



Resource Adequacy Primer

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Acronyms

BA	Balancing Authority
CAISO	California Independent System Operator
CCA	Community Choice Aggregator
CEC	California Energy Commission
CMUA	California Municipal Utilities Association
COD	Commercial Operations Date
CPUC	California Public Utilities Commission
DER	Distributed Energy Resource
EDAM	Extended Day-Ahead Market
EFC	Effective Flexible Capacity
ELCC	Effective Load Carrying Capacity
IOU	Investor-Owned Utility
IR	Interconnection Request
KW	Kilowatt
LRA	Local Regulatory Authority
LSE	Load-Serving Entity
MW	Megawatt
NQC	Net Qualifying Capacity
POU	Publicly Owned Utility
PRM	Planning Reserve Margin
QC	Qualifying Capacity
RA	Resource Adequacy
RPS	Renewable Portfolio Standard
SMUD	Sacramento Municipal Utility District
SOD	Slice of Day Framework
WEIM	Western Energy Imbalance Market

Executive Summary

California's electricity system is undergoing a transformative shift as it balances the urgent need for decarbonization with the fundamental requirement of grid reliability. Resource Adequacy (RA), the framework that ensures enough capacity is available to meet electricity demand, especially during peak periods, is both a critical planning tool for utilities and a key revenue stream for new electricity generation projects. This primer aims to educate stakeholders—including load-serving entities, state policymakers, and project developers—on the evolving RA landscape, broader energy market conditions, and the implications for solar canal projects.

The Role of Resource Adequacy in Grid Reliability and Project Finance

RA functions as the grid's "insurance policy," ensuring that sufficient generation resources are available to meet electricity demand. Each month, load-serving entities (LSEs) must meet regulatory requirements by securing bilateral contracts with independent power producers and building generation capacity, like solar+battery projects. Contracted and self-generated capacity must be equivalent to LSEs' forecasted peak demand, plus a planning reserve margin. RA contracts can provide important financial support for renewable energy projects, including solar canals.

Emerging Challenges in RA Procurement

California LSEs face multiple headwinds in the procurement of resource adequacy:

- Increasing electrification of buildings and transportation, combined with demand from data centers, drives up load and RA requirements.
- The retirement of fossil fuel plants reduces available RA capacity.
- The intermittency of clean energy resources can lead to reliability gaps.
- Interconnection delays can prevent new projects from coming online quickly.

These trends are fueling a highly competitive and expensive RA market, with prices rising sharply, especially during the summer months.

Regulatory Reforms and the Shift to "Slice of Day"

To adapt to evolving grid dynamics, the California Public Utilities Commission (CPUC) started implementing the Slice of Day (SOD) methodology in 2025. SOD requires LSEs to meet hourly capacity needs on the grid's highest demand day of each month.¹ As a result, solar-only resources, which cannot provide energy during nighttime, are valued less for

¹ "2025 Resource Adequacy and Slice of Day Guide" (California Public Utilities Commission, September 25, 2024),

<https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/resource-adequacy-homepage/resource-adequacy-compliance-materials/guides-and-resources/2025-ra-slice-of-day-filing-guide.pdf>.

RA compared to dispatchable resources like solar-plus-storage that can discharge during evening peak demand periods. This regulation is reshaping RA market dynamics and favors dispatchable generation technologies.

Impacts on Publicly Owned Utilities (POUs)

RA planning for POU is less centralized and varies by jurisdiction. While POU within the CAISO balancing authority must follow certain reporting obligations to ensure a functional grid, their local regulatory authorities (e.g. city council) determine specific RA requirements. Recent legislation, such as **AB 209 and AB 1373**, has pushed POU toward more standardized RA obligations and introduced penalties for non-compliance. This requires smaller load-serving entities (municipal utilities, irrigation districts) to navigate tight RA markets and rising costs while balancing affordability and clean energy goals.

Resource Adequacy Price Trends

RA prices have more than doubled over the past decade, with even sharper increases for Community Choice Aggregators (CCAs) and POU. In 2022, the CPUC reported that average system RA prices reached \$7,680/MW-month.² However, the CPUC noted 82 instances of LSEs paying over \$100/KW-month, or \$100,000/MW-month for RA between 2023 and 2024.³ This sharp escalation reflects a constrained capacity market and limited availability of dispatchable resources, particularly during peak periods.

