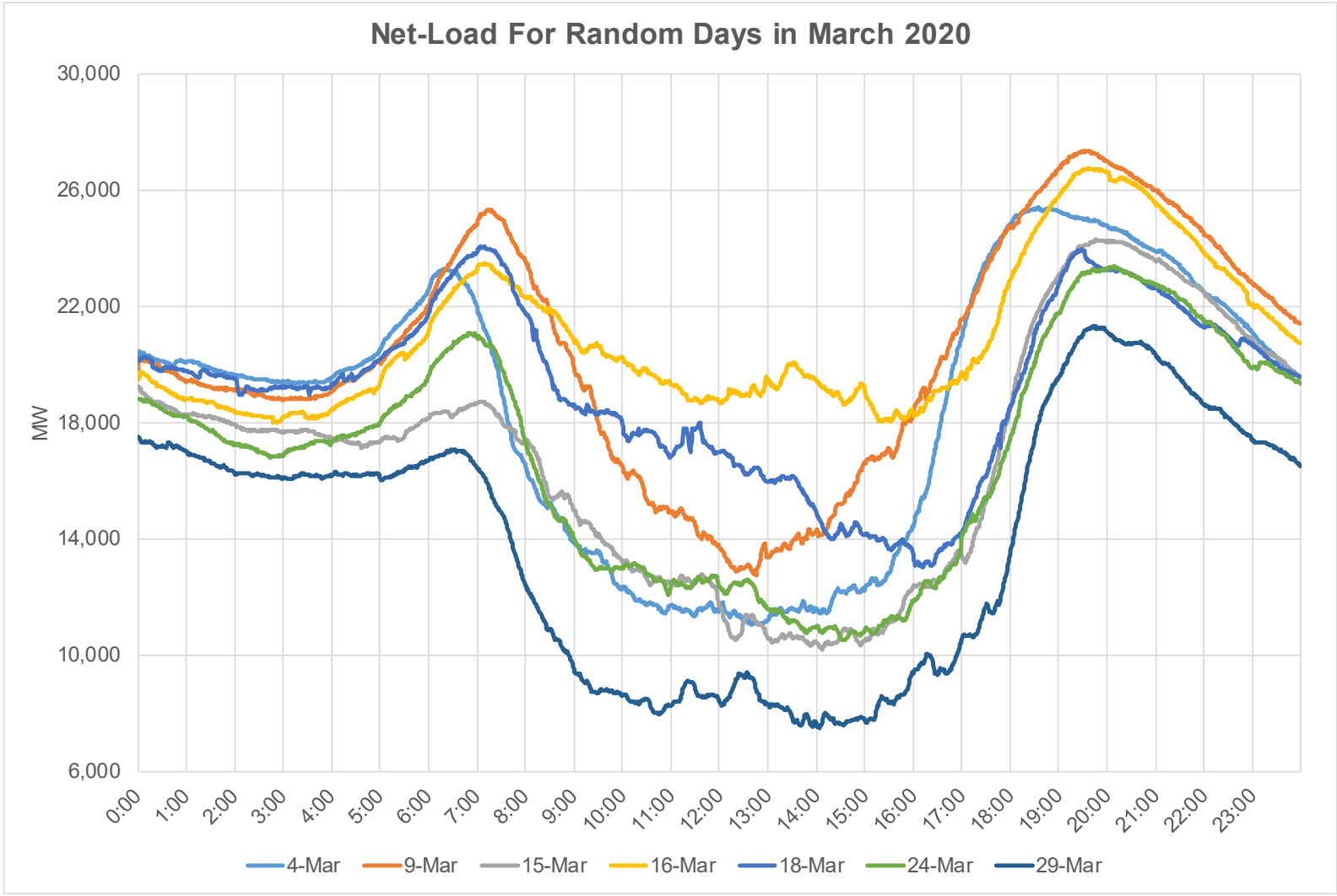
Total monthly wind/solar curtailment for 2020 (MWh)



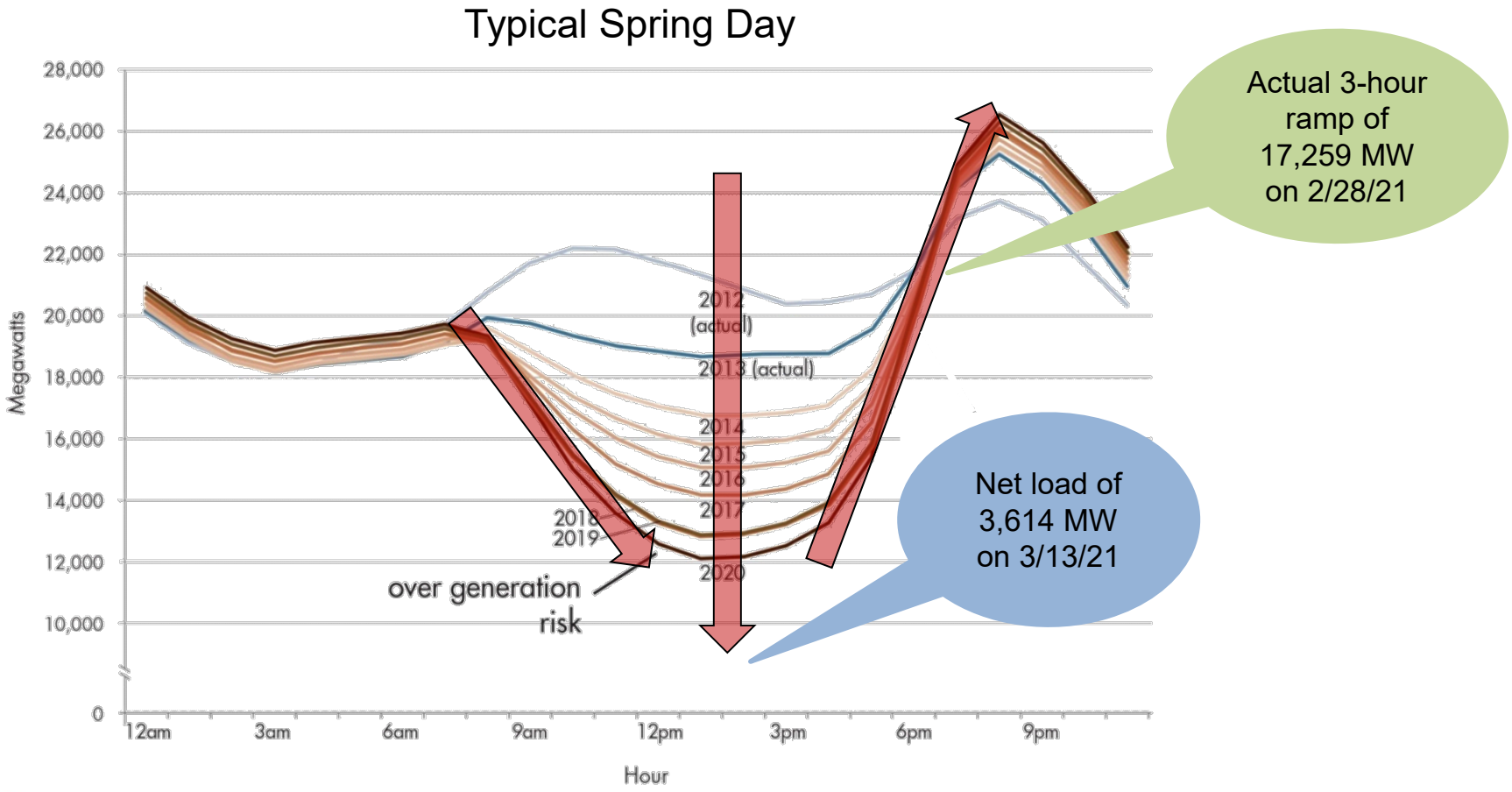
Total hourly curtailment for 2020 (MWh)



