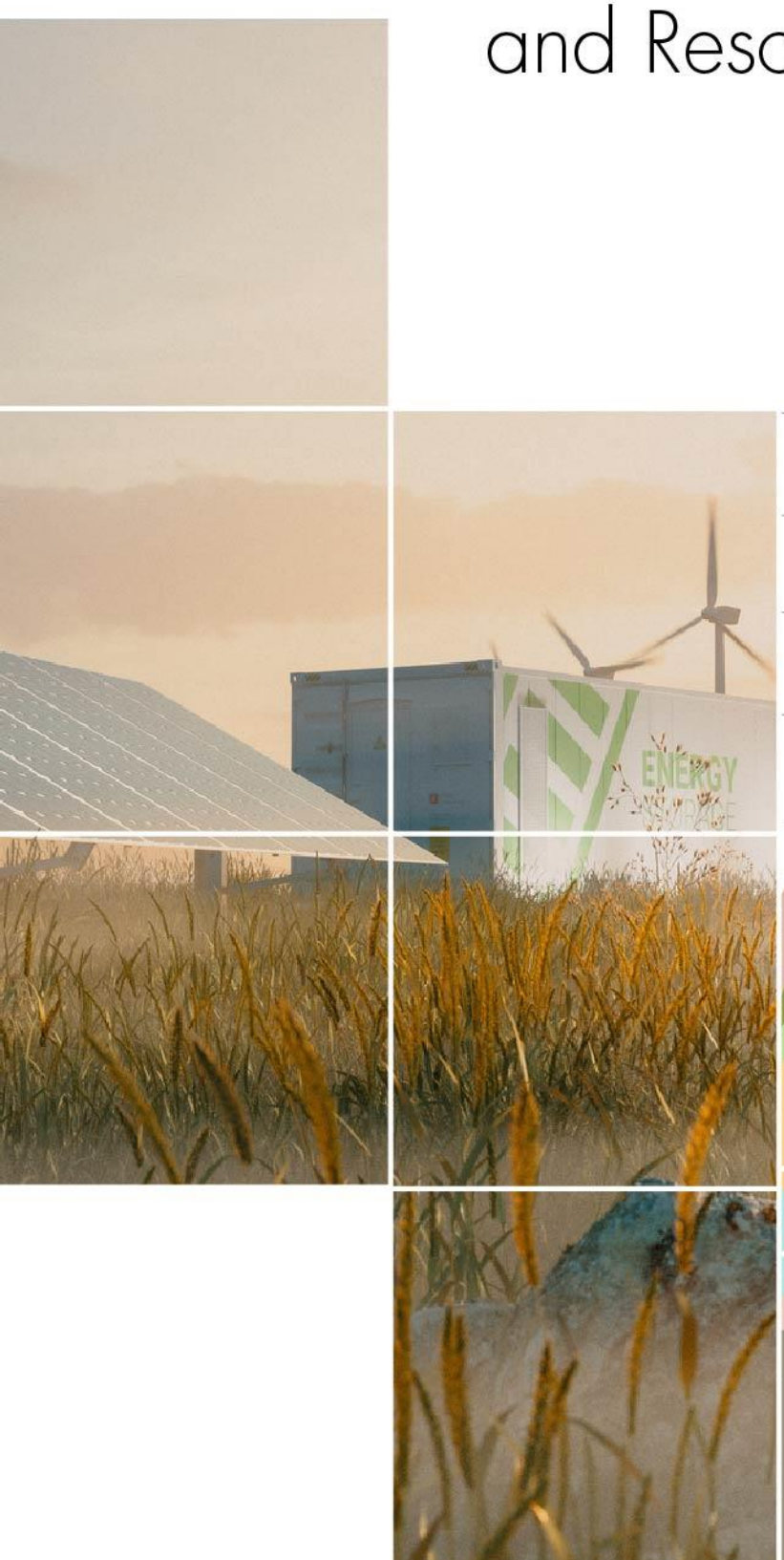
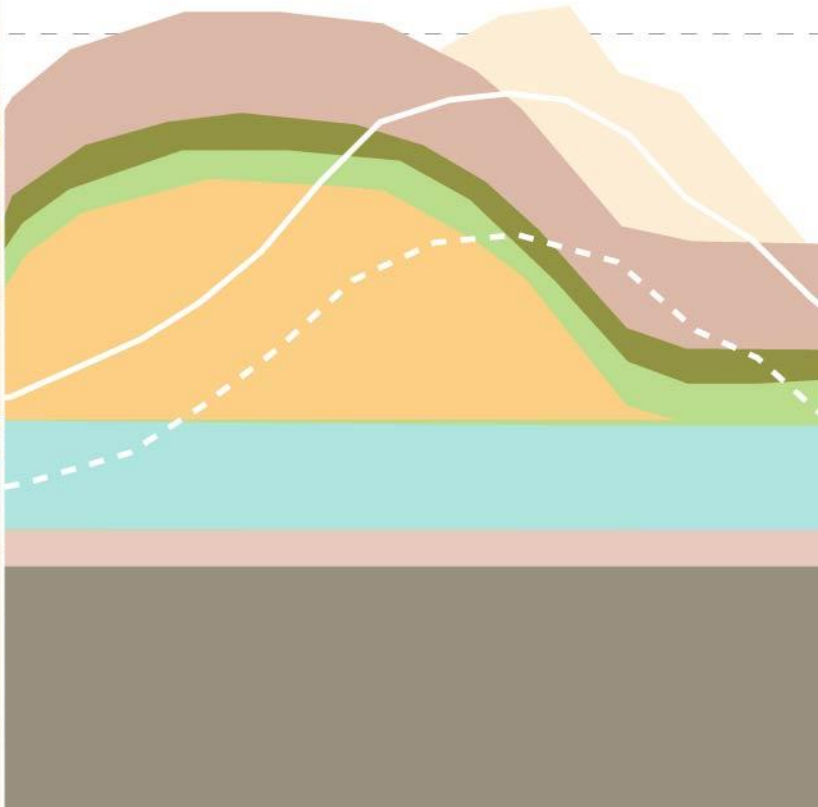
California ISO

2024 Summer Loads and Resources Assessment

May 8, 2024





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Acronyms

BAA	Balancing Authority Area
CAISO	California Independent System Operator
CCA	Community Choice Aggregator
CEC	California Energy Commission
CEDU	California Energy Demand Update
COD	Commercial Operation Date
CPUC	California Public Utilities Commission
DAM	Day ahead market
DEBA	Distributed Electricity Backup Assets Program
DLAP	Default Load Aggregated Point
DSGS	Demand Side Grid Support Program
DWR	Department of Water Resources
EEA	Energy Emergency Alert
ELCC	Effective Load Carrying Capability
ELRP	Emergency Load Reduction Program
ESP	Energy Service Provider
ESSRRP	Electricity Supply Strategic Reliability Reserve Program
ETC	Existing Transmission Contract
EUE	Expected Unserved Energy
F	Fahrenheit
FMM	Fifteen-Minute Market
HASP	Hour Ahead Scheduling Process
HE	Hour Ending
IEPR	Integrated Energy Policy Report
IFM	Integrated Forward Market
IOU	Investor-Owned Utility
IRP	Integrated Resource Planning
LMP	Locational Marginal Price
LOLE	Loss-of-Load Expectation
LOLH	Loss-of-Load Hours
LSE	Load Serving Entity
MSG	Multi-Stage Generator
MW	Megawatt
MWh	Megawatt-hour
NERC	North American Electric Reliability Corporation
NGR	Non-Generating Resource
NOB	Nevada-Oregon Border
NQC	Net Qualifying Capacity
NSI	Net Scheduled Interchange
OASIS	Open Access Same-Time Information System
OOS	Out Of State
OR	Operating Reserves
OTC	Once-Through-Cooling
PDR	Proxy Demand Response
PG&E	Pacific Gas and Electric
PPA	Power Purchase Agreement
PRM	Planning Reserve Margin
PSP	Preferred System Plan
PST	Pacific Standard Time
PTO	Participating Transmission Owner
NQC	Net Qualifying Capacity
RA	Resource Adequacy
RDRR	Reliability Demand Response Resource
RTM	Real-Time Market
SCE	Southern California Edison
SDG&E	San Diego Gas and Electric
SMEC	System Marginal Energy Component
SOC	State of Charge
SPAP	State Power Augmentation Project
TOR	Transmission Ownership Right
WDAT	Wholesale Distribution Access Tariff
WECC	Western Electricity Coordinating Council
WEIM	Western Energy Imbalance Market

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Executive Summary

The 2024 Summer Loads and Resources Assessment (Summer Assessment) indicates continued improvement in resource availability for the upcoming summer driven by accelerated resource development. New resource development, average to slightly above average hydro conditions and softening of the summer 2024 demand forecast more than offset generation retirements and the transition of gas-fired once-through cooling generation into the state's strategic reserves. This results in an increase in projected capacity margins that exceed demand and reserve requirements, and meet performance target levels.

Key highlights and observations from the Summer Assessment include the following:

Resource additions

- 926 MW of nameplate capacity has been added to the CAISO grid from January 1 through April 1, 2024.[1]
- Expected new additions from April 1, 2024 through June 30, 2024 total around 4,569 MW.

Table E.1 Actual and expected additions from September 1, 2023 through June 30, 2024 (MW)

Category	Battery	Wind	Solar	Biofuel	Geothermal	Hybrid	Total Nameplate Capacity
Additions from September 1, 2023 through December 31, 2023	1,321	95	1,842			318	**3,576**
Additions from January 1, 2024 through April 1, 2024	425		498			3	**926**
Expected additions from April 1, 2024 through June 30, 2024	3,199	18	818	3	41	490	**4,569**
Total	**4,945**	**113**	**3,158**	**3**	**41**	**811**	**9,071**

Load projections for 2024

- The CAISO's probabilistic assessment and stack analysis rely on a 1-in-2 planning demand forecast from the California Energy Commission's (CEC) 2023 Integrated Energy Policy Report (IEPR).
- For 2024, the CEC forecasted peak load occurs in July, which is 272 MW higher than the forecasted load for September 2024.

Table E.2 Monthly peak load forecast (May 2024 – October 2024)

Month	May	June	July	August	September	October
Monthly peak load forecast (MW)	34,346	41,902	46,244	45,059	45,972	36,984

[1] Includes new capacity that achieved commercial operation (COD) and was listed on the CAISO's Net Qualifying Capacity (NQC) list on or before April 1, 2024.

Probabilistic assessment

- The CAISO's probabilistic assessment[2] of the anticipated 2024 summer resource portfolio, based on the California Public Utilities Commission's (CPUC) Preferred System Plan (PSP) adopted in February 2024 and adjusted to reflect current expectations, resulted in no projected capacity shortfalls.
- The probabilistic assessment measures the potential for calling on emergency measures, not actual loss of firm load.
- Approaching summer 2024, the CAISO expects a surplus of 2,550 MW[3] to meet the "one day every 10 years loss-of-load expectation" ("1-in-10 LOLE") planning target.[4] This directionally aligns with the CPUC's analysis, which modeled surplus conditions in 2024.[5]
- The probabilistic analysis considers reasonable historical trends and history; it does not take into account extreme and emergency events.

Multi-hour stack analysis

- As part of this Summer Assessment, the CAISO also conducted an hourly assessment of the resource fleet's capacity sufficiency on peak days for each summer month in 2024, considering an 18.5 percent reserve margin.[6] This stack analysis shows that expected resources are sufficient to meet forecasted demand plus an 18.5 percent reserve margin for all summer months in 2024.
- The analysis also indicates that there is a surplus of at least 3,438 MW over forecasted demand plus an 18.5 percent reserve margin during peak net load hours of 18 through 22 in September as shown in Figure E.1.

[2] The CAISO's probabilistic assessment of expected resource fleet utilizes 500-iteration full year hourly chronological simulations and is able to capture a wide range of system conditions in load, solar and wind generation, and generation resource outages.

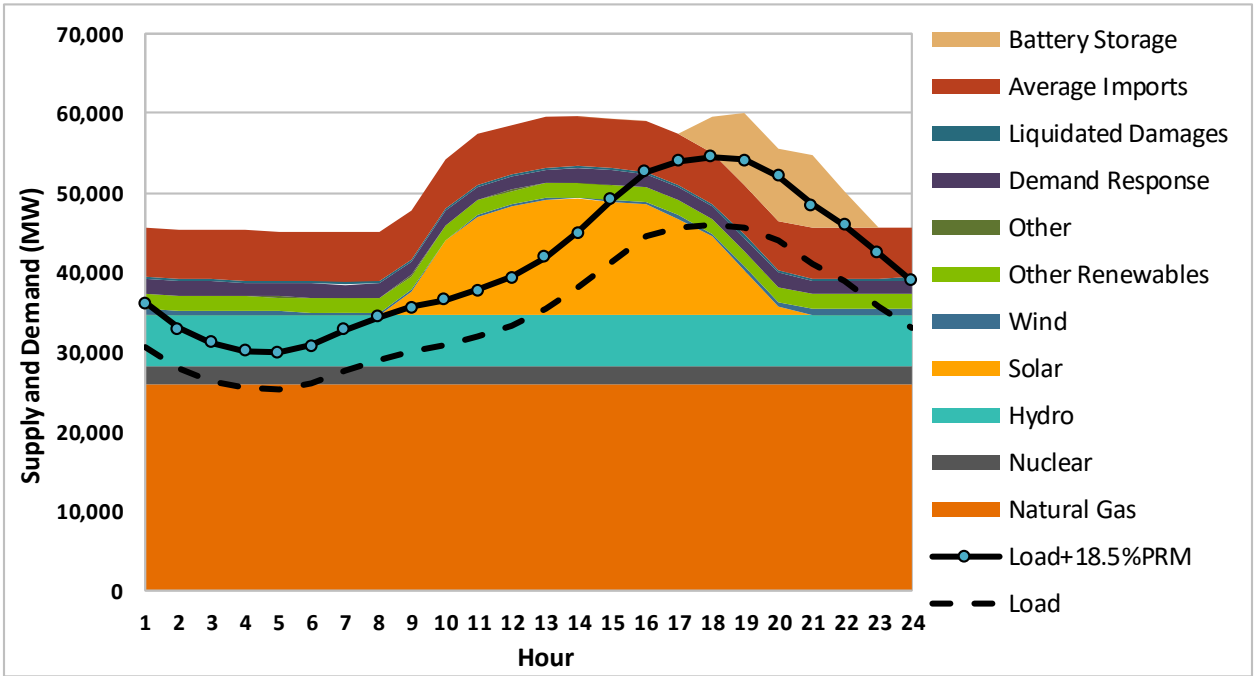
[3] The CAISO estimates that the softening of the 2024 load forecast which is based on 2023 IEPR accounted for the bulk of the surplus shown in this year's results, and that the 2024 load forecast based on 2022 IEPR would also have resulted in a 1-in-10 LOLE result being achieved albeit with a more modest surplus.