Opportunities and Innovation: Solar Canals and Storage

As LSEs seek clean, dispatchable resources to satisfy reliability standards, solar canal projects present a promising solution. These projects, paired with storage, can provide system-wide and local resource adequacy capacity. A five-megawatt utility-scale solar-only system could have an average annual RA value of ~\$70,000.⁴ However, their success hinges on navigating **complex RA eligibility rules, interconnection timelines, and market volatility.**

Bottom Line

California's RA framework is undergoing rapid change to keep pace with its clean energy goals and growing electricity needs. While these shifts create uncertainty, they also present strategic opportunities for innovative projects like solar canals. Understanding

² Sasha Cole et al., "2022 Resource Adequacy Report" (California Public Utilities Commission, May 2024), https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/resource-adequacy-homepage/2022-ra-report_05022024.pdf.²⁰

³ Haley Weinstein, "Creating a Pathway for Front-of-Meter Distributed Resource Adequacy to Fix California's Stunted Capacity Market," Clean Coalition, March 29, 2025, <https://clean-coalition.org/news/creating-a-pathway-for-front-of-meter-distributed-resource-adequacy-to-fix-californias-stunted-capacity-market/creat>

⁴ Sasha Cole et al., "2022 Resource Adequacy Report."

and adapting to the evolving RA landscape will be essential for developers, utilities, and policymakers alike.

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1. Introduction: What is Resource Adequacy?

Resource Adequacy (RA) is a reliability planning framework that refers to the electricity system's ability to reliably meet energy demand, particularly during times of peak load. The California Independent System Operator (CAISO) describes RA as an "insurance policy" for the grid, ensuring that sufficient capacity is available to meet forecasted energy demand.⁵ RA also supports the financial stability of energy projects, including solar canals.

Under California's RA framework, load-serving entities (LSEs) must contract, or self-supply, enough generation capacity to serve their projected load plus an extra "reserve" margin (since actual electricity demand may be higher than forecasted). Generators providing RA make bilateral contracts with LSEs to have a certain amount of energy available (capacity) at specified times and to "bid" (make an offer to sell electricity at a certain price) into the electricity market at those times. The price that a generator is paid to provide RA capacity, or be available to deliver electricity, is referred to as RA value or capacity value. RA is a key revenue stream for project financing beyond the sale of energy, enabling project developers and owners to cover capital and operating costs. Each LSE in California must procure RA capacity to meet regulatory requirements or reliability standards issued by the grid operator (CAISO in most cases), and they can face penalties if they don't procure enough. LSEs require a balanced portfolio of resources to maintain a reliable grid.

However, it has become increasingly challenging for LSEs to meet their RA requirements at affordable prices. Several evolving conditions have made RA procurement in California increasingly constrained and expensive.

- 1) **The demand for clean energy resources is high.** Each load-serving entity faces increasing Renewable Portfolio Standards (RPS) due to SB 100, which requires load-serving entities to meet 100% renewable energy sales by 2045. This means that, today, LSEs are mainly seeking to add clean energy resources to their portfolio.
- 2) **Renewables alone are not enough.** Rooftop solar and other forms of distributed clean energy have propelled solar production in California to reach record-high levels. However, without sufficient energy storage like lithium-ion batteries, intermittent clean energy resources like solar contribute little to grid reliability during peak periods. In fact, solar is being curtailed (shut off from entering the grid) during daytime hours when production is higher than the grid can use or store.⁶ When solar is combined with storage, the systems can meet power demand during evening peak hours after the solar production decreases, with the batteries storing clean energy fully discharged in the evening (typically 6-9pm). Consequently, LSEs

⁵ CAISO, "Resource Adequacy," Computer-based training, March 28, 2024, <https://www.caiso.com/content/cbt/resource-adequacy/story.html>.

⁶ "Managing the Evolving Grid | California ISO," accessed April 11, 2025, <https://www.caiso.com/about/our-business/managing-the-evolving-grid>.

are seeking clean and dispatchable (easily turned on and off) resources, like combined solar and storage projects, to ensure grid reliability during peak hours. This will be increasingly important as fossil generation is gradually phased out in the 2030s and 2040s. Today, the grid still relies on gas-fired generation to meet demand at night, early morning, and during some peak demand hours.