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



The actual net load and 3-hour ramps are years ahead of the ISO's original estimate primarily due to under forecasting rooftop solar PV installation



California ISO

Preliminary Results

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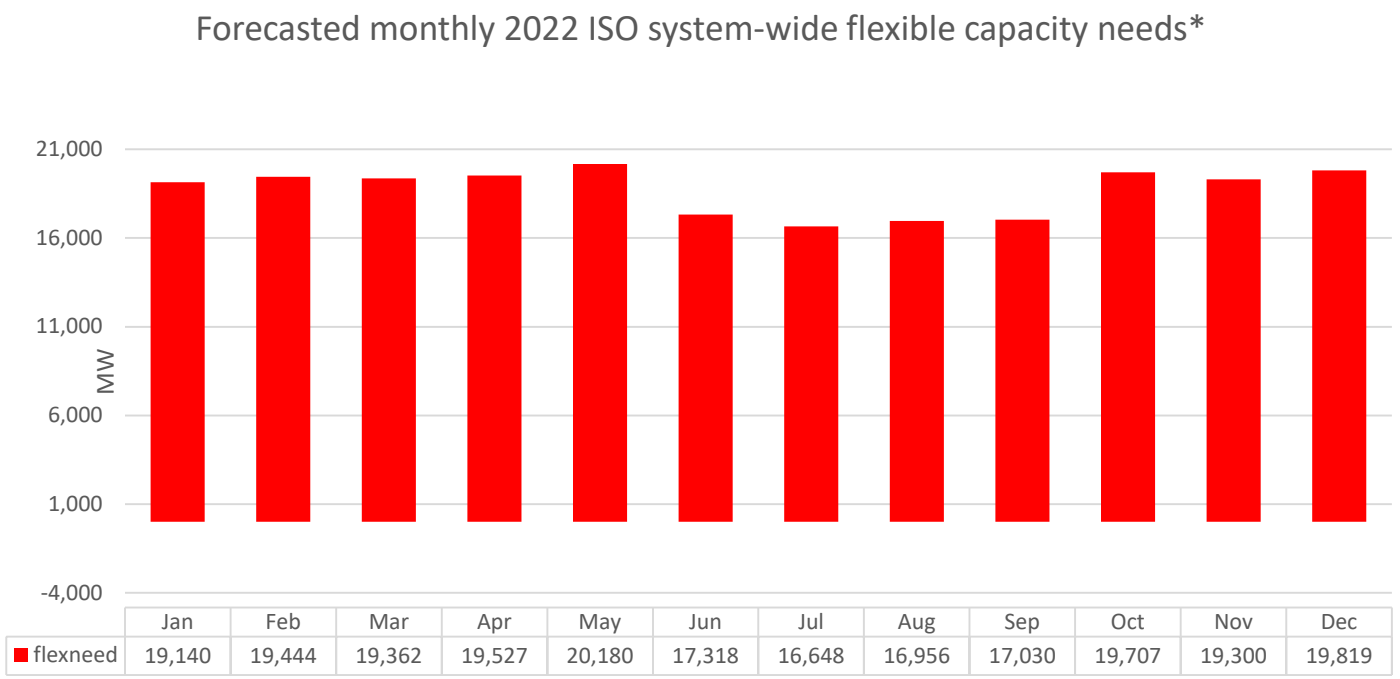
Forecasted monthly 2022 ISO system-wide flexible capacity needs*



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
flexneed	19,140	19,444	19,362	19,527	20,180	17,318	16,648	16,956	17,030	19,707	19,300	19,819

*Flexibility Requirement$_{MTHy}$= Max[(3RR$_{HRx}$)$_{MTHy}$] + Max(MSSC, 3.5%*E(PL$_{MTHy}$)) + ε

Components of the flexible capacity needs

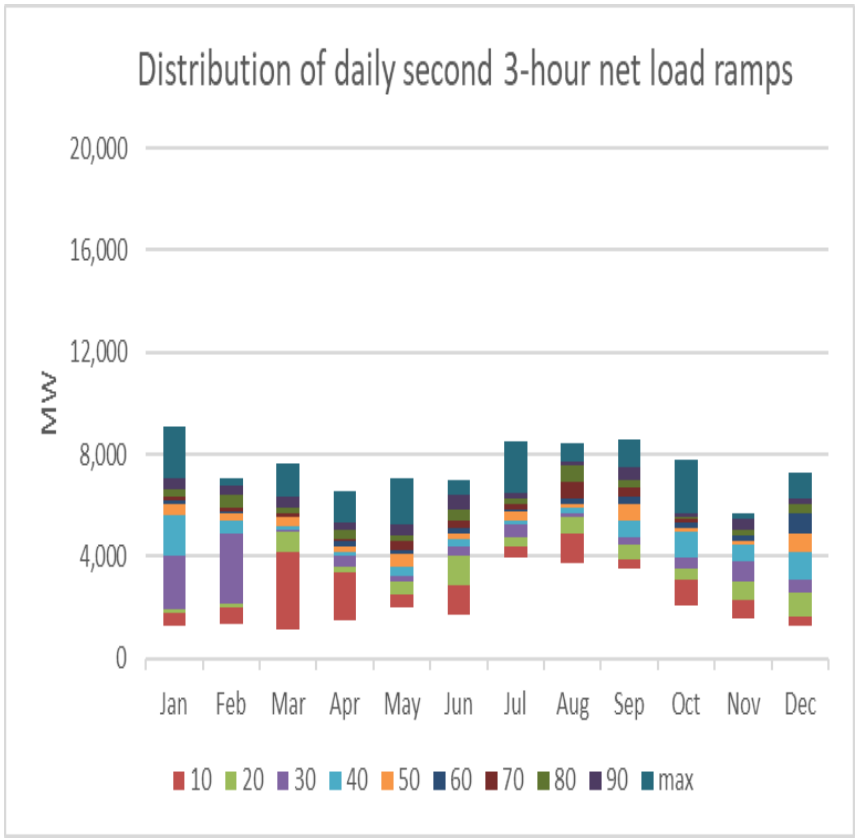
Month	Load contribution 2022	Wind contribution 2022	Solar contribution 2022	Total percent 2022
January	35.46%	-13.04%	-51.50%	100%
February	39.51%	-5.25%	-55.24%	100%
March	37.17%	0.42%	-63.25%	100%
April	38.20%	-9.68%	-52.12%	100%
May	34.65%	-6.82%	-58.53%	100%
June	28.06%	-3.37%	-68.57%	100%
July	25.65%	-1.03%	-73.32%	100%
August	32.04%	0.44%	-68.40%	100%
September	38.86%	8.06%	-69.20%	100%
October	37.10%	-3.18%	-59.72%	100%
November	41.69%	1.53%	-59.84%	100%
December	43.96%	-0.77%	-55.27%	100%