[4] LOLE is a measure of the number of days per year for which the available generation capacity is insufficient to serve the demand at least once during that day. 0.1 LOLE or 1-day-in-10 LOLE equates to "1 day with an event in 10 years".

[5] CPUC, 2023 Proposed Preferred System Plan Reliability and Emissions Analysis, October 2023: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2023-irp-cycle-events-and-materials/psp-ruling-reliability-and-emissions-analysis-slides_20231004.pdf

[6] The 18.5 percent reserve margin applied to a 1-in-2 load forecast level is a CAISO metric calculated to maintain operating reserves under reasonably stressed system conditions, taking into account load forecast uncertainty, e.g. a 1-in-5 peak load variance, and resource forced outage rates. The metric is described in more detail in Section 1.2 Multi-hour Stack Analysis, on page 13. It is not derived from a loss of load expectation probabilistic analysis and therefore does not ensure a 1-in-10 loss of load performance.

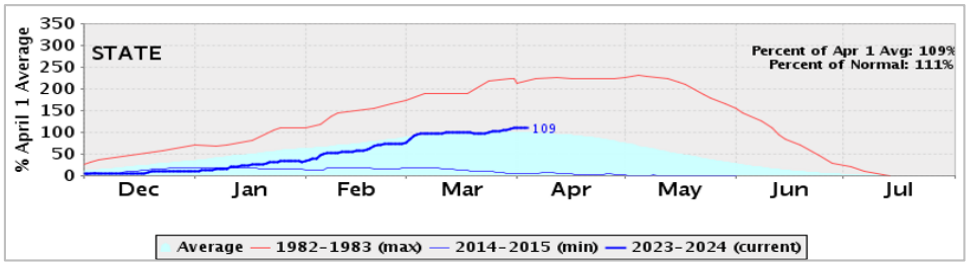
Figure E.1 Multi-hour stack analysis for peak days in September 2024



Hydro outlook

- Storage levels in California's major reservoirs provide one indication of water supply conditions for the coming year. As of April 17, 2024, California's major reservoir storage levels range between 86 to 149 percent of historical average.
- California snow water content trended slightly above historical average at 109 percent as of April 4, 2024 compared to 239 percent in 2023.

Figure E.2 California snow water content for water years 2023-24, 1982-83 & 2014-15



Weather outlook

Weather conditions such as temperatures, cloud cover, and precipitation impact variables affecting the CAISO market and system operations including hydro production, renewable production, and load levels. During summer, temperature is a key driver of load conditions, especially when there are extreme and widespread heat events.

- For the months of June through September 2024, forecasts continue to show the probability of above normal temperatures across the West, with the highest probabilistic chances across the

Desert Southwest, and lower chances of above normal temperatures in coastal locations, especially Southern California.
- Forecast guidance also shows an increased chance of above normal temperatures across the Desert Southwest in August and September 2024.

Emergency resources

Beginning in the summer of 2021, several emergency resource programs have been put into place, providing grid support during system emergencies and extreme events. The fleet of emergency resources and programs continues to grow in 2024.

- These programs include both conventional generation assets and voluntary load reduction programs administered by state agencies including the Department of Water Resources (DWR), the CPUC and the CEC. Many of these programs trigger based on various CAISO emergency notifications.
- For summer 2024, state emergency resource programs continue to grow. Supply accessible through the Electricity Supply Strategic Reliability Reserve Program (ESSRRP) and emergency assistance on the interties totals around 3,450 MW. The CEC and CPUC will provide estimates of state emergency demand response programs and other contingency resources in the CEC's California Reliability Outlook, to be published in May 2024. The CAISO details the processes for operation of various emergency resources in the CAISO's Emergency Procedure 4420.[7]

Preparation for summer operations

Preparing and publishing the Summer Assessment report and sharing the results with industry participants and stakeholders is one of many activities the CAISO undertakes each year to be as well positioned as possible for summer system operations. These activities also include fine-tuning market and operational measures to ensure effectiveness of the planned resource fleet in times of system stress, and enhancing operational coordination with state agencies and the industry to access contingency reserves should the system face the risk of shortfalls due to extreme events. The CAISO developed a public Extreme Weather Process and Communications document, which details the CAISO's timelines for operational coordination and communication channels for CAISO emergency notices, which may trigger the use of various emergency resources.[8]

It is important to note that the results presented in the Summer Assessment do not take into account extreme events experienced in the last several years (*e.g.* extreme drought, wildfires and the potential for widespread regional heating events and other disruptions) that continue to pose a risk for emergency conditions to the CAISO grid.

[7] CAISO Operating Procedure 4420, System Emergency: http://www.caiso.com/Documents/4420.pdf

[8] CAISO, Extreme Weather Event — Process And Communications: http://www.caiso.com/Documents/extreme-weather-event-process-and-communications.pdf

1 2024 Summer Assessment

As the electric industry prepares for summer operations, the CAISO's 2024 Summer Assessment provides a measure of anticipated resource sufficiency based on planning and procurement targets, and an update on the state's emergency resources in development to support grid reliability in the event of more extreme conditions.

This assessment evaluates the CAISO balancing authority area's (BAA) summer 2024 reliability using two distinct models:

1. Probabilistic Assessment based on the CPUC's 2024 Preferred System Plan (PSP) portfolio adjusted to reflect current expectations: The CAISO approaches the summer of 2024 with a 2,550 MW surplus for meeting "one day every 10 years" (1-in-10) Loss of Load Expectation (LOLE) planning target.[9] This assessment measures the potential for calling on emergency measures, not actual loss of firm load.
2. Multi-Hour Stack Analysis: The CAISO conducted an hourly assessment of the resource fleet sufficiency on peak days for each summer month in 2024, considering an 18.5 percent reserve margin.[10] The stack analysis showed that the forecasted demand plus an 18.5 percent reserve margin could be met for all summer months in 2024. The analysis also indicates that there is a surplus of at least 3,438 MW over forecasted demand plus an 18.5 percent reserve margin during peak net load hours of 18 through 22 in September.

In addition, state emergency resource programs continue to grow in summer 2024. Supply accessible through the Electricity Supply Strategic Reliability Reserve Program (ESSRRP) and emergency assistance on the interties totals around 3,450 MW.

Background

Each year the CAISO prepares an assessment of the expected supply and demand conditions for the coming summer for its BAA. Publishing the summer assessment and sharing the results with state regulatory agencies, industry participants, and stakeholders is one of many activities the CAISO undertakes each year to be transparent and to prepare for summer system operations.

Summer Assessments are critical to prepare for typically challenging summer conditions and high loads. The CAISO's methodology for summer assessments has evolved over the last 10 years from a deterministic assessment of anticipated summer conditions to a probabilistic approach focused on operational situational awareness. Over time, as shortfall conditions emerged and as the system peaks shifted to later

[9] LOLE is a measure of the number of days per year for which the available generation capacity is insufficient to serve the demand at least once during that day. 0.1 LOLE or 1-day-in-10 LOLE equates to "1 day with an event in 10 years".

[10] The 18.5 percent reserve margin applied to a 1-in-2 load forecast level is a CAISO metric calculated to maintain operating reserves under reasonably stressed system conditions, taking into account load forecast uncertainty, e.g. a 1-in-5 peak load variance, and resource forced outage rates. The metric is described in more detail in Section 1.2 Multi-hour Stack Analysis, on page 13. It is not derived from a loss of load expectation probabilistic analysis and therefore does not ensure a 1-in-10 loss of load performance.

hours of the day due to the growth of customer-sited solar, the CAISO shifted the focus of summer reliability analyses. These changes include:

- Increased scrutiny on expected summer conditions;
- Increased focus on changes in demand requirements and resource additions; and,
- Assessing risk associated with extreme events and the availability of emergency mitigation measures.

In this Summer Assessment, the CAISO developed two distinct products, aligned with evolving stakeholder needs: 1) A probabilistic assessment of existing and planned resources for 2024 and 2) A multi-hour stack analysis for summer months (May – September). Section 1.1 and Section 1.2 provides detailed analysis of stochastic modeling and stack analysis to assess the reliability of CAISO BAA for summer 2024.

1.1 Probabilistic Assessment

The CAISO assessed a resource portfolio reflecting existing resources and those expected to be available by June based on the CPUC's recently adopted Preferred System Plan (PSP) for 2024 developed in its Integrated Resource Plan (IRP) proceeding[11], adjusted to reflect current expectations, against a 1-in-10 LOLE planning target using probabilistic production cost simulations in the energy modeling software PLEXOS. This approach utilizes 500-iteration full year hourly chronological simulations and is able to capture a wide range of system conditions in load, solar and wind generation, and generation resource outages. Hence, the model was able to simulate 500 years with a unique combination of load, solar, wind and outage profile for each year. The resulting frequency distribution of capacity shortfalls (or surpluses) was used to calculate the portfolio's LOLE level in days/year.

Figure 1.1 shows a high-level representation of CAISO and rest of the WECC topology used in the stochastic model. The stochastic model maintains a detailed representation of individual generation resources and load inside the CAISO across four zones: PG&E Bay, PG&E Valley, SCE and SDG&E with inter-zonal limits enforced. Out of state tie-generators are modeled as imports and are counted against the net import limit. The remainder of the WECC resources and load are aggregated into a single external market zone and are directly connected to the CAISO through the PG&E Valley, SCE and SDG&E zones. This external zone is modeled to provide with economic imports and exports and is subject to CAISO's net import limit. A net import limit (algebraic sum of all imports and exports to the CAISO system) of 5,500 MW is used from June through September during hours 16 – 22. In all other hours, a limit of 11,665 MW is used in the model.

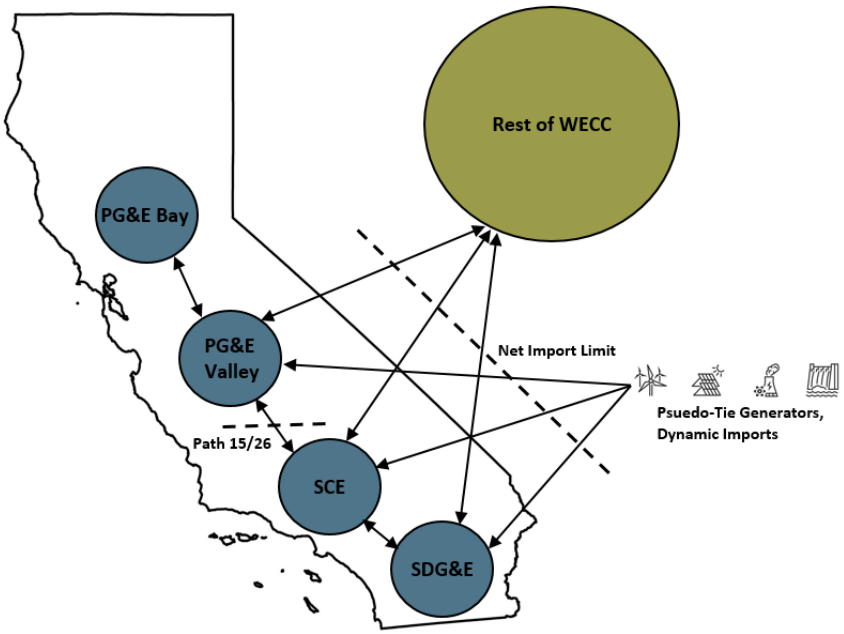
With respect to ancillary services, a single set of deterministic regulation and load following requirements are used for all iterations. Spinning and non-spinning reserves are each held at 3 percent of load. Because load is a stochastic variable, the hourly values of spinning and non-spinning reserve requirements vary in each iteration.

As mentioned before, the model uses four stochastic variables – load, solar, wind and forced outages. The methodology used to derive load, solar and wind stochastic variables and their distributions are detailed in subsequent sections. The forced outage variable is independent of the other stochastic variables and are generated for each resource in the CAISO BAA for the whole year. The forced outage samples are

[11] CPUC, Decision Adopting 2023 Preferred System Plan (D.24-02-047), February 15, 2024: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M525/K918/525918033.PDF

generated randomly using historical class average forced outage rates and are independent for each resource.

Figure 1.1 CAISO and rest of WECC zonal topology in the stochastic model



1.1.1 Resource Portfolio Assumptions

On February 15, 2024, the CPUC adopted the 2023 Preferred System Plan (PSP) portfolio.[12] For 2024, the portfolio includes planned capacity additions of over 7 GW, primarily 4-hour Lithium-ion batteries (4.3 GW) and solar resources (3 GW). About 2.2 GW of gas capacity is "not retained" in the portfolio beginning in 2024.[13] Since the PSP focuses on long-term planning targets, and the CAISO's assessment is focused on load and resource needs for the near-term, the CAISO adjusted the PSP portfolio for 2024 to align with CAISO's projection of resources expected to come online as of June 30, 2024. Given different purposes of the CPUC's PSP and the CAISO's Summer Assessment, 7.3 GW of planned battery and solar capacity in 2024 from the PSP is not considered in the stochastic model. In addition, 2.2 GW of gas capacity not retained in the first modeled year in the PSP portfolio is considered available capacity for 2024. Existing and new resources contracted under the state's Strategic Reliability Reserve (SRR) program are excluded from the model. As mentioned earlier, all pseudo-tied and dynamic imports from out of state generators are modeled and counted against the net import limit.

[12] *Ibid.*

[13] CPUC, 2023 Preferred System Plan Proposed Decision, Modeling & Analysis, pp. 13, January 12, 2024: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2023-irp-cycle-events-and-materials/2024-01-12-presentation-summarizing-updated-servm-and-resolve-analysis.pdf

Table 1.1 shows total installed capacity comparison between the CPUC's PSP 2024 portfolio and the CAISO's stochastic model used for Summer Assessment. Differences in the installed capacity can be reasonably expected between the CPUC's PSP and the CAISO's stochastic model due to different use cases and timelines under which the inputs and assumptions are built.