- 3) **Load growth increases RA requirements.** Continued electrification of transportation and buildings, plus the proliferation of power-hungry data centers, are contributing to electricity demand growth in California. As electricity needs rise, RA requirements increase accordingly. As a result, LSEs are faced with procuring more energy in the short term to meet their RA requirements. This has increased competition for RA contracts, driving up prices, particularly during the summer when demand is highest.
- 4) **Plant retirements are reducing available RA capacity.** As California moves to a cleaner grid and operating costs rise, gas plants are being retired in the state, and imported coal-fired power is being phased out. Retiring these polluting facilities benefits the health of local communities and reduces greenhouse gas emissions. However, these fossil resources provide “baseload” capacity, contributing to grid reliability at all hours, which LSEs must replace with RA in the form of zero-emission renewables and storage.
- 5) **Interconnection delays slow new RA capacity from coming online.** As of December 2023, CAISO had 995 energy projects in the interconnection queue, totaling 523.3 GW of capacity. The average project takes 5 years to complete from the interconnection request (IR) to the commercial operations date (COD). An estimated 70% of projects withdraw during the interconnection process.^{7 8}

This paper examines these evolving conditions and the implications for solar canal developers and other stakeholders.

Box 1. Considerations for Solar Canal Projects

Load-serving entities typically look at utility-scale projects for RA capacity because current CAISO market rules make it challenging for distributed energy resources (DERs) to be eligible.⁹ Due to solar canal projects’ unique characteristics as linear generation resources, they have the flexibility to interconnect and provide electricity to different load-serving entities and balancing

⁷ Joseph Rand et al., “Characteristics of Power Plants Seeking Transmission Interconnection As of the End of 2023,” n.d.

⁸ CAISO reforms, approved by FERC in September 2024, seek to reduce these timelines by prioritizing projects based on commercial interest, project viability, and system need. “FERC Approves CAISO Interconnection Reform Plan | Utility Dive,” accessed April 14, 2025, <https://www.utilitydive.com/news/ferc-california-caiso-interconnection-reform-plan/728633/>.

⁹ Justin Gundlach and Romany Webb, “Distributed Energy Resource Participation in Wholesale Markets: Lessons from the California ISO” 39 (2018), <https://climate.law.columbia.edu/sites/default/files/content/docs/others/Gundlach-and-Webb-2018-05-DE R-in-Wholesale-Markets.pdf>.

authorities. This can be an advantage for solar canal projects compared to location-fixed generation projects.

While many energy projects use RA eligibility to secure project financing contracts, projects can still proceed without RA eligibility. For instance, developers can monetize tax credits and energy generation through behind-the-meter energy contracts or energy-only agreements to finance projects. Still, RA can be an important portion of project financing.

2. Evolving Resource Adequacy Regulations for Investor-Owned Utilities and Community Choice Aggregators

Resource Adequacy (RA) requirements in California were established in the aftermath of the state's energy crisis in the early 2000s.¹⁰ The crisis underscored the need for a reliable and predictable supply of electricity and resulted in California ending the deregulation of energy markets. Under the new reliability framework, utilities were required to procure necessary generation resources to meet demand. Over time, these requirements have evolved to account for the growing adoption of variable renewable resources, as well as emerging challenges such as the risk of rolling blackouts from climate-driven extreme weather events and load growth from electrification and data centers.

In response to these challenges, particularly the rolling blackouts experienced in 2021, the California Public Utilities Commission (CPUC) launched a multiyear reform process to address the evolving needs of the state's energy system. This process culminated in the development of the **Slice of Day** (SOD) framework, which represents a significant shift in how resource adequacy is planned and accounted for in California. Finalized in 2023, SOD is being implemented and enforced for the first time in 2025 after being piloted in 2024. The goal of the framework is to ensure that LSEs under the CPUC's jurisdiction (e.g. investor-owned utilities, community choice aggregators) procure enough capacity to meet energy demand for every hour on the system's worst day each month (i.e. day with the highest forecast peak load) plus a planning reserve margin (PRM) of 17%.¹¹

Under this new framework, solar-only (and other intermittent) resources are expected to have little RA value due to the CPUC shifting from using "effective load-carrying capacity" to an "exceedance" methodology to calculate a resource's qualifying capacity. **Qualifying capacity** is the amount of a resource's capacity that is eligible to count towards meeting RA requirements every month.¹² Box 2 describes these two methodologies in more detail.

¹⁰ "Fixing California's Resource Adequacy Woes | Utility Dive," accessed October 23, 2024, <https://www.utilitydive.com/news/california-resource-adequacy-puc-caiso-Kahrl/631720/>.