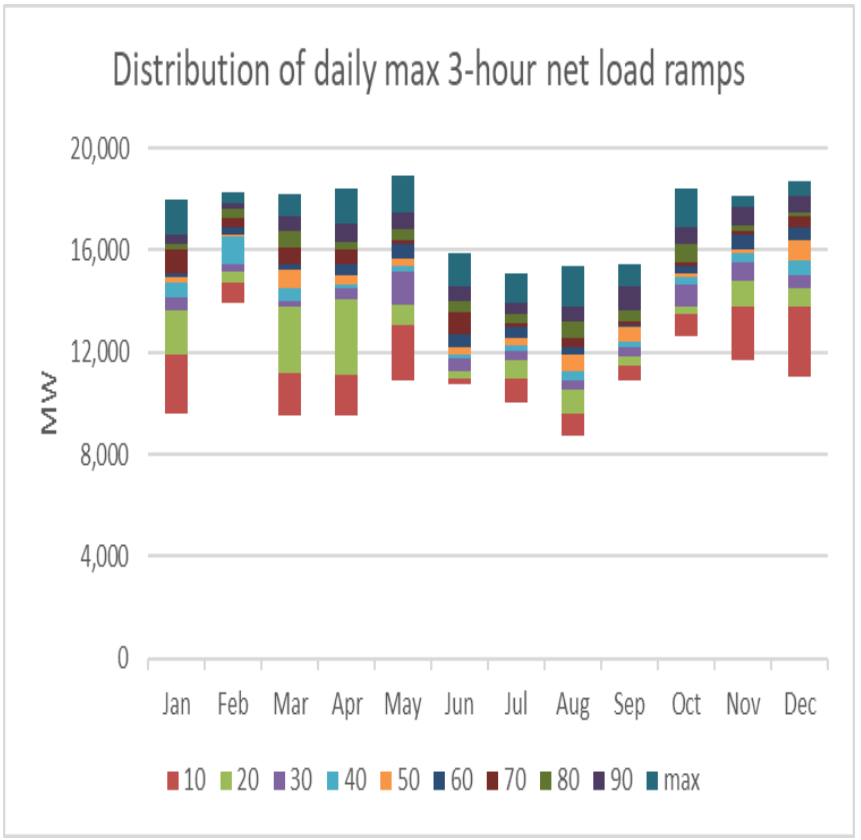
Δ Load – Δ Wind – Δ Solar = 100

Flexible capacity categories allow a wide variety of resources to provide flexible capacity

- Category 1 (Base Flexibility): Operational needs determined by the magnitude of the largest 3-hour secondary net load ramp
- Category 2 (Peak Flexibility): Operational need determined by the difference between 95 percent of the maximum 3-hour net load ramp and the largest 3-hour secondary net load ramp
- Category 3 (Super-Peak Flexibility): Operational need determined by five percent of the maximum 3-hour net load ramp of the month

The 2022 forecasted distribution range of daily maximum and secondary 3-hour net load ramps