Table 1.1 Total installed capacity by fuel type in CAISO's 2024 stochastic model

Installed Capacity (MW) / Fuel Type	CPUC's Preferred System Portfolio (2024)	CAISO's Stochastic Model (2024)
Coal	480	480
Natural Gas	23,744	**25,991**
CHP	1,925	1,925
Nuclear	2,935	2,935
Geothermal	1,303	1,303
Biomass	487	487
Biogas	217	217
Hydro	8,523	8,523
In-State Wind	8,027	8,027
Out-of-State Wind	11	11
Solar	22,037	**19,037**
Li-ion Battery (4-hr)	12,894	**8,554**
Li-ion Battery (8-hr)	67	67
Pumped Hydro Storage	1,483	1,483
Shed DR	2,446	2,446
Total	**86,579**	**81,486**

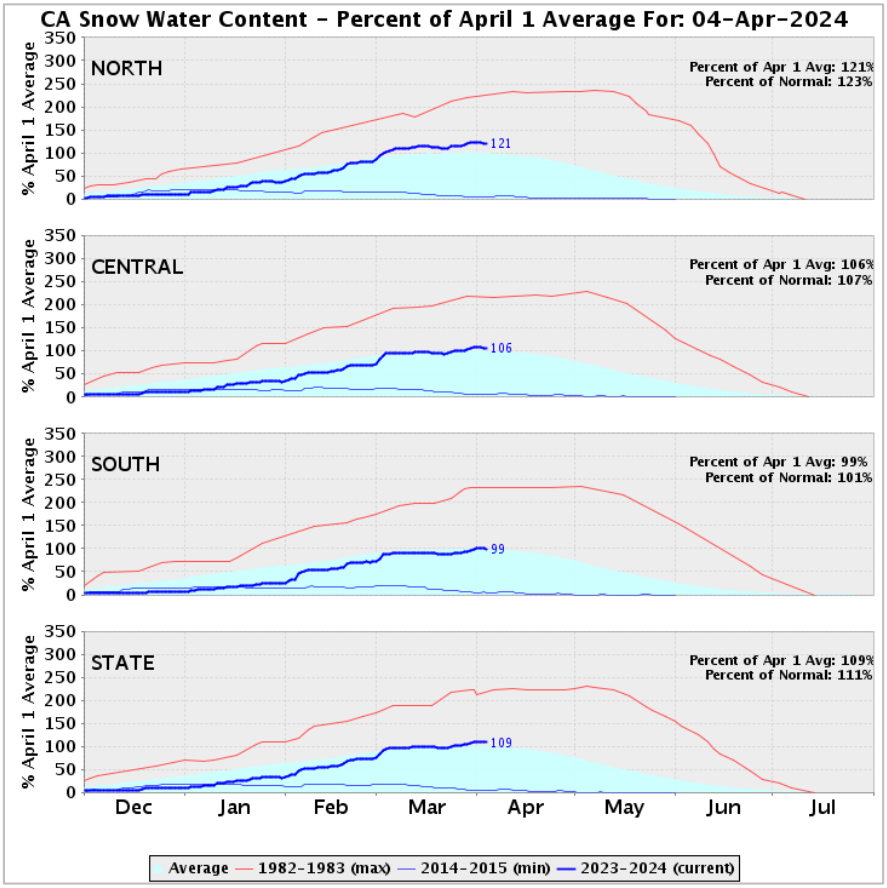
1.1.2 Hydro Modeling

Hydro generation is modeled on an aggregated basis as two types: non-dispatchable run-of-river and dispatchable hydro generation. Run-of-river hydro generation is modeled as a fixed generation profile. The dispatchable hydro generation is optimized subject to monthly maximum and minimum energy limits. These are derived from historical generation data using the historical hydro year with snowpack and reservoir conditions that most closely resemble the current year. Dispatchable hydro generation can provide system capacity, ancillary service and flexible capacity. Pump storage generators are modeled individually and are optimized subject to storage capacity, inflow and target limits, and cycling efficiency.

As shown in Figure 1.2 on a statewide basis, the snow water content is trending slightly above average as of April 4, 2024. The model in this analysis for an "average hydro" year was based on the 2010-2011 hydro year. Storage levels in California's major reservoirs provides a better indication of water supply conditions for the coming year. As of April 17, 2024, California's major reservoir storage levels ranged between 86 to 149 percent of historical average.[14]

[14] California Department of Water Resources, Daily Reservoir Storage Summary: https://cdec.water.ca.gov/reportapp/javareports?name=RES

Figure 1.2 California snow water content for water years 2023-24, 1982-83 & 2014-15 [15]



1.1.3 Stochastic Solar and Wind Profiles

Solar and wind base profiles[16] from the CPUC's recently adopted PSP are used as an input into the CAISO's mean reversion stochastic model.[17] Mean reversion ratios of solar and wind are calculated with a regression model using historical wind (2007 – 2014) and solar (2010 – 2021) data sourced from the National Renewable Energy Laboratory (NREL). The CAISO then applied these ratios to the solar and wind base profiles to generate 500 stochastic samples for solar and wind generation. Figure 1.3 and Figure 1.4 show the distributions of these 500 samples of solar and wind generation in 2024, respectively.

[15] California Department of Water Resources, California Data Exchange Center, CA Snow Water Content – Percent of April 1 average: http://cdec.water.ca.gov/snowapp/swcchart.action

[16] CPUC's system reliability modeling datasets for 2023: https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/long-term-procurement-planning/2022-irp-cycle-events-and-materials/system-reliability-modeling-datasets-2023

[17] The methodology was filed as part of CAISO's expert testimony in the CPUC Long-Term Procurement Plan (LTPP) proceeding, Appendix A, pg. 5 – 19, Nov 20, 2014: https://www.caiso.com/documents/nov20_2014_liu_stochasticstudytestimony_ltpp_r13-12-010.pdf

Figure 1.3 2024 hourly solar stochastic sample distribution

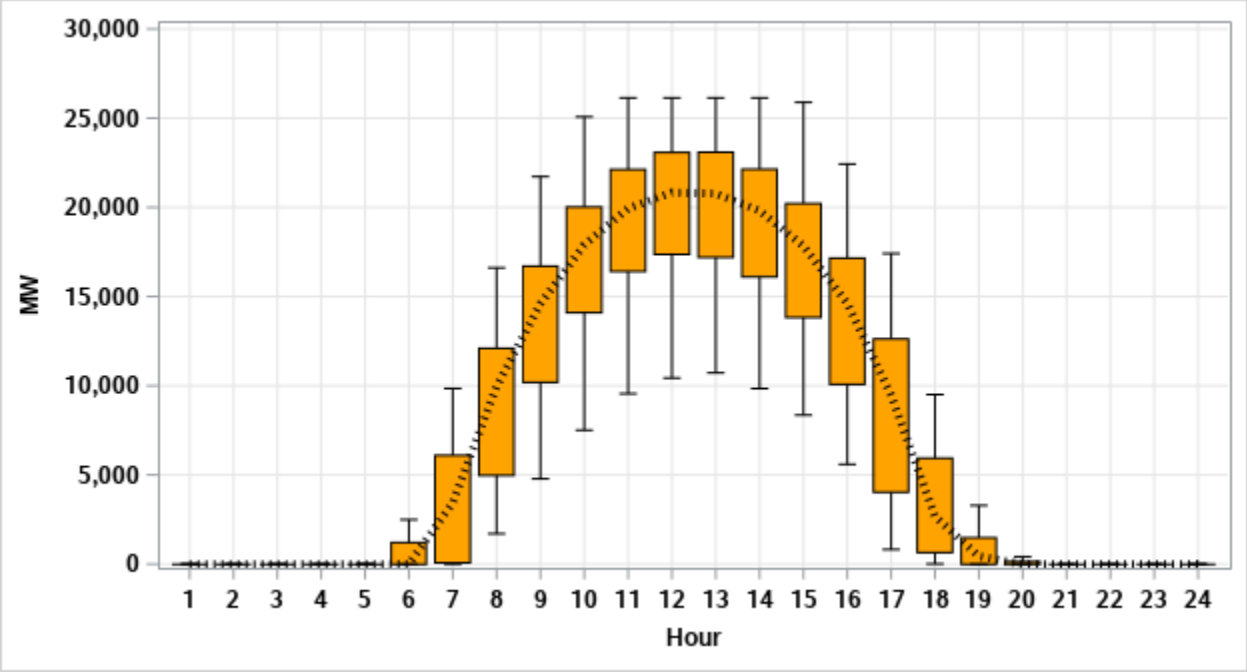
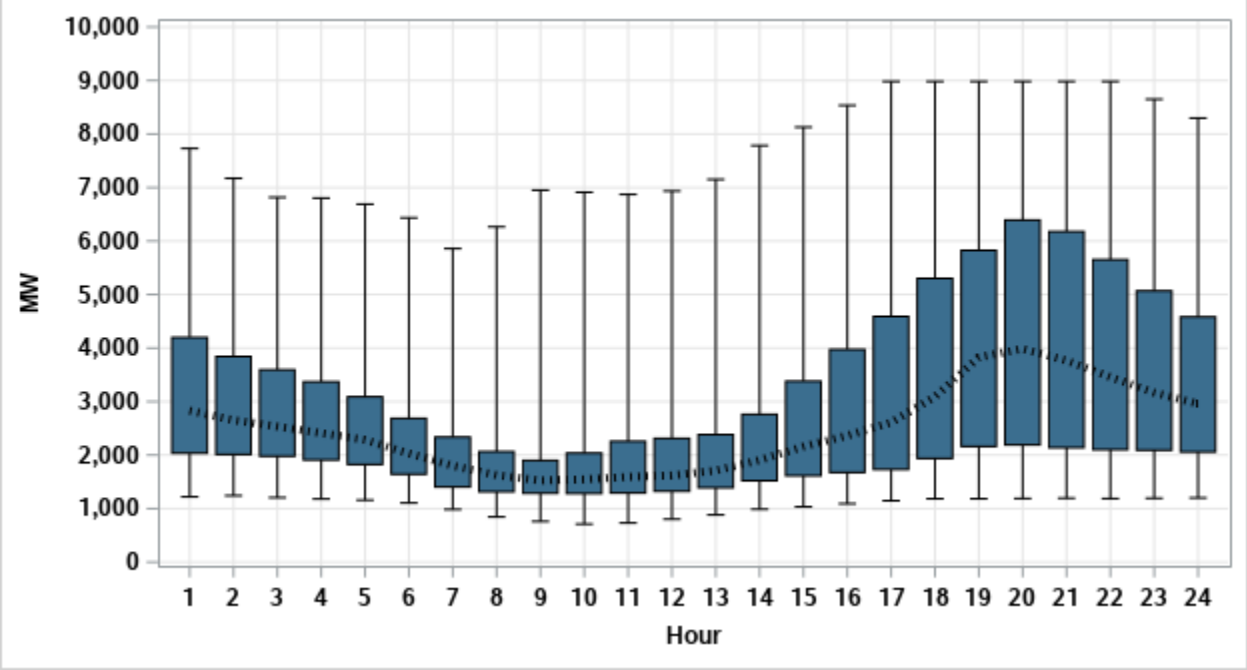


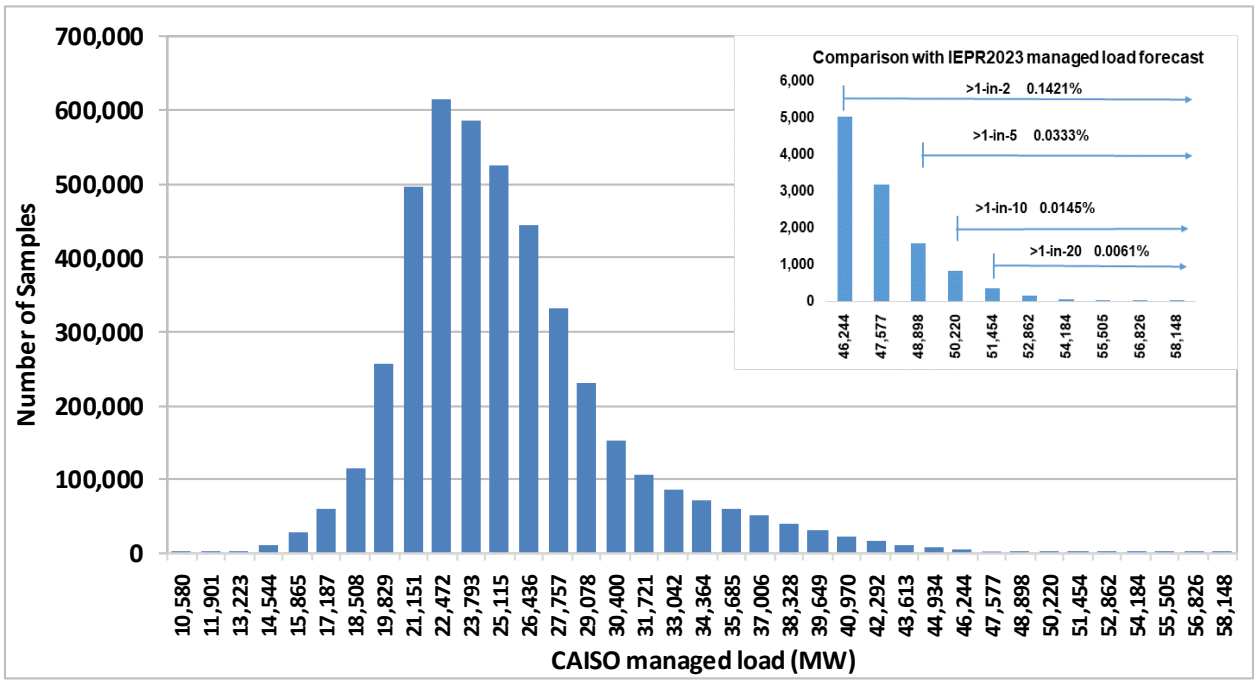
Figure 1.4 2024 hourly wind stochastic sample distribution



1.1.4 Stochastic Load Profiles

The CEC 2023 IEPR forecasts the CAISO 1-in-2, 1-in-5, 1-in-10, and 1-in-20 peak demand in 2024 to be 46,244 MW, 48,898 MW, 50,220 MW, and, 51,454 MW, respectively. The peak demand of 46,244 MW occurs on July 24, 2024 in hour ending 18. The CEC baseline managed hourly demand forecast was used as an input to CAISO's mean reversion load forecast model.[18] This model contains two steps: The first step uses CAISO's historical load profiles to calculate the mean reversion ratios with a regression model. The second step applies the calculated mean reversion ratios to CEC's baseline hourly demand forecast plus behind-the-meter solar generation to generate 500 stochastic hourly gross load profiles. The managed hourly load was calculated by subtracting behind-the-meter solar from the projected 500 stochastic gross load samples. Figure 1.5 shows the frequency distribution of loads used in the stochastic model.