¹¹ "2025 Resource Adequacy and Slice of Day Guide."

¹² "2025 Resource Adequacy and Slice of Day Guide."

Compared to solar-only resources, dispatchable resources like solar+storage are valued higher due to their contribution to grid reliability at net peak hours. For example, in the SOD framework, the contribution of energy storage resources to the RA market is no longer capped. Further, LSEs can count multiple battery cycles toward their RA requirements.¹³ However, under the new framework, charging must be considered when determining a storage asset's RA value. Thus, LSEs using storage resources must have sufficient hourly capacity to meet batteries' charging needs and efficiency losses. These factors favor market conditions for solar and storage resources.¹⁴

Looking ahead, the CAISO's forthcoming **Extended Day-Ahead Market (EDAM)** will also impact the evolving RA landscape. Scheduled for implementation in 2026, EDAM will build on the success of CAISO's Western Energy Imbalance Market (WEIM) by improving reliability, reducing costs, and increasing the environmental benefits of the interconnected grid.¹⁵ The EDAM is expected to stabilize RA prices as more suppliers enter the market.

Box 2: Qualifying Capacity Methodologies

Local regulatory authorities (LRAs), such as the CPUC, determine rules for calculating qualifying capacity (QC), or how different energy technologies (and non-energy technologies like demand response) are eligible to provide resource adequacy capacity. LRAs must submit QC values for different resources to the CAISO, which adjusts the QC to determine a monthly Net Qualifying Capacity (NQC) value for each resource after testing its deliverability, or ability to deliver output to the system load at peak demand. The NQC value is crucial because resources must either be fully or partially deliverable to count towards RA requirements.¹⁶ The assigned NQC ultimately determines how the resource is counted toward an LSE's RA requirements.

Effective load-carrying capacity (ELCC) is a common resource-counting methodology representing a resource's ability to generate energy when the grid is likely to face electricity shortfalls. For example, a 10 MW wind plant with an ELCC of 20% should contribute 2 MW towards grid reliability. However, ELCC is dependent on the amount of

¹³ "SLICE IT UP: CALIFORNIA's Slice-of-Day RA Approach and Impact on Energy Storage," accessed December 20, 2024,

<https://www.tyba.ai//blog/slice-it-up-caisos-slice-of-day-ra-approach-and-impact-on-energy-storage>.

¹⁴ "2025 Resource Adequacy and Slice of Day Guide."

¹⁵ "Extended Day-Ahead Market Fact Sheet" (California ISO, November 2024),

<https://www.caiso.com/documents/extended-day-ahead-market-edam-fact-sheet.pdf>.

¹⁶ Resource Adequacy Modeling and Program Design Working Group, "CAISO RA Processes and CPUC's Slice of Day" (California ISO, January 2024),

<https://stakeholdercenter.caiso.com/InitiativeDocuments/White-Paper-ResourceAdequacyProcesses-CPU C-Slice-of-Day-Jan09-2024.pdf>.

a resource on the grid (i.e. marginal value), so in high-renewable portfolios, increasing amounts of variable generation resources may contribute little to grid reliability.¹⁷

The CPUC—the main LRA with jurisdiction over IOUs and CCAs—has used both ELCC and exceedance methodologies over the years. The SOD framework returns to using exceedance, which is a statistical approach for calculating the expected generation from a resource for a certain percentage of time. For example, a 75% exceedance profile represents how much solar output can be expected on each hour of the day on 75% of days in a month.¹⁸ The CPUC uses historical CAISO meter settlement data, which measures actual resource production, as a basis for calculating exceedance for solar and wind technologies.¹⁹ Under the exceedance methodology, solar’s contribution is 0 during evening hours. LSEs had to replace this capacity in their RA showings when SOD was implemented (e.g. 1,460 MW in the September 2023 supply stack during net peak hours had to be replaced, as calculated by CalCCA.)²⁰ Ultimately, the shift to SOD lowers the value of solar-only resources, especially as these resources are increasingly being curtailed in the afternoon hours.

Types of Resource Adequacy

All load-serving entities in the CAISO balancing authority must meet their assigned System, Local, and Flexible RA requirements. Each of these categories plays a critical role in ensuring that the grid has the necessary resources to meet demand under varying conditions.