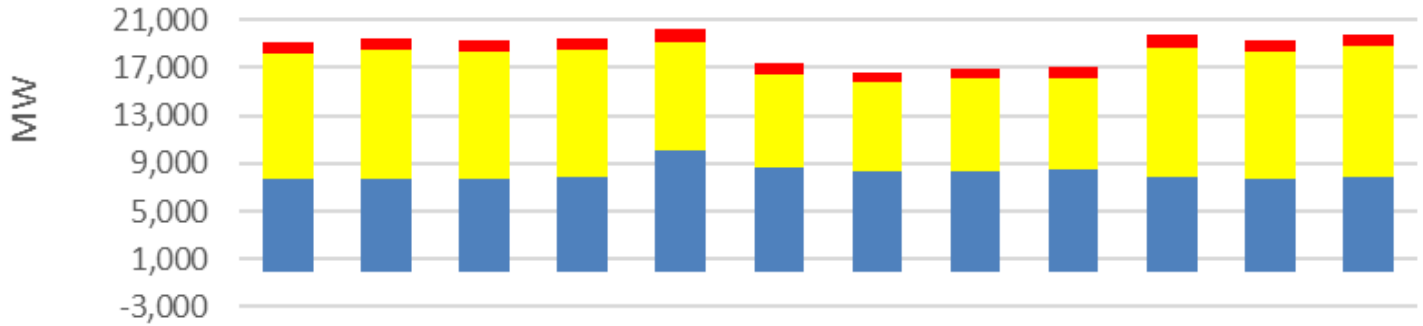




Seasonal breakout of flexible capacity needs

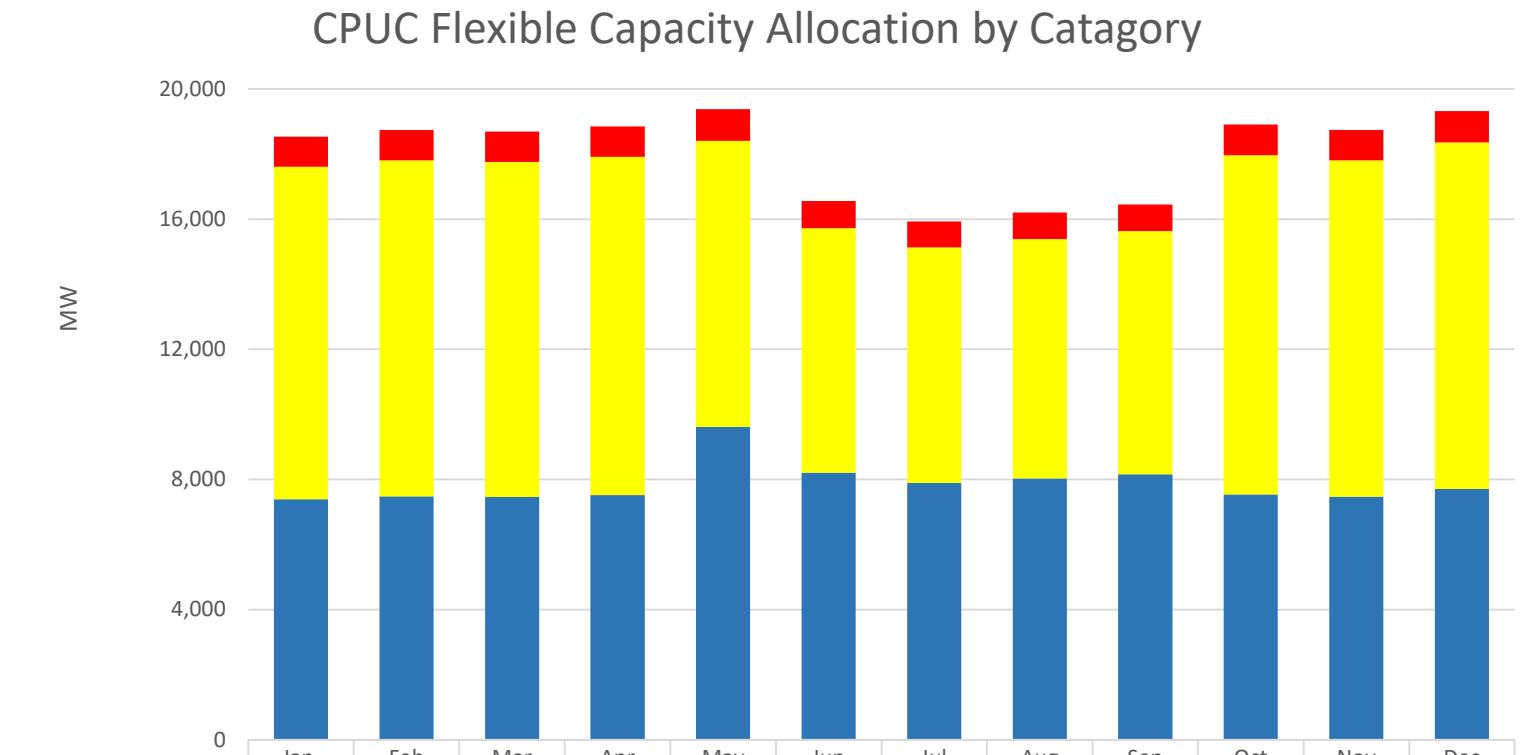
	Actual Contributions			Seasonal Contribution		
	Unadjusted			Adjusted		
Month	Base Flexibility	Peak Flexibility	Super-Peak Flexibility	Base Flexibility	Peak Flexibility	Super-Peak Flexibility
January	51%	44%	5%	40%	55%	5%
February	39%	56%	5%	40%	55%	5%
March	42%	53%	5%	40%	55%	5%
April	36%	59%	5%	40%	55%	5%
May	37%	58%	5%	50%	45%	5%
June	44%	51%	5%	50%	45%	5%
July	56%	39%	5%	50%	45%	5%
August	55%	40%	5%	50%	45%	5%
September	55%	40%	5%	50%	45%	5%
October	43%	52%	5%	40%	55%	5%
November	31%	64%	5%	40%	55%	5%
December	39%	56%	5%	40%	55%	5%

Total flexible capacity needed in each category – seasonally adjusted



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Super-Peak Flexibility	957	972	968	976	1,009	866	832	848	852	985	965	991
Peak Flexibility	10,53	10,70	10,66	10,75	9,160	7,861	7,557	7,696	7,730	10,85	10,62	10,91
Base Flexibility	7,644	7,765	7,733	7,798	10,01	8,591	8,259	8,412	8,449	7,870	7,708	7,915

CPUC jurisdictional flexible capacity allocation - by flexible capacity category



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Super-Peak Flexibility	927	937	935	943	969	828	796	810	823	946	937	966
Peak Flexibility	10,212	10,328	10,301	10,389	8,796	7,513	7,228	7,352	7,468	10,421	10327	10647
Base Flexiblity	7,393	7,477	7,458	7,521	9,613	8,211	7,900	8,036	8,162	7,545	7476	7708

Start time of 3-Hour net load ramp to evaluate seasonal must offer obligations

	Three Hour Net Load Ramp Start Hour (Hour Ending)					
Month	12:00	14:00	15:00	16:00	17:00	18:00
January			31			
February			20	8		
March			5	8	18	
April				2	27	1
May				1	24	6
June				4	24	2
July					30	1
August	1	1		10	19	
September			7	19	4	
October			5	26		
November		2	23	5		
December			31			

Seasonal must-offer obligations for peak and super-peak flexible capacity

- Recommended Must-offer obligation hours in Hour Ending

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HE15-HE19	v	v									v	v
HE16-HE20									v	v		
HE17-HE21			v	v	v	v	v	v				

Review of preliminary assessment results

- Flexible Capacity need is largest in the off-peak months
  - Flexible capacity makes up a greater percentage of resource adequacy needs during the off-peak months
  - Increase almost exclusively caused by 3-hour ramp, not increase in peak load
- Growth of behind-the-meter solar PV and utility scale PV contributes to the larger flexible capacity requirements
- Using the ISO flexible capacity contribution calculation majority of 3-hour net load ramps are attributable to CPUC jurisdictional LSEs
- The Peak and Super-Peak MOO hours have changed from the 2020 study (information below is in Hour Ending)
  - November through February: HE 15- HE 19 (2:00 p.m. to 7:00 p.m.)
  - March through August: HE 17 – HE 21 (4:00 p.m. to 9:00 p.m.)
  - September through October: HE 16- HE 20 (3:00 p.m. to 8:00 p.m.)