Figure 1.5 2024 stochastic load sample distribution



[18] The methodology was filed as part of CAISO's expert testimony in the CPUC Long-Term Procurement Plan (LTPP) proceeding, Appendix A, pg. 5 – 19, Nov 20, 2014: https://www.caiso.com/documents/nov20_2014_liu_stochasticstudytestimony_ltpp_r13-12-010.pdf

1.1.5 Probabilistic Study Results

The CAISO used a PLEXOS simulation model for probabilistic assessment of the CAISO BAA for summer 2024. This stochastic model utilizes 500-iteration full year hourly chronological simulations and is able to capture a wide range of system conditions in load, solar and wind generation, and generation resource outages. It uses mixed-integer programing (MIP) to determine the optimal generation dispatch. The model assesses the adequacy of an adjusted portfolio based on the CPUC's PSP to meet the forecasted load based on the CEC's 2023 IEPR 1-in-2 planning forecast. The CAISO's 1-in-2 peak demand forecast of 46,244 MW occurs on July 24, 2024 hour ending 18. In contrast, the 2022 IEPR forecast projected a 2024 peak load forecast of 47,475 MW on September 3, 2024 hour ending 20.

The model runs chronologically to dispatch capacity, ancillary services, and load following to seek the least cost, co-optimized solution to meet system demand and flexibility requirements simultaneously. Operational constraints include forced and planned outage rates, unit commitment parameters, minimum unit up and down times, unit heat rates, and ramp rates for each generator in the CAISO system. The end status of one optimization is set as the initial status of the next optimization. If the simulation results indicate that there is a surplus for an assessment year, a negative perfect capacity generation is added to the supply to reduce the surplus amount until unserved energy, regulation up, or spinning reserve shows shortfall in any hour of a day, then the model will count it as one loss of load event. The model runs 500 iterations to count the number of loss of load events to determine the surplus amount. Once the number of the loss of the load event reaches 50 out 500 iterations, it equates to a "one day every 10 years" (1-in-10) LOLE planning target. Simulation results in Table 1.2 show that the CAISO is approaching the summer of 2024 with a surplus of 2,550 MW, which exceeds the 1-in-10 LOLE planning target.

Table 1.2 Probabilistic assessment inputs/assumptions and simulation results

Inputs/Assumptions and Simulation Results	2024
Inputs/Assumptions	
Adjusted PSP portfolio based on CAISO's expectation of resources as of June 30, 2024	Total installed capacity - 81,486 MW
Hydro year	Average (2010-2011)
Net Import limit	5,500 MW (June - Sep HE 16 -22) 11,665 MW (All other hours)
Load forecast based on CEC's 2023 1-in-2 IEPR Planning Scenario	Peak managed load from 2023 IEPR - 46,244 MW (July 24, HE 18) Peak managed load from 2022 IEPR - 47,475 MW (Sep 3, HE 20)
Number of load, solar, wind and forced outage stochastic samples	500
Simulation Results	
LOLE	< 0.1
Capacity surplus	2,550 MW

1.2 Multi-hour Stack Analysis

In addition to the probabilistic assessment, the multi-hour stack analysis provides an additional perspective on the amount of capacity the CAISO expects to be available for summer 2024, considering an 18.5 percent reserve margin. The stack analysis shows that expected resources are sufficient to meet forecasted demand plus an 18.5 percent reserve margin for all summer months in 2024. The analysis also indicates that there is a surplus of at least 3,438 MW over forecasted demand plus an 18.5 percent reserve margin during peak net load hours of 18 through 22 in September.

Methodology

The new multi-hour approach focuses on a reasonable expectation of resource availability during every hour of the peak day in each of the summer months. For many resource types, the Net Qualifying Capacity (NQC) provides a reasonable estimation of the contribution/availability of those resources every hour. In this analysis, solar and wind generation profiles are derived based on the past eight (8) years (2016 – 2023) of generation data for the five (5) highest load days using an exceedance methodology. Exceedance is a statistical method that shows the amount of generation that one can expect from a resource a given percentage of the time.[19] For 4-hour battery energy storage resources, discharge energy is adjusted and spread across a larger number of at-risk hours. This approach smooths the energy available above the reserve margin. Intertie capacity is based upon historical monthly showings from 2016 through 2023. Total generation is then compared to the CEC's 2023 IEPR 1-in-2 planning load forecast.

The CAISO considered several sets of parameters to determine the appropriate reserve margin (RM) against which to assess the resource fleet. In this context, the CAISO considered the reserve margin requirements to maintain operating reserves under stressed system conditions, ensuring the ability to comply with several NERC and WECC reliability standards in real-time. The combined effect of these requirements (operating and regulation reserves, load forecast uncertainty and to account for forced outage rates) established a threshold need for an 18.5 percent margin above a 1-in-2 load forecast level. This measure is another indicator of resource sufficiency, but does not directly translate into a particular level of loss-of-load expectation (LOLE) over an entire year. Additionally, the 18.5 percent margin threshold established in this assessment is within the CPUC's planning reserve margin (PRM) range (minimum of 17 percent PRM for 2024, and an effective PRM of up to 22.5 percent).[20,21]

[19] CPUC, Renewables and Exceedance – A Primer, Slice of Day: Structural Elements Technical Workshop presentation, September 22, 2021: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/resource-adequacy-homepage/ra_t3b2_workshop-1_presentation-np.pdf

[20] CPUC, Decision (D.) 21-12-015 Phase 2 Decision Directing PG&E, SCE and SDG&E To Take Actions to Prepare for Potential Extreme Weather in the Summers of 2022 and 2023, December 2, 2021: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M428/K821/428821475.PDF

[21] The CAISO has used both "reserve margin" and "planning reserve margin" terms in this assessment. Reserve margin applies more generally to any margin above peak load or other load level. The CAISO has reserved the use of planning reserve margin to apply to reserve margins established by the CPUC or other local regulatory agencies for resource adequacy program purposes.

Table 1.3 Reserve margin requirements above 1-in-2 load forecast

Reserve Requirement	% of Expected Load	Additional Capacity Need
Operating reserves	6%	To carry 6 percent of expected load as contingency reserves as required by NERC. This capacity is accessible for operational needs in EEA3 condition only.
Regulation reserves	1%	To meet operational needs like frequency response and regulation requirements
Forced outage rates	7.5%	To account for overall forced outage rates of the existing fleet
Load forecast uncertainty	4%	To meet a 1-in-5 load forecast level (~4 percent above the 1-in-2 level)
An 18.5 percent reserve margin above 1-in-2 load forecast is used in this assessment.		

Key inputs and assumptions

- **Existing and new resources:**
  - Existing resources are based on CAISO Master Control Area Generating Capability List on OASIS as of February 16, 2024 and the 2024 NQC list published on February 13, 2024.
  - Expected new resources are resources not on the NQC list, but are expected to be online by June 30, 2024. The NQC of an expected resource (excluding wind, solar, and battery) is based upon technology factors in the 2024 NQC list. The installed capacity by month is shown in Table 1.5.
  - Existing and new resources contracted under the Strategic Reliability Reserve (SRR) program are excluded from this stack analysis.
- **Demand:** Load profile used in this analysis is based on the CEC's 2023 IEPR 1-in-2 planning forecast for CAISO for a peak day in each summer month of 2024.

Table 1.4 Monthly peak load forecast (May 2024 – October 2024)

Month	May	June	July	August	September	October
Monthly peak load forecast (MW)	34,346	41,902	46,244	45,059	45,972	36,984

- **Energy storage:** Battery storage resources are assumed to be capable of one 4-hour cycle per day, but also are capable of spreading out their discharge energy across more than four hours.[22] Hence, the base scenario assumes these resources can discharge for five (5) continuous hours, at 45 percent of full available capacity for the 1st and 5th hour, and 90 percent of full available capacity from 2nd through 4th hours. The 90 percent assumption is based on available years of historical state-of-charge data, which shows that the system-wide state-of-charge typically does not go below 5 percent or above 95 percent. Additionally, batteries are assumed to discharge during the hours the grid needs these resources the most. This is consistent with operational goals to maintain sufficient state-of-charge for these resources to discharge during the most critical hours.
- **Nuclear:** Nuclear capacity within the CAISO footprint is included in the model, and capacity outside the CAISO footprint (Palo Verde dynamic import) is included as imports.

[22] CPUC, Report on Resource Adequacy Slice of Day Implementation and Year Ahead Showings, pg. 55, February 5, 2024: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/resource-adequacy-homepage/resource-adequacy-compliance-materials/slice-of-day-compliance-materials/energy-division-report-on-ra-sod-implementation-and-year-ahead-showings.pdf

- **Wind and Solar:** Wind and solar profiles are derived based on eight (8) years of historical generation data (2016 – 2023) for the five (5) highest load days using exceedance methodology. Solar profiles are calculated using a 70 percent exceedance level. Wind profiles are calculated using an 80 percent exceedance level.
- **Demand Response:** Demand response capacity is sourced from the 2024 NQC list and the CIRA database.
- **Resource Adequacy Imports:** Import capacity, including the contribution of tie generators, is based on average historical intertie monthly RA showings from CIRA from 2016 through 2023.

Table 1.5 Projected capacity by resource type (May 2024 – October 2024)[23]

Capacity (MW)	May	June	July	August	September	October
Expected resources	3,985	4,378	4,569	4,569	4,569	4,569
Demand response	1,388	1,577	1,680	1,729	1,734	1,512
Imports	3,299	3,897	5,450	5,824	6,256	3,817
Nuclear	2,280	2,280	2,280	2,280	2,280	2,280

Analysis

The stack analysis compares existing and new resources expected to be online by June 30, 2024 to forecasted demand plus an 18.5 percent reserve margin for the peak days of each summer month in 2024. Imports are assumed to be at an average level for each month. Figure 1.6 and Figure 1.7 show the results of the multi-hour stack analysis for the months of May through September 2024.

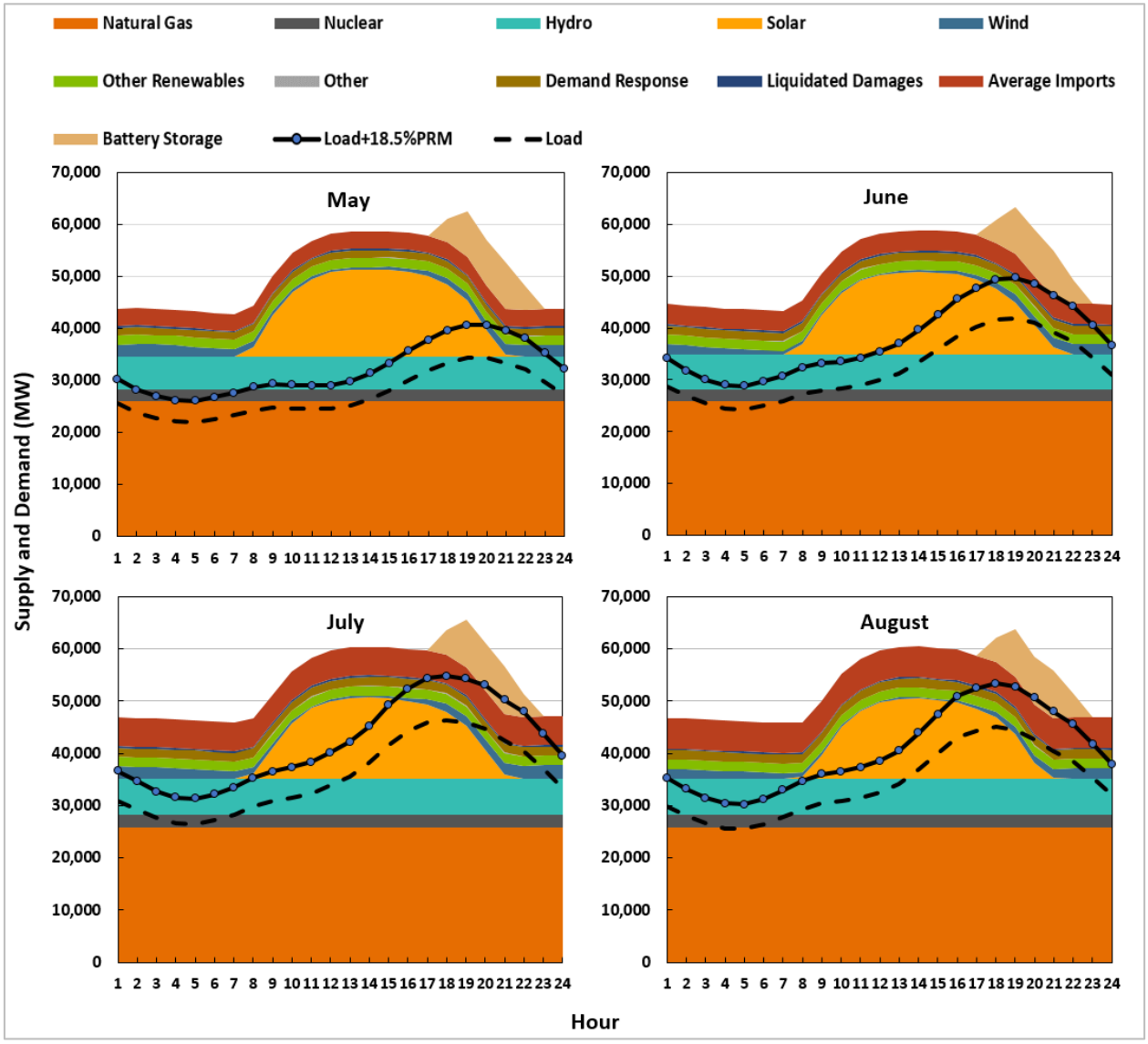
The analysis finds that expected resources are sufficient to meet forecasted demand plus the 18.5 percent reserve margin for all summer months in 2024. The figures show that the grid relies on imports to meet the reserve margin requirement for June through September. The figures also show that batteries help meet and exceed the 18.5 percent margin for July through September.