Table 1: Comparison of Resource Adequacy Types

Type	What is it?	Who sets the rules?	How are requirements determined?	When is it measured ?	How is it measured?
System	Resources that will be available to meet	California Energy	CEC's Coincident Peak Forecast	Monthly and	Net Qualifying

¹⁷ “ELCC Explained: The Critical Renewable Energy Concept You’ve Never Heard Of,” The Equation, October 12, 2020,

<https://blog.ucsusa.org/mark-specht/elcc-explained-the-critical-renewable-energy-concept-youve-never-heard-of/>.

¹⁸ NP Energy, “Renewables and Exceedance – A Primer,”

https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/resource-adequacy-homepage/ra_t3b2_workshop-1_presentation-np.pdf.

¹⁹ “California’s Resource Adequacy Reforms Are Here,” accessed November 27, 2024,

<https://www.orrick.com/en/Insights/2024/07/Californias-Resource-Adequacy-Reforms-Are-Here>.

²⁰ “California’s Constrained Resource Adequacy Market: Ratepayers Left Standing in a Game of Musical Chairs” (CalCCA, January 16, 2024),

https://cal-cca.org/wp-content/uploads/2024/02/CalCCA-Stack-Analysis-2023-2026-updated-01_16_24-pdf.

	CAISO demand when needed to meet system needs.	Commission (CEC) and Local Regulatory Authorities (LRAs)	(1-in-2 forecast), which represents the peak demand forecast with a 50% probability of being exceeded, and a specified Planning Reserve Margin (PRM).	annually	Capacity (NQC)
Local	Resources located in local reliability areas with insufficient transmission to meet demand in the event of certain outages.	CAISO	CAISO study using the 1-in-10 CEC forecast, which represents a severe weather scenario.	Annually	Net Qualifying Capacity (NQC)
Flexible	Resources that can rapidly ramp up or down to accommodate variations in load and intermittent energy generation.	CAISO	Based on the 1-in-2 CEC hourly forecast, which considers the largest three-hour ramp for each month to ensure system reliability.	Monthly	Effective Flexible Capacity (EFC)

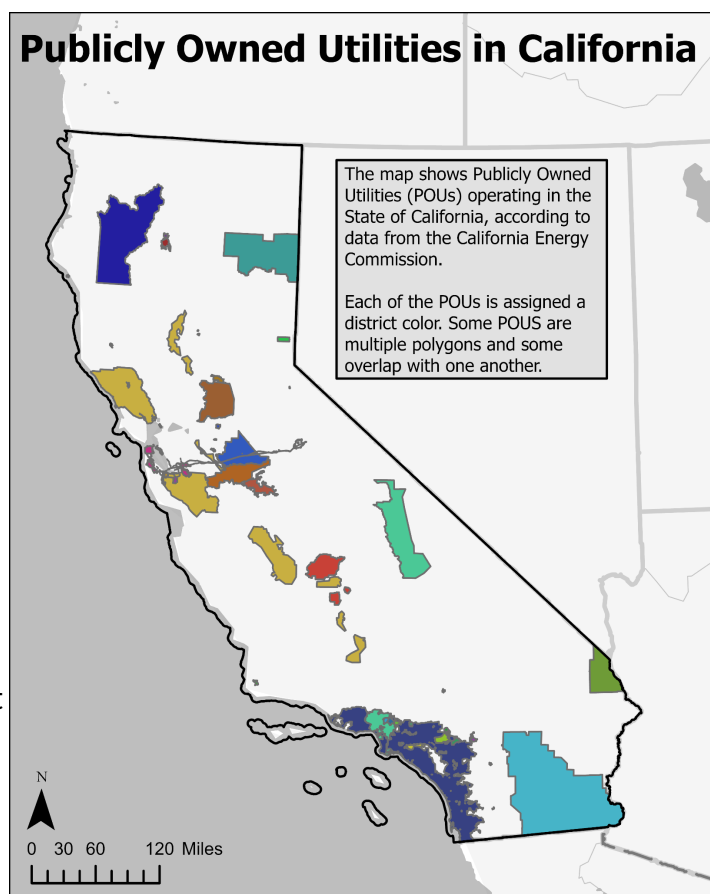
3. Resource Adequacy Requirements for Publicly Owned Utilities

Compared to investor-owned utilities, resource adequacy requirements for publicly-owned utilities are much more decentralized. POUs are regulated by their local regulatory authority (LRA), which can range from the local city council to a board, so their resource adequacy obligations and planning frameworks vary. In contrast, the CPUC serves as the LRA for Investor-Owned Utilities (IOUs) and CCAs. The LRA is responsible for developing resource-counting methodologies and setting the required Planning Resource Margins (PRMs) for their jurisdictions.