AVAILABILITY ASSESSMENT HOURS

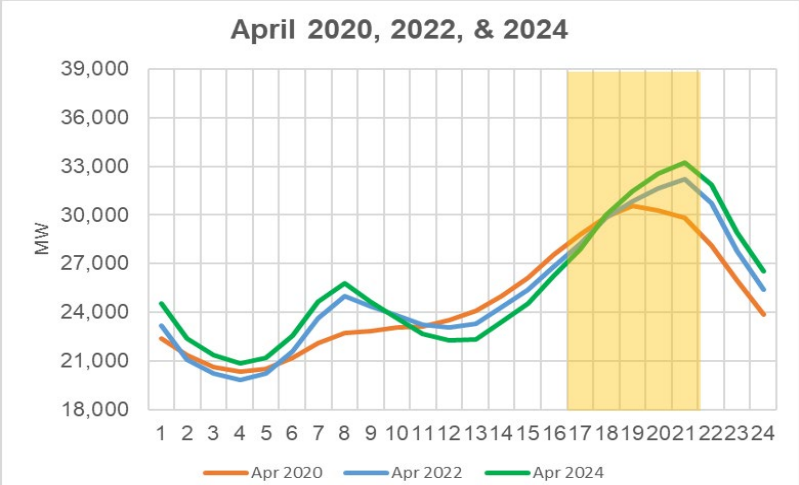
Availability assessment hours: Background and purpose

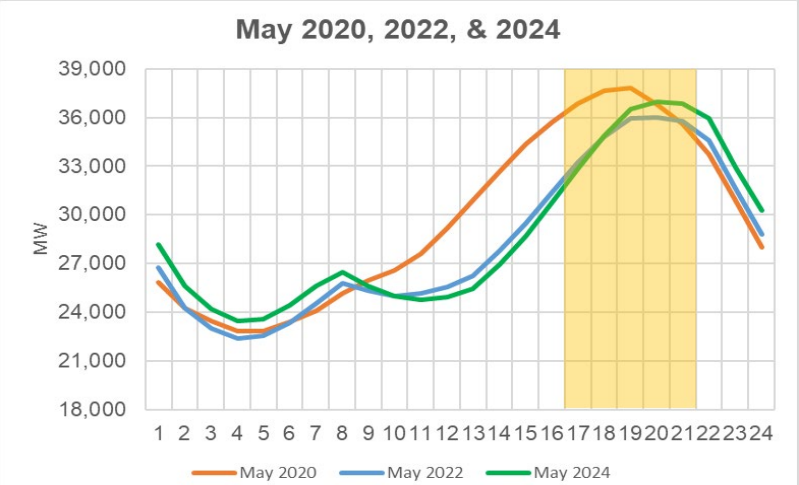
- Concept originally developed as part of the ISO standard capacity product (SCP)
  - Maintained as part of Reliability Service Initiative – Phase 1 (i.e. RA Availability Incentive Mechanism, or RAAIM)
- Determine the hours of greatest need to maximize the effectiveness of the availability incentive structure
  - Resources are rewarded for availability during hours of greatest need
  - Hours determined annually by ISO and published in the BPM
    - See section 40.9 of the ISO Tariff

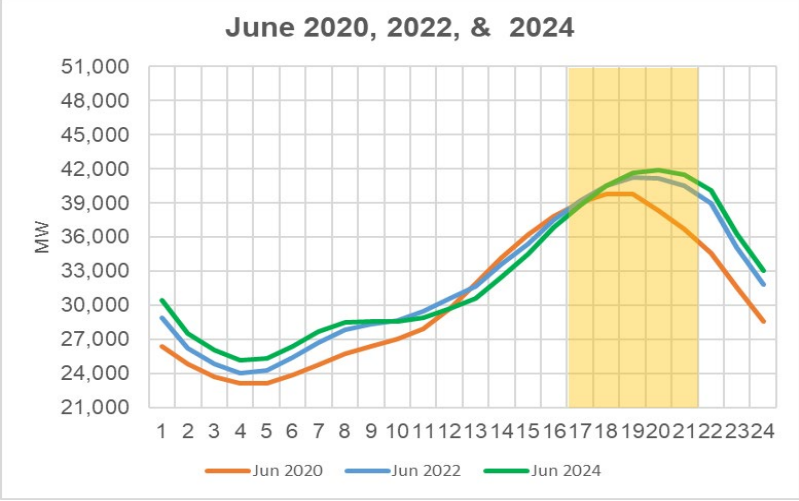
Methodology overview of system/local availability assessment hours

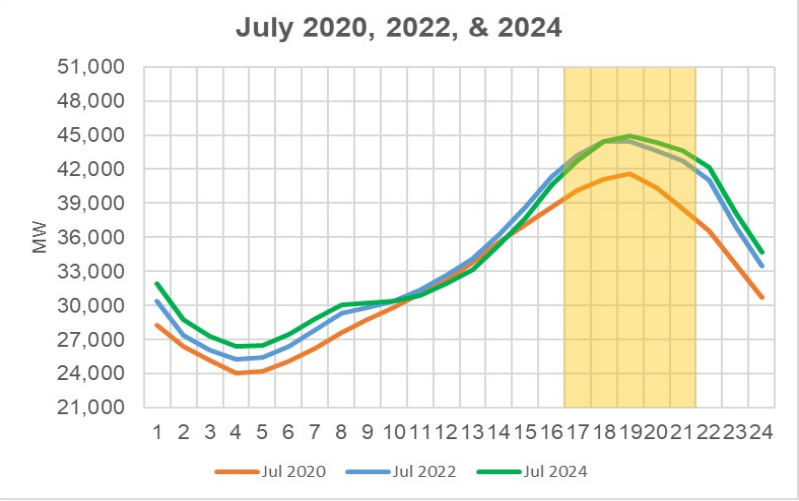
- Used CEC IEPR data described in previous slides to obtain:
  - Hourly Average Load
    - By Hour
    - By Month
    - Years 2020-2024
- Calculated:
  - Top 5% of Load Hours within each month using an hourly load distribution
  - Years 2022 - 2024