For 2024, the CEC 1-in-2 managed annual peak load forecast of 46,244 MW occurs on July 24th hour ending 18. This is only 272 MW higher than the second highest load forecast which occurs in September hour ending 18. September continues to be the month when the grid is most stressed because of the reduced availability of solar relative to July as shown in Figure 1.6 and Figure 1.7. There is about 3 GW of additional solar available in the peak load hour of July compared to September.

During the peak net load hours of 18 through 22 in September, the analysis also shows a surplus of at least 3,438 MW over the 18.5 percent reserve margin.

[23] Expected resources include all projects with COMX and SYNC status as of April 1, 2024, while only those "Active" resources that are shown on the CAISO NQC list as of February 1, 2024 are counted.

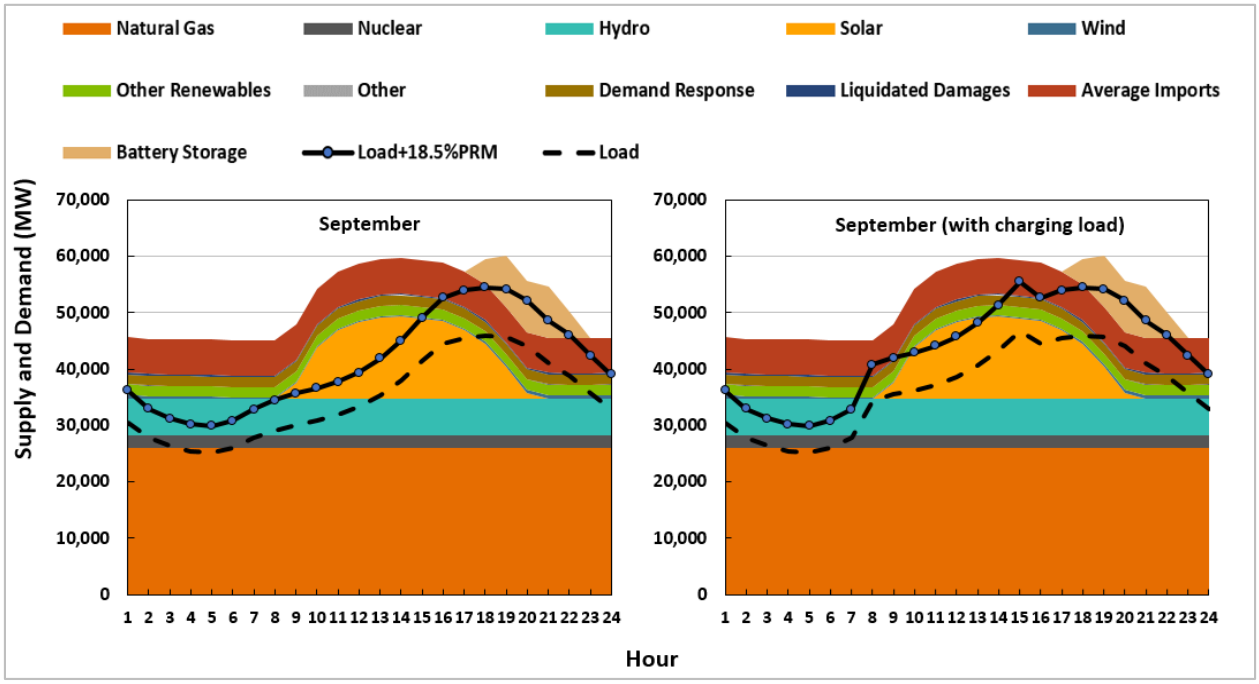
Figure 1.6 Multi-hour stack analysis for peak days in May through August[24]



[24] Liquidated damages are contracted import capacity that are shown as credits in the CAISO's RA systems.

The baseline load forecast used in this model does not include charging load of metered battery resources. To understand the charging needs of these batteries and their impact on grid conditions, the CAISO developed a sensitivity scenario that includes charging load of metered battery resources. An 85 percent round-trip efficiency is assumed for battery resources, and battery resources are assumed to charge for eight hours from 8 am to 3 pm. Figure 1.7 shows results of this sensitivity. Results show a reliance on imports in some hours to meet the reserve margin requirement with charging load. Grid conditions continue to evolve as we add more battery resources to the system, and the CAISO will continue to monitor and assess the impact of battery resources.

Figure 1.7 Multi-hour stack analysis for September peak days with charging load sensitivity



2 Loads and Resources

In this chapter, the CAISO provides a more in-depth discussion of the resource development and load forecasts summarized and considered in the analysis set out in Chapter 1. Section 2.1 provides an update on existing and expected resources available for summer 2024. Section 2.2 shows the progress towards meeting 2024 resource planning targets ordered by the CPUC. Section 2.3 includes a discussion of the CPUC's Preferred System Plan (PSP) adopted on February 15, 2024. Finally, Section 2.4 shows the CAISO's near-term load projections based on the CEC's 2023 IEPR demand forecast.

2.1 Supply Conditions for 2024

In this assessment, the CAISO considers both existing and in-development resources expected to be available to serve demand during the forecasted summer peak in 2024. The CAISO expects around 3,199 MW of Battery, 818 MW of Solar, 490 MW of hybrid, and 62 MW of other renewables to declare commercial operation by June 30, 2024. For existing resources, the CAISO reports resource capacity based on their Net Qualifying Capacity (NQC)[25] and Net Dependable Capacity (NDC)[26] or installed capacity. The CAISO identifies new resources as those making progress toward achieving commercial operation in the interconnection process.

2.1.1 Existing Resources

Table 2.1 shows existing resource capacity by fuel type with their corresponding NQC and NDC totals and the amounts of each resource type by deliverability status. The table excludes pseudo-tie and dynamic import resources outside of the CAISO BAA, which total around 9,000 MW. Figure 1.1 shows a map of existing resources as of February 16, 2024. Deliverability is a measure of the transmission system's ability to deliver energy to the grid in times of critical system need. The CAISO determines deliverability status of a resource based on its ability to provide energy to the grid during stressed system conditions. The study process results in each resource being assigned either Full Capacity, Interim Deliverability, Partial Deliverability or Energy Only deliverability statuses.[27]

[25] Each resource has a qualifying capacity (QC) and net qualifying capacity (NQC). Qualifying capacity values are fuel-type specific and are set using methodologies determined by the appropriate local regulatory authority (LRA). The NQC value is resource-specific and is determined by the CAISO based on the QC and the deliverability status of the resource. NQC provides a reasonable estimation of a resource's capability to serve system needs in critical hours.

[26] Net dependable capacity is the maximum continuous net output of a generating unit (net of auxiliary load), considering seasonal de-rates.

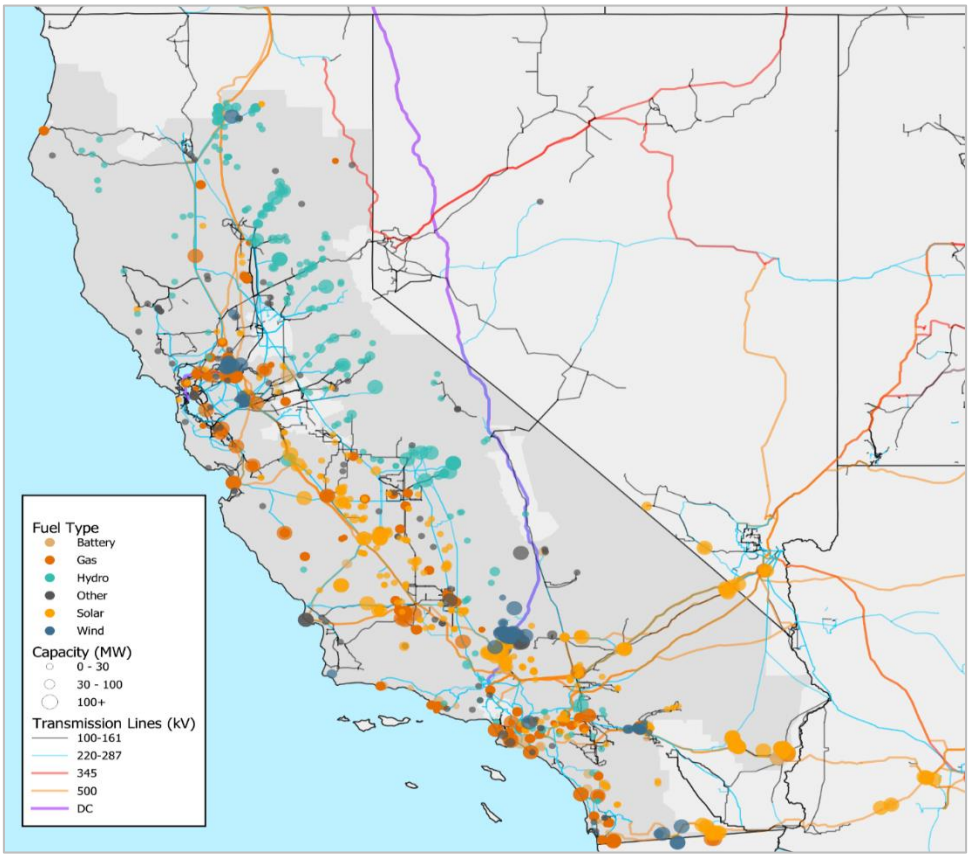
[27] *Full Capacity* deliverability status entitles a generating facility to a NQC amount that could be as large as its QC amount and may be less pursuant to the assessment of its Net Qualifying Capacity by the CAISO.
Interim Deliverability allows an interconnection customer that has requested Full Capacity or Partial Capacity deliverability status to obtain non-zero NQC pending the in-service date of all the required network upgrades required for its requested deliverability status.
Partial Capacity deliverability status entitles a generating facility to a NQC amount that cannot be larger than a specified fraction of its QC amount, and may be less pursuant to the assessment of its NQC amount by the CAISO.
Energy Only is a condition elected by an interconnection customer for a generating facility interconnected with the CAISO controlled grid where the generating facility will be deemed to have a NQC of zero, and, therefore, cannot be considered to be a resource adequacy resource.

The technology factor is based on historical performance by fuel type during each month of the year and results in a resource being assigned a NQC value. For dispatchable resources like battery and natural gas plants, the NQC value is typically near its NDC or installed capacity. For intermittent resources like wind and solar, the NQC is typically lower because the plant may not be able to provide energy when called upon unless the weather conditions allow.

Table 2.1 Existing resources by fuel type and deliverability status (excludes tie-generators)

Deliverability	Full Capacity		Interim Deliverability		Partial Deliverability		Energy Only		Total	
Fuel Type	NDC	NQC	NDC	NQC	NDC	NQC	NDC	NQC	NDC	NQC
Battery	3,758	3,652	2,862	2,811	476	325	74	0	7,170	6,788
Biogas	232	175					19	0	251	175
Biomass	421	329					5	0	426	329
Distillate	110	110							110	110
Geothermal	1,297	1,146			162	102			1,459	1,248
Hybrid	20	12	1,541	658	8	7			1,569	677
Hydro	10,910	7,031			2	0	17	0	10,929	7,031
Natural Gas	25,898	24,841	417	403	704	624	5	0	27,024	25,868
Nuclear	2,300	2,280							2,300	2,280
Other	608	37							608	37
Solar	12,108	1,751	3,508	459	104	11	1,538	0	17,258	2,221
Waste Heat	89	78							89	78
Wind	6,292	1,036					6	0	6,298	1,036
Total	**64,043**	**42,478**	**8,328**	**4,331**	**1,456**	**1,069**	**1,664**	**0**	**75,491**	**47,878**

Figure 2.1 CAISO balancing area existing resources as of February 16, 2024



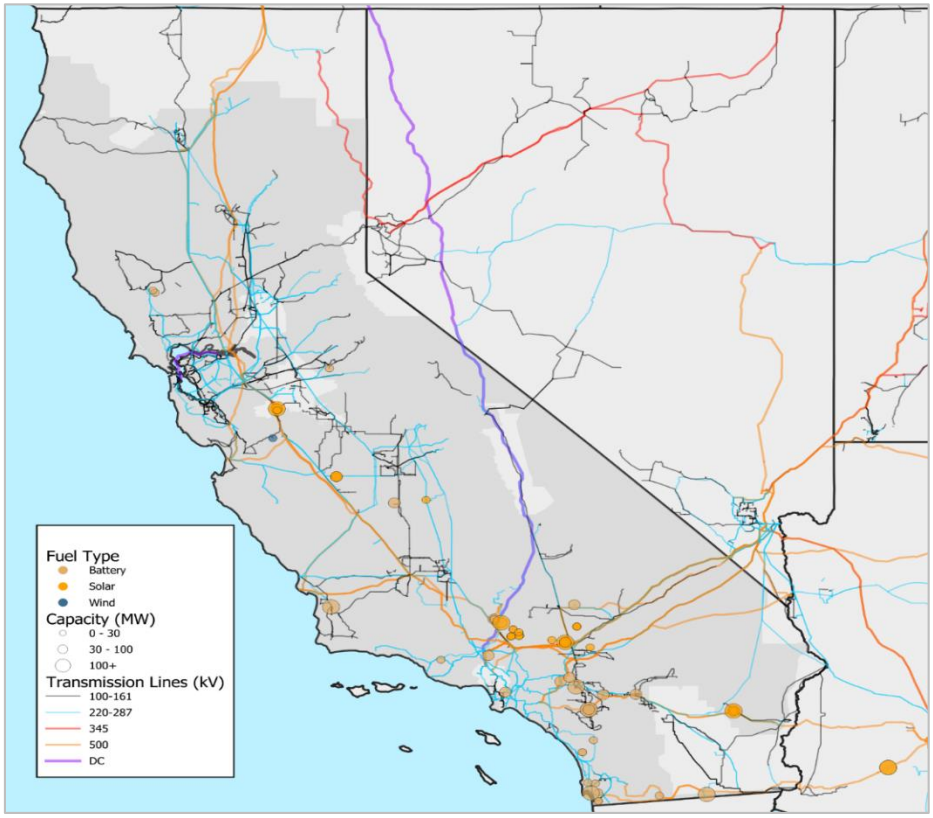
2.1.2 Expected Resources

In addition to existing resources, the CAISO expects several in-development resources to come online by June 30, 2024. As shown in Table 2.2, there are about 3,199 MW of Battery, 818 MW of Solar, 490 MW of hybrid, and 62 MW of other renewables (NDC values) that have a high likelihood of declaring commercial operation by June 30, 2024. The CAISO used a set of criteria based on New Resource Implementation (NRI) status and target commercial operation date (COD) to determine whether to count a project as available for the summer. NRI status indicates the development stage of a resource as it progresses through construction and testing towards being fully commercially available. Notable NRI status labels are Active (under construction), SYNC (permission to connect to the grid and begin to test injecting energy at the point of interconnection), COMX (a resource at partial capacity may begin to participate in the market before full capacity is available), and COD (fully commercially online). All SYNC and COMX resources with target COD's before June 30, 2024 count as available in this assessment, while only those Active resources on the CAISO NQC list as of February 1, 2024 are counted. Figure 2.2 shows a map of expected new resources as of June 30, 2024.