Figure 1. Map of Publicly Owned Utilities in California

While POUs in CAISO's balancing authority are required to follow CAISO's reporting obligations, they can either design their own resource adequacy programs or default to the CAISO framework (see Appendix). POUs outside the CAISO balancing authority (BA), such as the Los Angeles Department of Water and Power and Sacramento Municipal Utilities District, must follow their BA's reliability standards.

When making procurement decisions to meet resource adequacy requirements, POUs are under pressure to balance affordability for their customers with the need to meet the state's renewable portfolio standard under SB 100. SB 100 requires renewable energy and zero-carbon resources to supply 100% of electric retail sales by 2045,



Created by Max Dunsker using CEC data

and LSEs must transition their energy portfolios to be progressively cleaner until then.²¹ Procuring dispatchable clean resources is the newest hurdle for POUs.²²

Additional legislative developments aim to strengthen energy reliability for publicly owned utilities. **AB 209** from the 2021-2022 legislative cycle directed the California Energy Commission (CEC), with support from the CPUC, to release recommendations for POUs within the CAISO balancing authority to develop minimum PRMs. The final recommendations, released in the CEC's 2024 California Energy Resource and Reliability Outlook, outline a modeling approach for POUs to estimate a minimum planning reserve margin. The recommendations note that utilities reliant on a small number of generators may see higher PRMs and, therefore, need to phase in the implementation of a higher PRM over time to control rate increases in the face of a highly constrained short-term RA

²¹ California Energy Commission, "SB 100 Joint Agency Report" (California Energy Commission, current-date), 100, <https://www.energy.ca.gov/sb100>.

²² "SMUD Unveils First Large Utility-Scale Battery Storage," accessed February 5, 2025, <https://www.smud.org/Corporate/About-us/News-and-Media/2022/2022/SMUD-unveils-first-large-utility-scale-battery-storage>.

market.²³ Yet, during public comment periods, California Municipal Utilities Association (CMUA) noted that smaller publicly owned utilities face little variability in their load and may be forced to procure additional resources that are neither cost-effective nor environmentally sustainable to meet these planning reserve margins.²⁴

AB 1373 from the 2023-2024 legislative cycle authorizes the Department of Water Resources to procure long-lead time resources on behalf of all load-serving entities in the CPUC Integrated Resource Planning purview.²⁵ Relevant to resource adequacy, the law required the CEC, also in consultation with CPUC, to send the Legislature a report assessing POU's performance in meeting minimum PRMs and system RA requirements. The report was published in April 2024, finding that at least 15 POUs had not procured enough RA between July and September 2023, compared to their reported peak demand plus PRMs.²⁶ The law also authorizes the CEC to adopt regulations establishing a new fee structure, or capacity payment, for POUs that do not meet their PRMs during a month where the Department of Water Resources' Electricity Supply Strategic Reliability Reserve Program (ESSRRP) dispatches resources to meet a reliability need. It also requires the CEC to assess capacity payments to POUs annually and to deposit payments into the DWR ESSRRP fund to recover the costs of this backstop procurement. The draft regulations were released in May 2024 and were expected to be finalized in the first quarter of 2025.^{27 28}

Overall, these laws may change California POUs' RA procurement needs. Understanding individual POU's RA requirements further requires research on individual California POUs' resource adequacy planning frameworks.

²³ Reliability Analysis Branch Energy Assessments Division, "California Energy Resource and Reliability Outlook, 2024" (California Energy Commission, August 14, 2024), <https://efiling.energy.ca.gov/GetDocument.aspx?tn=258494>.

²⁴ Jen-Ann Lee, "California Municipal Utilities Association Comments - on AB 209 POU PRM Workshop" (California Energy Commission, n.d.), <https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=21-ESR-01>.

²⁵ California Public Utilities Commission, "Decision Determining Need For Centralized Procurement Of Long Lead-Time Resources," August 29, 2024, <https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M539/K202/539202613.PDF>.

²⁶ Yee Yang, Chie Hong, and Kristen Widdifield, "Assembly Bill 1373 Report Assessment of Publicly Owned Utilities' Resource Adequacy" (California Energy Commission, April 2024).