Expected load shape evolution: Summer season

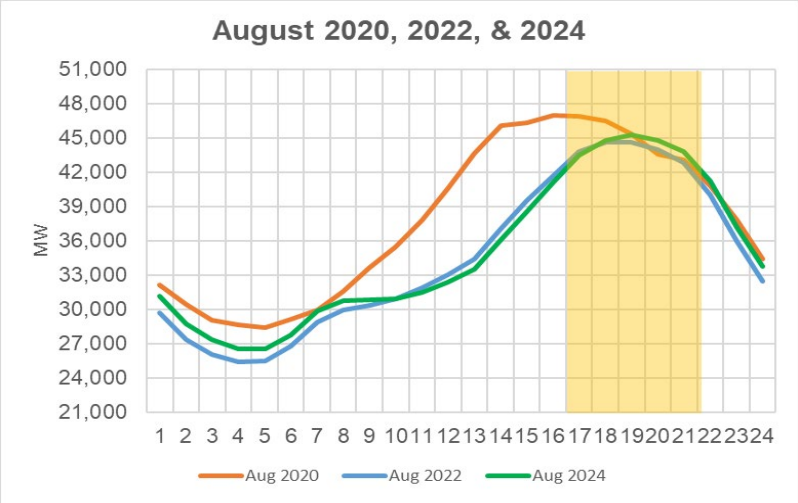


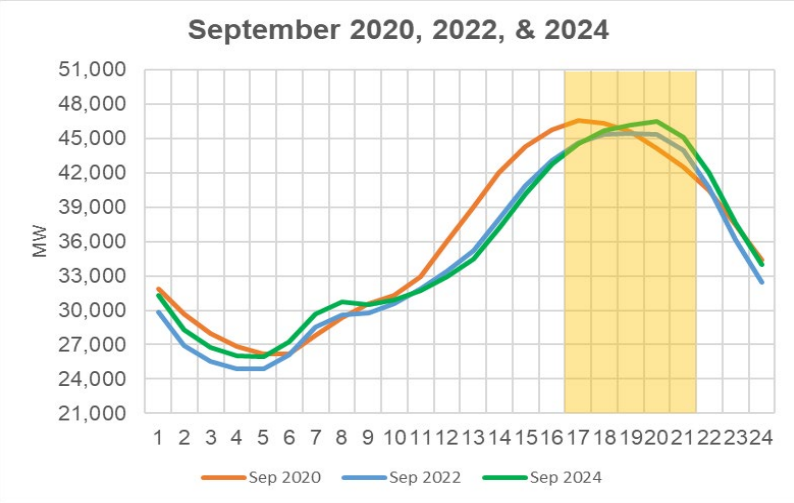


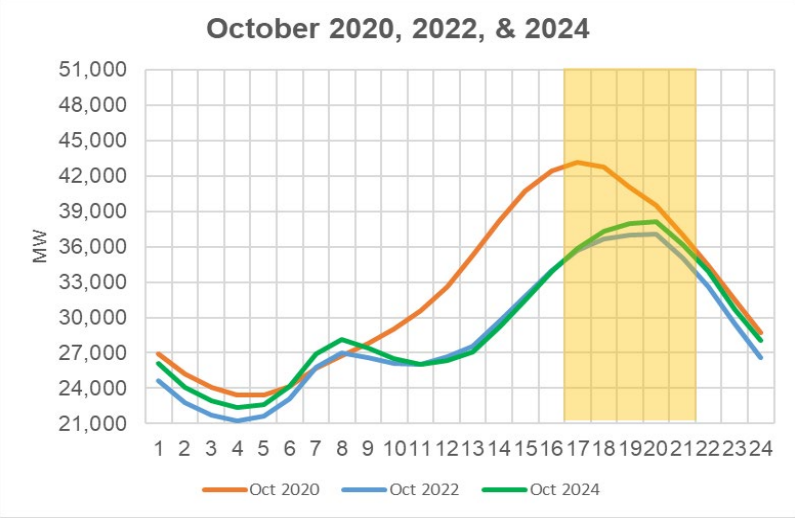




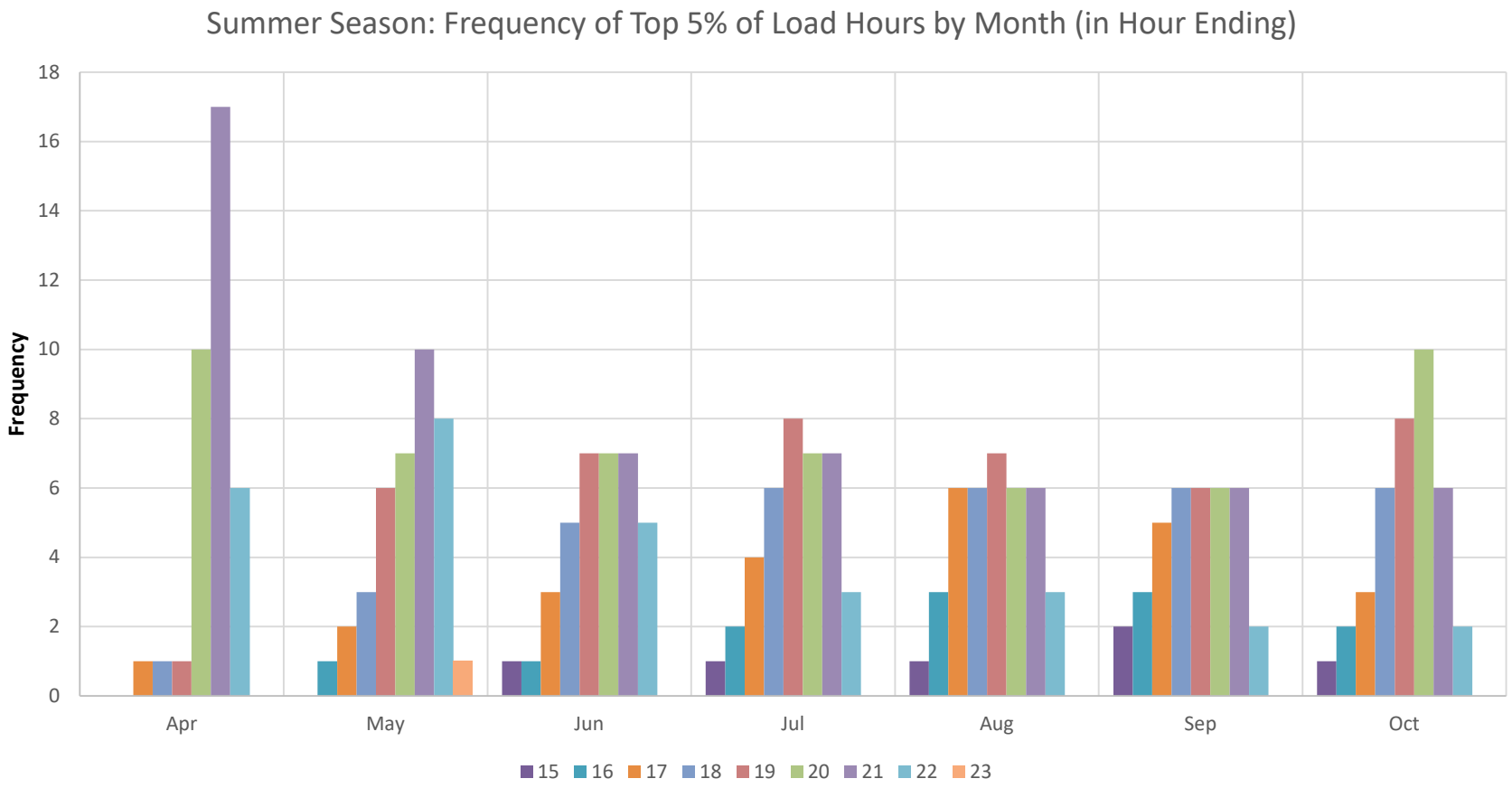
Expected load shape evolution: Summer season