Table 2.2 Expected additions from April 1, 2024 through June 30, 2024 (MW)

Category	Battery	Wind	Solar	Biofuel	Geothermal	Hybrid	Total Nameplate Capacity
Expected additions from April 1, 2024 through June 30, 2024	3,199	18	818	3	41	490	**4,569**
Total	**3,199**	**18**	**818**	**3**	**41**	**490**	**4,569**

Figure 2.2 CAISO balancing area expected new resources as of June 30, 2024

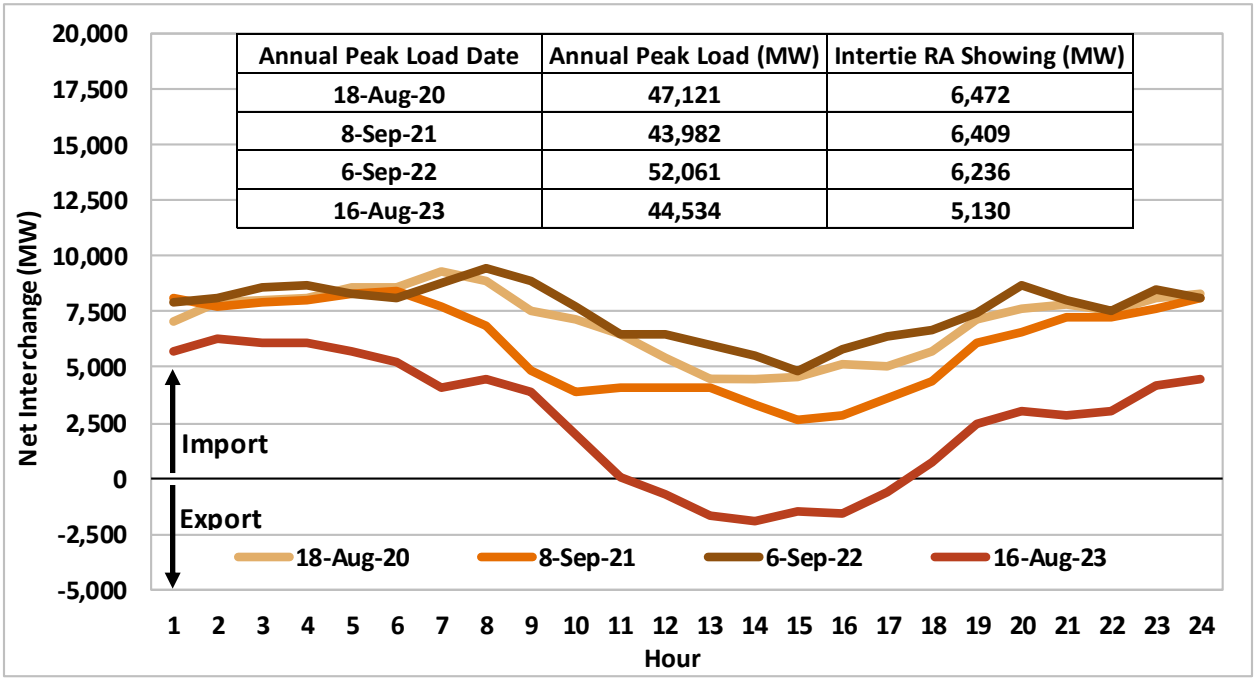


2.1.3 Net Interchange

The CAISO relies on import capacity to meet demand, particularly in evening hours when grid conditions can be most challenging. As such, it is important to monitor import trends including the net interchange and intertie RA showings. The net amount of import to and export from the CAISO, as well as Western Energy Imbalance Market (WEIM) transfers, constitutes CAISO net interchange. Figure 2.3 shows the hourly average net interchange amount on annual peak loads days over the past four (4) years (2020 to 2023). As shown in the figure, CAISO was a net importer in all hours during each annual peak load day from 2020 through 2022. However, during the 2023 peak, the CAISO BAA shifted to being a net exporter of energy during the middle of the day. Figure 2.3 also shows the actual intertie RA showing import amount for each of the annual peak load month over the last four (4) years. The data table shows that actual intertie RA showings for August and September are dropping over the last 4 years.

Figure 2.3 Historical net interchange on annual peak load days (2020 – 2023)

Annual Peak Load Date	Annual Peak Load (MW)	Intertie RA Showing (MW)
18-Aug-20	47,121	6,472
8-Sep-21	43,982	6,409
6-Sep-22	52,061	6,236
16-Aug-23	44,534	5,130



2.2 Progress towards achieving CPUC's Authorized Procurement for 2024

The California Public Utilities Commission's (CPUC) procurement requirements have triggered the bulk of new resource development in the CAISO BAA. Recognizing this trend, the CAISO provides an overview of recent procurement requirements established by the CPUC and the progress towards achieving those requirements. Based on the CPUC's and the CAISO's data, the CPUC's 2024 authorized procurement of 6,000 MW in net qualifying capacity should be met considering the progress of expected resource additions by June 30, 2024.

The CPUC and California Energy Commission (CEC) regularly report the progress of CPUC-jurisdictional LSEs in achieving procurement requirements established by the CPUC. However, this data does not include capacity not reported as under contract with CPUC-jurisdictional LSEs, or capacity under contract with publicly owned utilities. The CAISO reports the total of all resources moving through its interconnection process on track to come online this summer for both CPUC-jurisdictional and non-CPUC jurisdictional LSEs. New capacity figures reported by the CAISO therefore include the total of all installed capacity, regardless of how much of the resource may be under contract.

The CPUC and CEC report new capacity data based on net qualifying capacity (NQC), while the CAISO tracks and reports new resources primarily based on net dependable installed or nameplate capacity, and uses NQC values where appropriate.

Through two decisions in 2021 and 2023, the CPUC ordered LSEs to procure 15,500 MW of NQC to come online between 2023 and 2028.[28] The CPUC's recent Preferred System Plan (PSP) portfolio assumes compliance with those orders and includes the NQC associated with the ordered procurement. Table 2.3 shows the annual procurement requirements. Resources connecting to the distribution system under a Wholesale Distribution Access Tariff (WDAT) contracted with a CPUC jurisdictional LSE are also included in the analysis.

Table 2.3 CPUC ordered procurement requirements (in MW, Net Qualifying Capacity)

CPUC Orders	2023	2024	2025	2026	2027	2028
Decision [D.]21- 06-035 Mid-Term Reliability (MTR)	2,000	6,000	1,500	0	0	2,000
Decision [D.]23-02-040 (Supplemental MTR)	0	0	0	2,000	2,000	0
Total Annual Capacity Requirements	**2,000**	**6,000**	**1,500**	**2,000**	**2,000**	**2,000**
Cumulative Procurement Ordered	**2,000**	**8,000**	**9,500**	**11,500**	**13,500**	**15,500**

The procurement requirement of 2,000 MW established for 2023 by the CPUC has already been met with a surplus of 978 MW as of August 1, 2023 (Table 2.4). This surplus, along with an additional 2,439 MW that came online between August 2023 and April 2024, shows significant progress towards the

[28] CPUC, Decision Requiring Procurement to Address Mid-Term Reliability (D.21-06-035), June 24, 2021: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M389/K603/389603637.PDF
CPUC, Decision Ordering Supplemental Mid-Term Reliability Procurement (D.23-02-040), Feb 23, 2023: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M502/K956/502956567.PDF

CPUC procurement target for 2024.[29] Of the 6,000 MW needed in 2024, only 2,583 MW of NQC remains to be added to achieve the procurement target as shown in Table 2.4.

Table 2.4 Progress towards 2023 and 2024 authorized procurement orders as of April 1, 2024 (in MW, Net Qualifying Capacity)

Category	Procurement Order	Online Capacity	Surplus (Shortfall)
2023 Authorized Procurement	2,000	2,978	978
2024 Authorized Procurement	6,000	2,439	(3,561)
Total	**8,000**	**5,417**	**(2,583)**

Table 2.5 shows the breakdown of existing and in-development resources that count towards the 6,000 MW (NQC) authorized procurement target for 2024. With the surplus from 2023 and additions from August 2023 to April 2024 accounting for 3,417 MW of NQC, about 2,583 MW remains to meet the 2024 target. Expected new resource additions NQC as of June 30, 2024 totaled to be around 2,480 MW (COMX [1,193 MW] and SYNC [1,287 MW]) leaving a shortfall of 103 MW to meet the 6,000 MW need. [30]

Table 2.5 Estimated 2024 authorized procurement surplus (shortfall) (MW)[31]

Category	Net Qualifying Capacity	Nameplate Capacity
Surplus until August 2023	978	2,036
Additions from August 2023 through December 2023	1,957	4,022
Additions from January 2024 through April 1, 2024	482	926
Expected additions from April 1 through June 30, 2024	2,480	3,463
Total Additions	**5,897**	**10,447**
2024 Authorized Procurement	**6,000**	
Surplus (Shortfall)	**(103)**	

The list of resources used to inform Table 2.1, Table 2.4 and Table 2.5 is based on a snapshot view on February 16, 2024 of existing and in-development projects expected to be available by June 30, 2024. The amount of in-development resources in the NRI process constantly changes as projects hit milestones on

[29] About 825 MW of authorized procurement from tranche 3 of CPUC decision D.19-11-016 was met with resources that came online before August 1, 2023: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/publicirpcompliancereport080123.pdf

[30] Expected additions from April 1 through June 30, 2024 in Table 2.5 include only projects with NRI status in COMX and SYNC categories since these have a higher likelihood of declaring COD by June 30. This table excludes resources with NRI status "Active" which total around 1,106 MW (nameplate) and hence can differ from expected additions number reported elsewhere in the report.

[31] Using September technology factors from the CAISO NQC list and assuming 48 percent factor for hybrids, resource additions counting towards 2024 procurement target amount to 8,411 MW of nameplate capacity.

their way to reaching full capacity and declaring commercial operation. To reflect any status changes, the CAISO pulled another snapshot view on April 1, 2024 to assess new resource progress. This showed an additional 300 MW of nameplate capacity had entered SYNC status (permission to connect to the grid and begin to test injecting energy at the point of interconnection) that is not accounted for in this summer assessment analyses. These are primarily battery storage resources that will have an NQC near to their nameplate capacity and should be more than sufficient to cover the 103 MW of shortfall.

2.3 Future Resource Mix based on CPUC's 2023 Preferred System Plan (PSP)

The CPUC Integrated Resource Plan (IRP) targets electric sector decarbonization to support statewide greenhouse gas (GHG) reduction efforts while maintaining system reliability. The CPUC aggregates each load serving entity's (LSE) IRP plans and combines these plans with model-selected capacity to develop a Preferred System Plan (PSP) portfolio. The CPUC adopted the 2023 PSP on February 15, 2024.[32] This portfolio targets reducing yearly GHG emissions from the electric sector to 25 million metric tons (MMT) by 2035. Previously, the CPUC adopted 38 MMT by 2030 planning target.[33]

Figure 2.4 shows cumulative buildout of planned new resources in the 2023 PSP, including those ordered in IRP procurement orders listed in Table 2.3 and a buildout of model-selected new candidate resources from the PSP portfolio. For 2024, the portfolio includes planned (and model-selected) capacity additions of over 7 GW, primarily 4-hour Lithium-ion batteries (4.3 GW) and solar (3 GW). About 2.2 GW of gas capacity is "not retained" in the portfolio, e.g. could be allowed to be retired, beginning in 2024.[34] By 2035, planned and selected capacity in the PSP increases to over 55 GW of clean energy resources, including 4.5 GW of offshore wind.

Table 2.6 shows PSP's total installed capacity by fuel type from 2024 through 2045. Total installed capacity includes baseline resources (existing and in development) as well as planned/new resources.