²⁷ "AB 1373 Draft Regulations for Capacity Payments," May 29, 2024, <https://efiling.energy.ca.gov/GetDocument.aspx?tn=256584>.

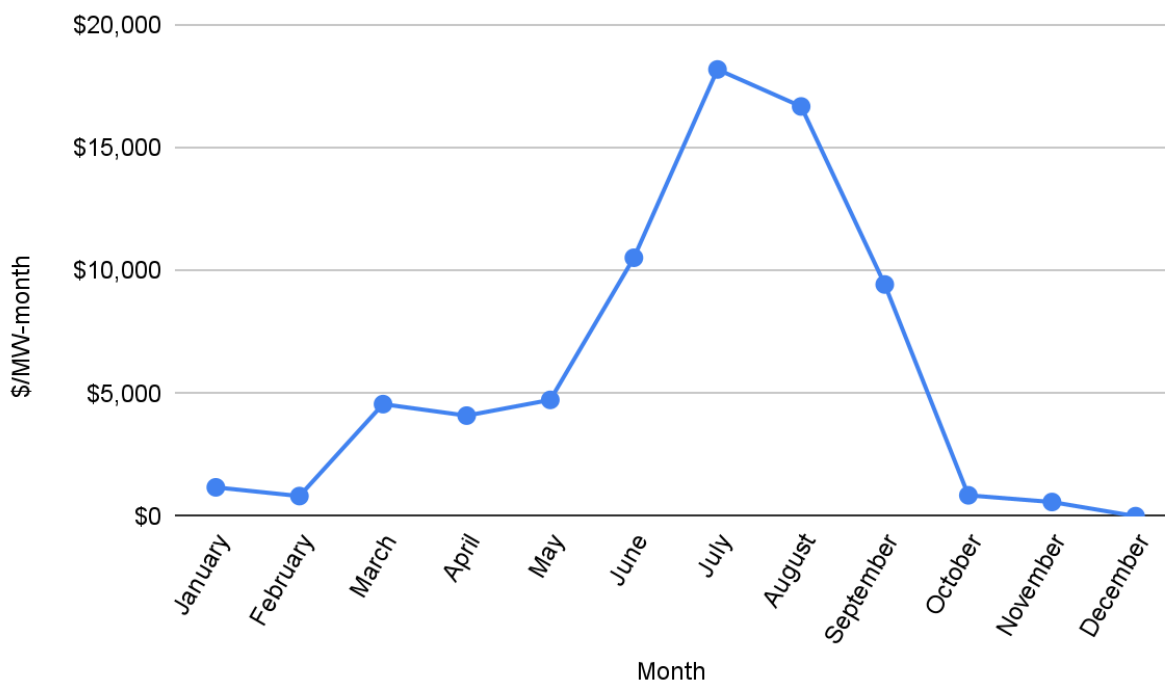
²⁸ As of May 14, 2025, the most recent document in CEC Docket 24-OIR-01 titled, Rulemaking on AB 1373 POU Capacity Payment to Implementation, was submitted in June 2024.

4. Resource Adequacy Prices

Over the past few years, the cost of procuring RA has risen steadily, particularly in 2021 and 2022, when the CPUC's latest RA price analysis is available. These price increases are largely due to the limited availability of resources and competition among LSEs to procure sufficient RA to meet the requirements of their local regulatory authority (e.g. CPUC). In 2022, the weighted average price was \$7,680/MW-month for system resource adequacy contracts, reflecting a more than doubling of RA prices over 10 years.

To put this in context, a 5 MW utility-scale solar-only project (without storage) would have an average annual RA value of ~\$70,000²⁹ compared to an estimated capital expenditure of \$8 million in 2022.³⁰ Since solar projects only produce electricity for part of the day and solar output varies each month, their net qualifying capacity is adjusted accordingly. As Figure 2 shows, the weighted resource adequacy value (in dollars per MW-month) for a 5 MW utility-scale solar project in 2022 varied significantly every month, spiking in July and August, when electricity demand is highest. See Appendix 3 for full calculations.

Figure 2. 2022 Monthly Weighted Average System RA Price for 5 MW Utility-Scale Solar Project (\$/MW-month)



Source: CPUC 2022 Resource Adequacy Report

²⁹ Sasha Cole et al., "2022 Resource Adequacy Report."