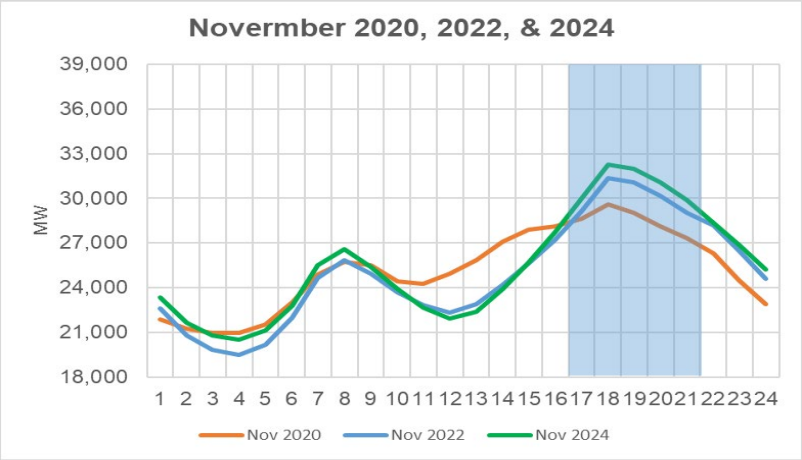


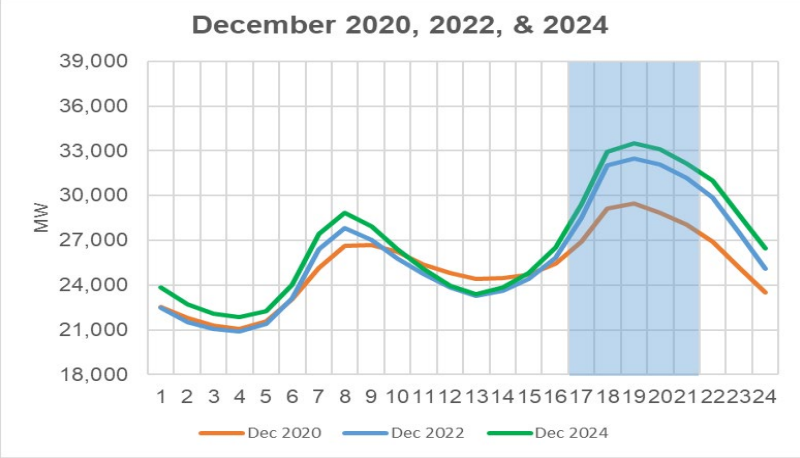


Summer Season
2022 top 5% of load hours (in HE)

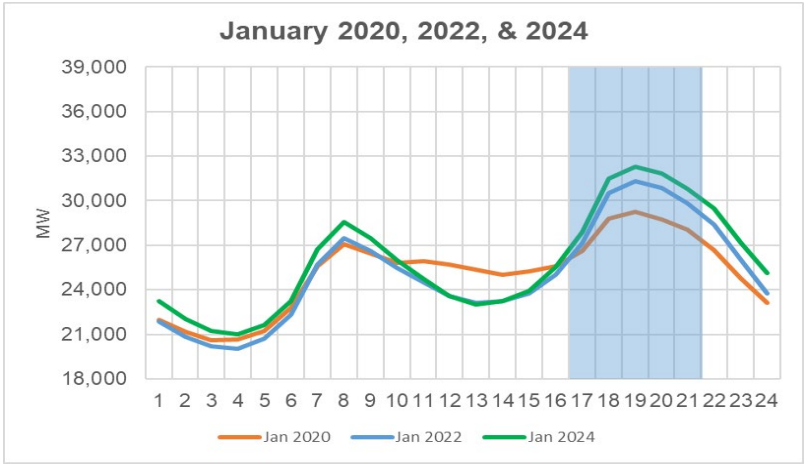


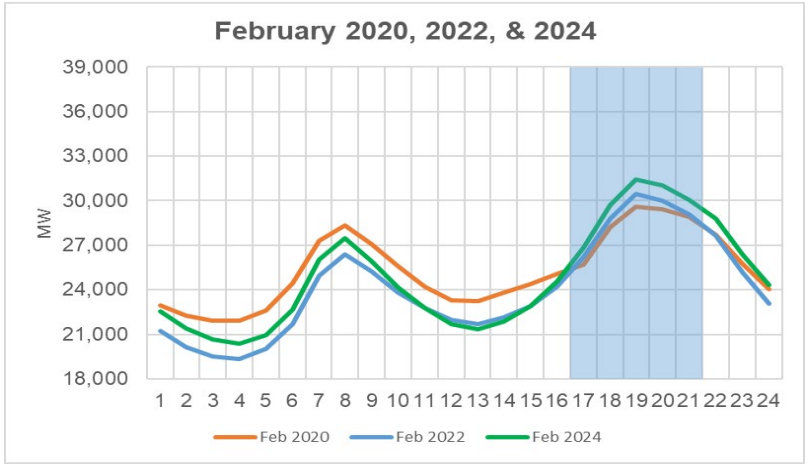
Expected load shape evolution: Winter season