[32] CPUC, Decision adopting 2023 Preferred System Plan (D.24-02-047), Feb 15, 2024: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M525/K918/525918033.PDF

[33] CPUC, Decision adopting 2021 Preferred System Plan (D.22-02-004), Feb 10, 2022: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M451/K412/451412947.PDF

[34] CPUC, 2023 Preferred System Plan Proposed Decision, Modeling & Analysis, pp. 13, January 12, 2024: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2023-irp-cycle-events-and-materials/2024-01-12-presentation-summarizing-updated-servm-and-resolve-analysis.pdf

Figure 2.4 CPUC's 2023 PSP cumulative planned additions by fuel type (2024 – 2045)

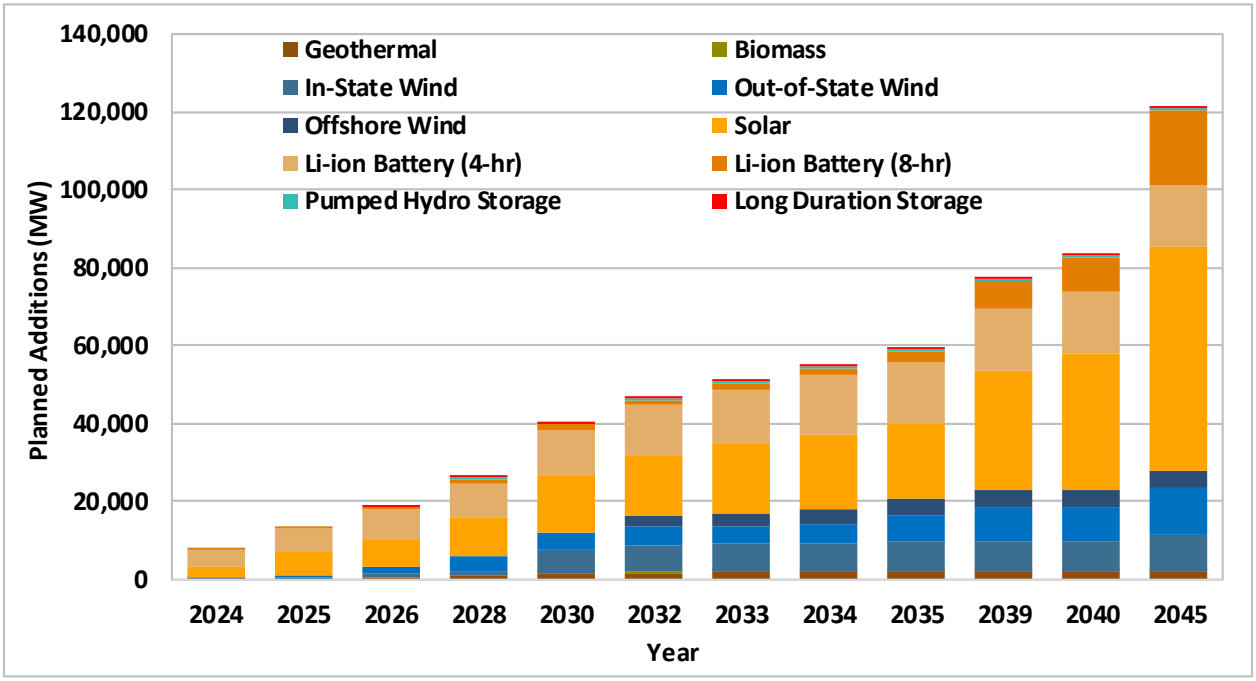


Table 2.6 CPUC's 2023 PSP total installed capacity by fuel type (2024 – 2045)[35]

Total Installed Capacity (MW) / Fuel Type	2024	2025	2026	2028	2030	2032	2033	2034	2035	2039	2040	2045
Coal	480	0	0	0	0	0	0	0	0	0	0	0
Natural Gas	23,744	23,700	23,300	23,300	23,300	23,300	23,300	23,300	23,300	23,300	23,300	19,400
CHP	1,925	1,900	1,900	1,900	1,900	1,600	1,400	1,200	1,000	200	0	0
Nuclear	2,935	600	600	600	600	600	600	600	600	600	600	600
Geothermal	1,303	1,300	2,100	2,500	2,900	3,200	3,300	3,400	3,400	3,400	3,400	3,400
Biomass	487	500	500	700	700	700	700	700	700	600	600	600
Biogas	217	200	200	200	200	200	200	200	200	200	200	200
Hydro	8,523	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500
In-State Wind	8,027	8,200	8,600	8,900	13,700	14,800	14,800	14,800	15,700	15,700	15,700	17,000
Out-of-State Wind	11	600	1,700	3,400	4,500	4,500	4,500	5,300	6,300	8,300	8,300	12,000
Offshore Wind	0	0	0	0	0	2,700	3,300	3,900	4,500	4,500	4,500	4,500
Solar	22,037	25,000	25,900	28,900	33,800	34,800	36,900	38,000	38,000	49,700	54,000	76,500
Li-ion Battery (4-hr)	12,894	15,200	17,000	18,000	20,500	21,600	23,000	23,900	24,700	24,700	24,700	24,700
Li-ion Battery (8-hr)	67	100	600	1,200	1,400	1,600	1,600	1,900	3,000	7,400	9,200	19,700
Pumped Hydro Storage	1,483	1,500	1,500	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Long Duration Storage	0	0	100	300	300	400	400	500	500	500	500	500
Shed DR	2,446	2,500	2,200	2,300	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400
Total	**86,579**	**89,800**	**94,700**	**102,700**	**116,700**	**122,900**	**126,900**	**130,600**	**134,800**	**152,000**	**157,900**	**192,000**

[35] PSP portfolio presented here does not include "Customer Solar" and "Li-ion Battery (BTM)" categories
Natural gas category does not include capacity contracted under the state's Strategic Reliability Reserve (SRR)
Natural gas category excludes 2.7 GW of capacity not retained due to economic reasons (2.2 GW for 2024 and 2025)
Diablo Canyon unit 1 retires on November 30, 2024 and unit 2 retires on August 26, 2025 (total capacity about 2300 MW)
Li-ion battery category includes Hybrid resource capacity

2.4 CEC's Near-Term Load Projections

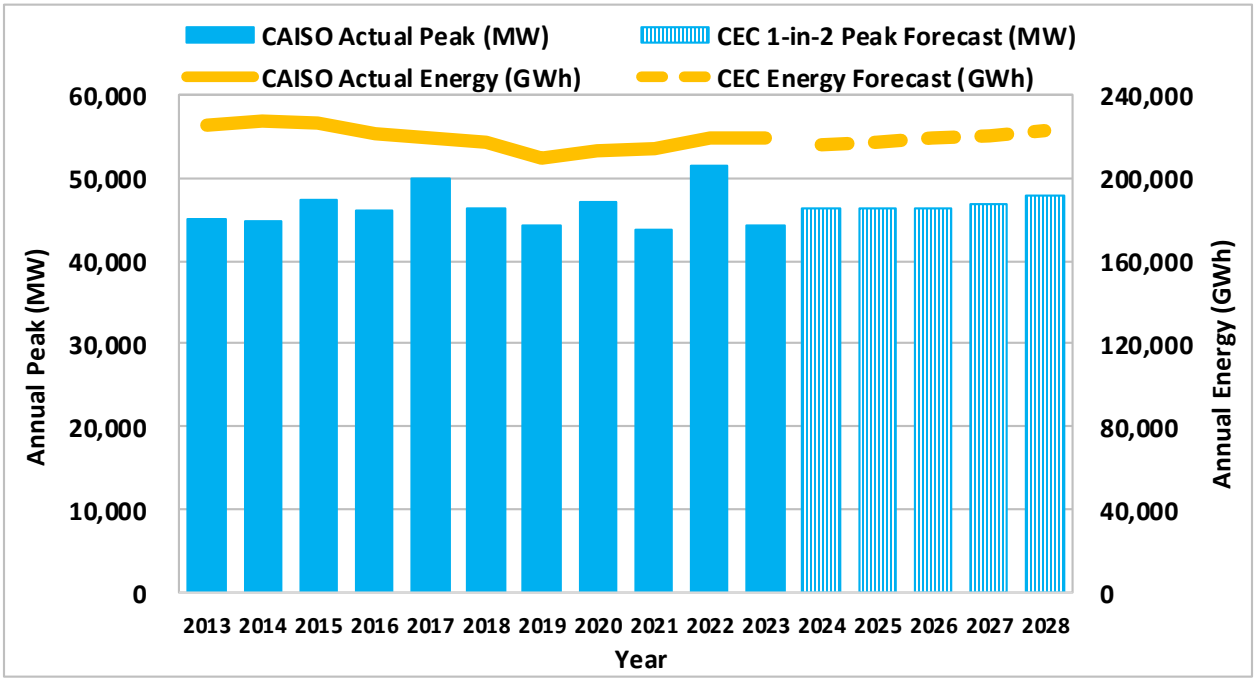
The CAISO's near-term load projections rely on the CEC's 2023 IEPR demand forecast, adopted in February 2024, using the managed load from 1-in-2 planning forecast. The planning forecast is used by the CAISO and state agencies for electricity system-level planning activities. It represents the CEC's estimates of baseline economic, demographic, and price scenarios, as well as "mid-level" impacts of energy efficiency, building electrification, and transportation electrification.[36] Table 2.7 shows 2024 summer monthly peak load forecasts for the CAISO BAA. The table shows that CEC forecasted peak load for 2024 occurs in July, which is about 272 MW higher than the forecasted load for September 2024.

Table 2.7 Monthly peak load forecast (May 2024 – October 2024)

Month	May	June	July	August	September	October
Monthly peak load forecast (MW)	34,346	41,902	46,244	45,059	45,972	36,984

Figure 2.5 shows that from 2013 to 2023, CAISO's actual annual peak demand fluctuated between 43,789 MW and 51,479 MW while its actual annual energy consumption varied from 209,429 GWh to 227,309 GWh. The figure also shows CEC's CAISO 1-in-2 peak demand forecast[37] of 46,244 MW in 2024 increases gradually by 3.3 percent to 47,770 MW in 2028. In addition, the CEC is also projecting CAISO's annual energy in 2024 to be 215,875 GWh with an increase to 222,698 GWh by 2028.

Figure 2.5 CAISO historical and projected annual peak load and energy (2013 – 2028)



[36] CEC, Adopted 2023 Integrated Energy Policy Report with Errata, Feb 14, 2024: https://efiling.energy.ca.gov/GetDocument.aspx?tn=254463

[37] A 1-in-2 forecast assumes there is a 50 percent probability that the forecasted peak will be less than actual peak load and a 50 percent probability that the forecasted peak will be greater than actual peak load.

3 Emergency Resources

For summer 2024, state emergency resource programs continue to grow. Supply accessible through the Electricity Supply Strategic Reliability Reserve Program (ESSRRP) and emergency assistance on the interties totals around 3,450 MW. The CEC and CPUC will provide estimates of state emergency demand response programs and other contingency resources in the CEC's California Reliability Outlook, to be published in May 2024. The CAISO details processes for operation of various emergency resources in the CAISO's Emergency Procedure 4420.[38]

Following the widespread heat events of 2020, the CAISO, the California Legislature, and state entities have taken several measures to ensure grid reliability under extreme events, beyond conventional planning standards. These measures and programs include pursuing and approving procurement of additional resources, retaining existing resources in service, and improving operational readiness and measures to access resources or load reductions when the risk of shortfalls exists. Beginning summer 2021, several emergency resource programs have also emerged, which provide grid support during system emergencies and extreme events. These programs include both conventional generation assets and voluntary load reduction programs administered by state agencies including the Department of Water Resources (DWR), the CPUC and the CEC. Many of these programs trigger based on various CAISO emergency notifications.

3.1 Strategic Reliability Reserve (SRR)

Extreme weather events and risks such as wildfire or severe drought remain a threat to grid reliability and can strain the grid for days or weeks. The Strategic Reliability Reserve (SRR) was developed in 2022 as part of Assembly Bill 205, to expand the resources capable of managing or reducing demand during extreme events. The SRR provides funding to secure additional resources to address extreme events beyond traditional resource planning targets. The SRR consists of three programs detailed below, two of which are administered by the CEC and one administered by the DWR.

Electricity Supply Strategic Reliability Reserve Program (ESSRRP)

DWR oversees the ESSRRP to provide additional generation during extreme events to support grid reliability in California BAAs. DWR also oversees the State Power Augmentation Program (SPAP) established in 2021, which includes of 120 MW of temporary emergency capacity. This includes 60 MW at the Roseville Energy Park in the BANC territory and another 60 MW at the Greenleaf 1 site in the CAISO BAA.

In August 2023, the State Water Board extended the once-through cooling (OTC) policy compliance dates for Alamitos, Huntington Beach, and Ormond Beach generating stations for three years from December 31, 2023, to December 31, 2026, contingent on these resources participating in the ESSRRP. These OTC resources represent about 2,859 MW of generating capacity through the end of 2026, which will help to maintain electric grid reliability during extreme events.

[38] CAISO Operating Procedure 4420, System Emergency: http://www.caiso.com/Documents/4420.pdf

The ESSRRP may also cover above-market costs of securing imported firm energy above RA capacity contracted through the CPUC's RA program.[39] Table 3.1 shows the list of resources in the ESSRRP and SPAP programs, which are projected to be available for summer 2024 operations.

Table 3.1 ESSRRP resources available for summer 2024

Resource Name	BAA	Max Capacity (MW)
Alamitos Gen Sta. Unit 3	CISO	326.8
Alamitos Gen Sta. Unit 4	CISO	334.4
Alamitos Gen Sta. Unit 5	CISO	480.0
Huntington Beach Gen Sta. Unit 2	CISO	226.8
Ormond Beach Gen Sta. Unit 1	CISO	741.3
Ormond Beach Gen Sta. Unit 2	CISO	750.0
Channel Islands Power	CISO	27.5
Greenleaf 1	CISO	60.0
Roseville Peakers TM2500	BANC	60.0
Enchanted Rock Lodi	CISO	48.0
Enchanted Rock Claribel	BANC	48.0
Enchanted Rock Marshall Unit 1	TIDC	11.7
Enchanted Rock Marshall Unit 2	TIDC	11.7
Enchanted Rock Marshall Unit 3	TIDC	11.7
Enchanted Rock Marshall Unit 4	TIDC	11.7
Total ESSRRP Capacity (MW)		**3,149.5**

Demand Side Grid Support (DSGS) Program

In 2022, California State Assembly Bills 205 and 209 established authorization and funding for the CEC to administer the Demand Side Grid Support Program (DSGS). This program aims to incentivize electric customers to provide load reduction and backup generation to support grid reliability during extreme events from May through October. The CEC launched the DSGS program in August 2022. DSGS customer response is voluntary – there are no penalties for non-participation and no requirements to reduce load by a particular amount during a DSGS event. DSGS events are triggered based on CAISO emergency notifications.

Distributed Electricity Backup Assets (DEBA) Program

In 2022, California State Assembly Bills 205 and 209 established authorization and funding for the CEC to administer the Distributed Electricity Backup Assets (DEBA) program. This program incentivizes the construction of clean and efficient distributed energy assets that serve as emergency supply or load reduction for the electric grid during extreme events. The DEBA program is a statewide program, intended to procure clean and efficient distributed energy assets that will serve as on-call emergency supply or load reduction during extreme events. The CEC adopted the first edition of DEBA program guidelines in October 2023 and issued a first round of bulk grid DEBA awards in June 2024.

[39] Electricity Supply Reliability Reserve Fund Progress Report, pg.13, December 2023: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Electricity-Supply-and-Strategic-Reserve-Office/202312-ESRRFJLBC-Progress-ReportFINAL.pdf

3.2 Emergency Load Reduction Program (ELRP)

The CPUC established the Emergency Load Reduction Program in 2021. ELRP is a five-year demand response pilot program. In 2021, the ELRP program was limited to commercial customer participation. Starting 2022, the CPUC expanded the ELRP to residential customers. The ELRP is managed by the state's three investor-owned utilities (IOUs) – PG&E, SCE, and SDG&E and is a voluntary demand response program designed to compensate customers for reducing energy consumption in the summer months (May-October) during a grid emergency. ELRP customer response is voluntary – there are no penalties for non-participation and no requirements to reduce load by a particular amount during an ELRP event. ELRP events are triggered by CAISO's emergency notifications or in some cases, a CAISO-issued Flex Alert. The CEC and CPUC will provide estimates of ELRP and other contingency resources in the CEC's California Reliability Outlook, to be published in May 2024.

3.3 Emergency Assistance on the Interties

The CAISO is authorized to take actions during system emergencies whether to receive or provide emergency assistance on the interties in the real-time market.[40] Imports coming from emergency assistance reflect energy imported from neighboring BAAs with whom the CAISO has contractual agreements during emergency conditions. For summer of 2024, the CAISO projects about 300 MW of emergency assistance available on the interties.

3.4 Thermal resources generating beyond limits

In advance or during a system emergency, the CAISO can dispatch additional capacity above the net MW allowed at a point of interconnection (POI). This additional capacity is projected to be around 40 MW for the summer 2024. In addition, a Department of Energy 202c order may allow resources to operate at their maximum generation levels and produce beyond permitted limits in emergency conditions.

3.5 NERC Energy Emergency Alert Designations

Historically, the CAISO has used Alerts, Warnings, and Emergencies (AWE) notifications to signal activation of system emergency procedures. Effective May 1, 2022, the CAISO changed its messaging system to align with NERC's Energy Emergency Alert (EEA) designations. There are three (3) levels of EEAs and CAISO may progress through these in any order if system conditions warrant. In addition, the CAISO made this change to align its emergency levels with Reliability Coordinators and neighboring BAA (procedures, and to ensure that everyone is using consistent terminology during supply shortages. Table 3.2 outlines the notification and emergency levels the CAISO currently uses.

[40] CAISO Operating Procedure 4410, Emergency Assistance: http://www.caiso.com/Documents/4410.pdf

Table 3.2 CAISO balancing authority area emergency notifications

Emergency Declarations	Circumstances
CAISO BAA Declarations	
Flex Alert	A Flex Alert is a call to consumers to voluntarily conserve electricity when the CAISO anticipates energy supply may not meet high electricity demand.
Restricted Maintenance Operations (RMO)	When high demand is anticipated, the CAISO will caution utilities and transmission operators to avoid taking grid assets offline for routine maintenance to assure that all generators and transmission lines are available.
Transmission Emergency	Declared by CAISO for any event threatening or limiting transmission grid capability, including line or equipment overloads or outages.
CAISO/RC West Declarations	
EEA Watch	Analysis shows all available resources are committed or forecasted to be in use, and energy deficiencies are expected. Market participants are encouraged to offer supplemental energy. Consumers are encouraged to conserve energy. This notice can be issued the day before the projected shortfall or if a sudden event occurs.
EEA 1 (All available generation resources in use)	Real-time analysis shows all resources are in use or committed for use, and energy deficiencies are expected. Market participants are encouraged to offer supplemental energy and ancillary service bids. Consumers are encouraged to conserve energy.
EEA 2 (Load management procedures in effect)	CAISO requests emergency energy from all resources and has activated its emergency demand response programs. Consumers are urged to conserve energy to help preserve grid reliability.
EEA 3 (Using load as reserves)	CAISO is unable to meet minimum contingency reserve requirements and has asked utilities to prepare for the possibility of rotating power outages.
EEA 3 (Firm load interruption)	Energy supply is insufficient to meet demand, and utilities have been directed to initiate rotating power outages.

4 Weather Outlook

For the months of June through August 2024, forecasts show the probability of above normal temperatures across the Western U.S. With the highest probabilistic chances of above normal temperatures across the Desert Southwest, and lower chances of above normal temperatures in coastal locations, especially coastal Southern California. In August and September of 2024, we continue to see an increased chance of above normal temperatures across the Desert Southwest. In addition, different temperature forecast models show a risk of above normal temperatures across the Pacific Northwest.

Weather such as temperatures, cloud cover, and precipitation impact the variables affecting market and system operations, including hydro production, renewable production, and load levels. During summer, temperature is a key driver of load conditions, especially when there are extreme and widespread heat events. Meteorologists utilize a variety of tools and data, including large-scale weather trends and teleconnections, sea-surface temperatures, the El Nino Southern Oscillation (ENSO), and historical temperature and precipitation data to create a seasonal forecast of what the upcoming season could bring.

The Climate Prediction Center, a branch of the National Oceanic and Atmospheric Association (NOAA), produces various temperature and precipitation outlooks indicating potential temperature and precipitation trends for the next year. These are three-month average temperature and precipitation outlooks that take into consideration the tools and data described above. For summer 2024, this includes the months of June, July and August.

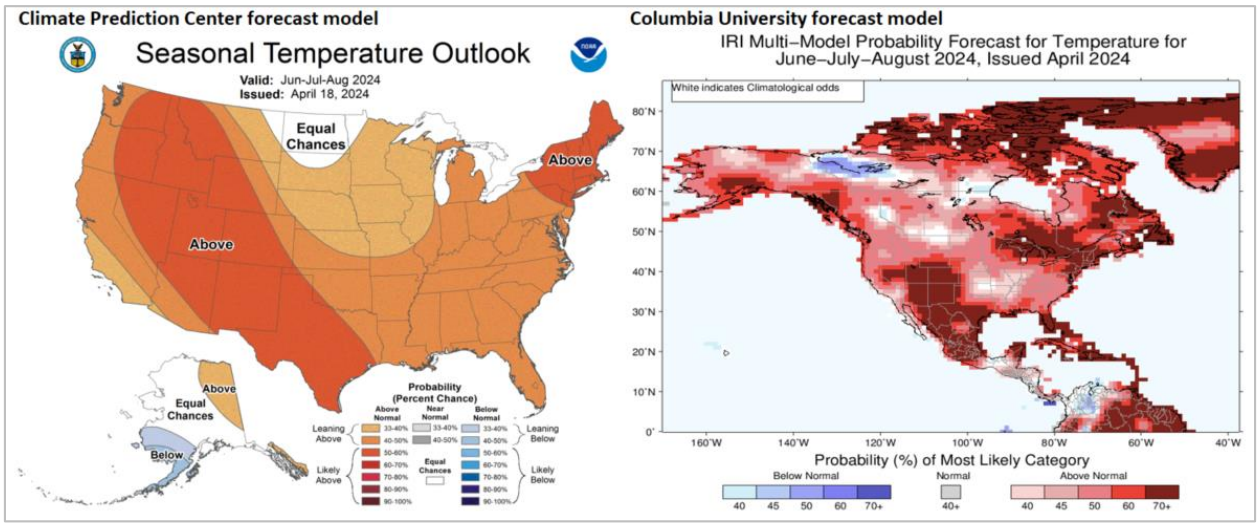
The Columbia Climate School at Columbia University International Research Institute (IRI) also runs a model that is utilized in seasonal forecasting. The IRI model also uses multiple inputs, including a calibrated output of forecast information output by NOAA, Environment and Climate Change Canada as well as NASA. Temperature and precipitation outlooks produced are also a three-month average.

Temperature Outlook

Figure 4.1 shows the percent chance across the United States that temperatures will be above or below normal for the three-month average period of June, July, and August 2024 based on two forecast models from the Climate Prediction Center and Columbia University. Areas of white indicate equal chances for above or below normal temperatures for that area in the Climate Prediction Center forecast model shown on the left. Across California, the Climate Prediction Center is forecasting varying degrees of probability of above normal temperatures. The southwest section of the state has the lowest chances for above normal temperatures. Areas further north and east have higher chances for above normal temperatures. The latest seasonal weather models suggest that the summer could start cooler in June and July, especially for coastal areas due to increased marine air presence. An area of monitoring is the late summer into fall season; we see continued chances of above normal temperatures in the Desert Southwest, with chances for interior California to also see above normal temperatures.

The greatest uncertainty with the Climate Prediction Center forecast is the potential for California temperatures, particularly along the coast, to experience on average, a near-normal summer. This is due to potential for the summer weather feature that is known for bringing extreme temperatures remaining primarily over the Desert Southwest. As a result, California could see a better chance for a more influence of the cooler marine air. This potential is reflected in Columbia University's IRI model shown on the right in Figure 4.1.

Figure 4.1 Temperature outlook for June, July and August issued by the Climate Prediction Center[41] (left) and Columbia University[42] (right)



Both forecast sources agree that the area of the Desert Southwest, Western and Southern Texas and the Four Corners area have the highest chance for above normal temperatures. This could mean more frequent heat events, longer duration heat events, more extreme heat events, or any combination, as all could lead to the temperatures for a region coming in above normal for a period. The forecast from the Climate Prediction Center shows a slightly higher chance for above normal temperatures to be more widespread for the Pacific Northwest compared to the IRI model; however, both do show these areas have risk to be above normal.

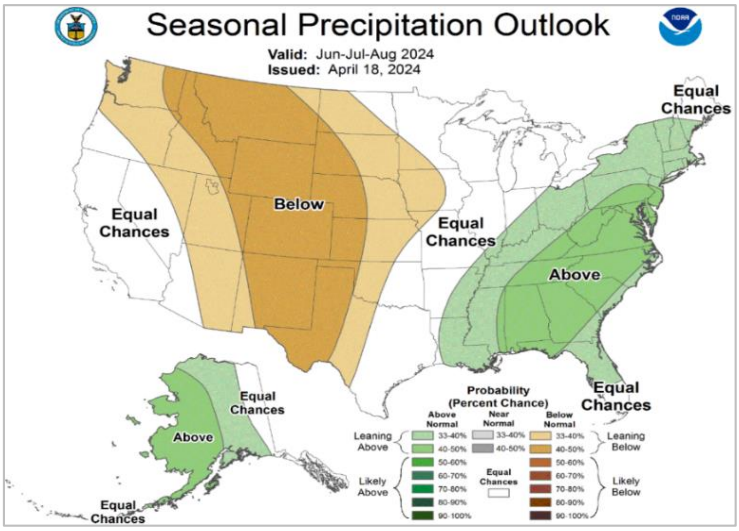
Precipitation Outlook

Similar to temperature, precipitation outlooks are also issued to indicate the probability of above or below normal precipitation across an area for a three-month period. Figure 4.2 shows the precipitation outlook for June, July and August 2024. Historically, much of California receives very little rainfall during the months of June through September. The exception is parts of southeastern deserts, which can receive some rainfall due to the North American monsoon. Equal chances for above or below precipitation for California indicate that there are no strong climate signals for above average summer rainfall. However, as observed with Hurricane Hilary in 2023 and the remnants of Hurricane Kay in 2020, it is possible for impacts from tropical systems to bring rainfall across the region during usually dry summer months.

[41] NOAA's Climate Prediction Center three-month temperature outlook as of April 18, 2024: https://origin.cpc.ncep.noaa.gov/products/predictions/long_range/seasonal.php?lead=3

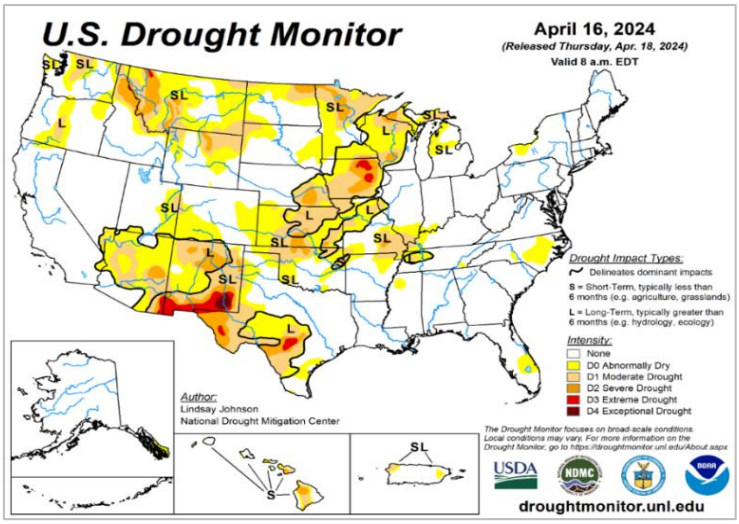
[42] Columbia University's Climate School three-month temperature outlook, Issued April 2024: https://iri.columbia.edu/our-expertise/climate/forecasts/seasonal-climate-forecasts/

Figure 4.2 The precipitation outlook for June, July and August issued by the Climate Prediction Center[43]



Across most of the Desert Southwest and through the interior Pacific Northwest, there is potential for below normal rainfall from the typical summer monsoon. Many of the areas expected to receive below normal precipitation for the summer months are already experiencing drought, as seen in Figure 4.3. As a result, the drought for these areas will likely worsen which could contribute to the risk for above normal temperatures.

Figure 4.3 The areas of current drought across the United States as of April 16, 2024[44]



[43] NOAA's Climate Prediction Center three-month temperature outlook as of April 18, 2024: https://origin.cpc.ncep.noaa.gov/products/predictions/long_range/seasonal.php?lead=3

[44] U.S. Drought Monitor as of April 16, 2024: https://droughtmonitor.unl.edu/Maps/MapArchive.aspx

5 Preparation for Summer Operations

Preparing and publishing the Summer Assessment report and sharing the results with industry participants and stakeholders is one of many activities the CAISO undertakes each year to prepare for summer system operations. These include fine-tuning market and operational metrics to ensure the effectiveness of the planned resource fleet in times of system stress, and enhancing operational coordination with state agencies and the industry overall to access contingency reserves should the system face the risk of shortfalls due to more extreme events.

As noted, the CAISO, state entities, and stakeholders have employed a number of contingency measures to continue to improve system preparedness and performance. These have included pursuing and approving procurement of additional resources, with a significant amount going into operation over the past year; ensuring existing resources are retained in service; and improving operational coordination around resources or load reductions accessible under stressed grid conditions. The CAISO processes for operation of various emergency resources are detailed in the Emergency Procedure 4420.[45] The CAISO developed a public Extreme Weather Process and Communications document, which provides detail on CAISO timelines for operational coordination and communication channels for CAISO emergency notices, which trigger the use of various emergency resources.[46]

Other activities include coordinating meetings on summer preparedness with the WECC, California Department of Forestry and Fire Protection (Cal Fire), natural gas providers, transmission operators and neighboring BAs. For 2024, the CAISO will continue to engage the appropriate entities in a tabletop exercise simulating stressed grid conditions. The CAISO's ongoing coordination with these entities helps ensure that everyone is prepared for the upcoming summer operational season.

[45] CAISO Operating Procedure 4420, System Emergency: https://www.caiso.com/Documents/4420.pdf

[46] CAISO, Extreme Weather Event — Process And Communications: http://www.caiso.com/Documents/extreme-weather-event-process-and-communications.pdf