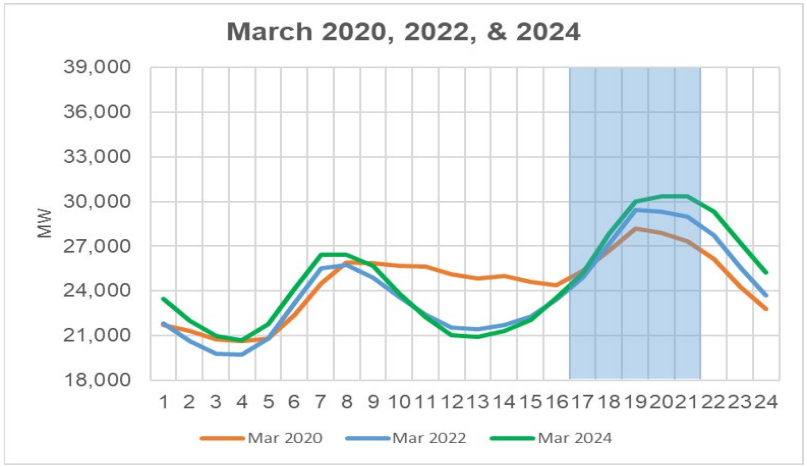




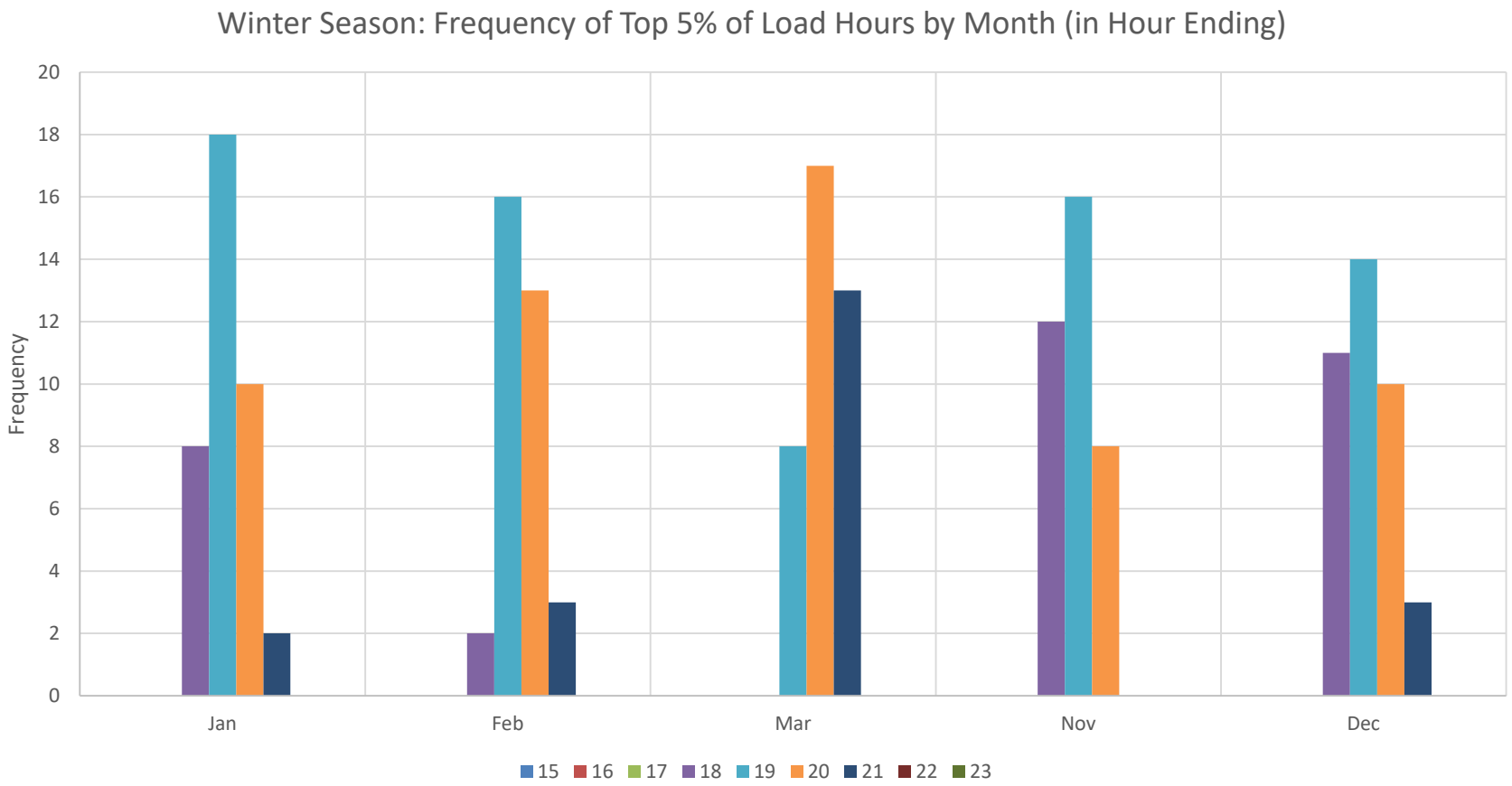
Expected load shape evolution: Winter season







Winter Season
2022 top 5% of load hours (HE)



Availability assessment hours draft recommendation

Winter Season Draft Recommendation

Year	Start	End
2021 (Final)	HE 17	HE 21
2022 (Draft)	HE 17	HE 21
2023 (Estimate)	HE 17	HE 21
2024 (Estimate)	HE 17	HE 21

Summer Season Draft Recommendation

Year	Start	End
2021 (Final)	HE 17	HE 21
2022 (Draft)	HE 17	HE 21
2023 (Estimate)	HE 17	HE 21
2024 (Estimate)	HE 17	HE 21

Reliability Requirements; Section 7 – No BPM Updates Needed

2021 System and Local Resource Adequacy Availability Assessment Hours

Analysis employed: Top 5% of load hours using average hourly load

Summer: April 1 - October 31

Availability Assessment Hours: 4pm – 9pm (HE17 – HE21)

Winter: November 1 - March 31

Availability Assessment Hours: 4pm – 9pm (HE17 – HE21)

2021 Flexible Resource Adequacy Availability Assessment Hours and must offer obligation hours

Flexible RA Capacity Type	Category Designation	Required Bidding Hours	Required Bidding Days
January – February November – December			
Base Ramping	Category 1	5:00am to 10:00pm (HE6-HE22)	All days
Peak Ramping	Category 2	2:00pm to 7:00pm (HE15-HE19)	All days
Super-Peak Ramping	Category 3	2:00pm to 7:00pm (HE15-HE19)	Non-Holiday Weekdays*
March – August			
Base Ramping	Category 1	5:00am to 10:00pm (HE6-HE22)	All days
Peak Ramping	Category 2	4:00pm to 9:00pm (HE17-HE21)	All days
Super-Peak Ramping	Category 3	4:00pm to 9:00pm (HE17-HE21)	Non-Holiday Weekdays*
September – October			
Base Ramping	Category 1	5:00am to 10:00pm (HE6-HE22)	All days
Peak Ramping	Category 2	3:00pm to 8:00pm (HE16-HE20)	All days
Super-Peak Ramping	Category 3	3:00pm to 8:00pm (HE16-HE20)	Non-Holiday Weekdays*

Next steps

- Please submit comments on today's stakeholder call discussion and the Draft Flexible Capacity Needs Assessment for 2022 by April 30, 2021.

- Submit comments through the ISO commenting tool using the template provided on the process webpage at https://stakeholdercenter.caiso.com/RecurringStakeholderProcesses/Flexible-capacity-needs-assessment-2022.

- Plan to publish Final Flexible Capacity Needs Assessment for 2022 on May 14, 2021.

Questions?

Thank you for your participation.