³⁰ Joachim Seel et al., "Utility-Scale Solar," 2024,

<https://emp.lbl.gov/sites/default/files/2024-10/Utility%20Scale%20Solar%202024%20Edition%20Slides.pdf>.

RA prices also vary by LSE, with Community Choice Aggregators (CCAs) often facing higher costs compared to Investor-Owned Utilities (IOUs). CalCCA, which advocates on behalf of California's CCAs, notes that IOUs tend to have long-standing contracts with generators and thus pay lower rates for RA, on average, compared to CCAs. CalCCA also notes that the lack of clarity about upcoming RA obligations makes it challenging to make long-term RA contracts. Their analysis found that as of 2023, average monthly RA prices had risen to above \$13,000 per MW-month, with the highest observed prices of over \$60,000 per MW-month.³¹

POUs face the same constrained capacity markets as CCAs. As described by the California Municipal Utilities Association (CMUA), POUs "reported a quintupling of average RA prices between 2019 and 2024, up from about \$5,000 per MW-month to \$25,000 per MW-month. Because demand is higher, summer months are the most expensive. In 2024, POUs are seeing prices of below \$3,000 per MW-month in January and February, but prices likely will approach \$100,000 per MW-month in September, when California utilities typically experience their peak load."³² These dynamics reveal an increasingly competitive capacity market in California, placing upward pressure on prices while an evolving regulatory landscape pushes the value of variable resources down.

³¹ "California's Constrained Resource Adequacy Market: Ratepayers Left Standing in a Game of Musical Chairs."

³² "Issue Brief: Electric Reliability, Resource Adequacy, and California's Electric Grid" (California Municipal Utilities Association, February 2024), https://www.cmua.org//Files/2024_Capitol_Day/CMUA_IB_Electric_Reliability_2024.pdf.

5. Conclusion: Ongoing Challenges and Critiques of the RA System

The rising cost of RA, particularly the competition for dispatchable resources, has raised concerns among CCAs, POUs, and other smaller LSEs. Critics argue that the current system favors IOUs with established long-term contracts, leaving newer entities like CCAs to pay significantly higher prices for RA resources. This situation exacerbates affordability challenges for these electricity providers and, by extension, their customers.

Additionally, the limited supply of RA—especially resources capable of providing flexible or dispatchable capacity—continues to be a point of contention. As California's grid transitions toward greater reliance on renewable resources, particularly solar and wind, the need for clean dispatchable resources to manage variability becomes even more pressing. This shift further complicates RA procurement for LSEs, particularly as they strive to meet both the state's renewable energy targets and the growing electricity demand. The challenges of procuring RA are compounded by the ongoing competition for renewables, with LSEs under increasing pressure to meet procurement mandates while navigating a constrained capacity market.

Looking ahead, ongoing reform to resource adequacy frameworks at the CPUC and CAISO, a legislative proposal for Western Regionalization (SB 540), anticipated load growth, and the implementation of new interconnection processes may change RA dynamics. Further, advocates continue pushing for a simpler pathway for distributed energy resources (DERs) to contribute to grid reliability. Configuring solar canal systems as distributed energy resources may be a preferred approach if regulations make it easier for DERs to provide RA value.

In this context, solar canal projects may present an innovative solution to help LSEs meet RA requirements. These projects, when coupled with energy storage such as batteries, could provide reliable, dispatchable electricity to meet demand during periods of grid strain while contributing to California's renewable energy goals. Some load-serving entities may offer an easier pathway for solar canals than others, depending on their RA requirements, their interconnection process, and the solar canal project design. Overall, navigating the regulatory landscape and securing RA contracts for solar canal projects will likely remain a complex endeavor in the near term.

Appendix 1: Key Regulators and Oversight

The landscape for RA involves several key entities at the state, regional, and federal levels:

- **FERC:** The Federal Energy Regulatory Commission has authority over wholesale power markets and transmission-scale resources, including CAISO's operational requirements.
- **NERC:** The North American Electric Reliability Corporation establishes national reliability standards for generating resources and high-voltage transmission systems.
- **WECC:** The Western Electricity Coordinating Council (WECC) ensures that ISO/RTOs in the Western Interconnection comply with NERC's standards. WECC also manages the tracking of renewable energy credits (RECs) for the Western Interconnection.
- **CAISO:** As the independent system operator for California, CAISO manages grid reliability, operates the day-ahead and real-time markets, and oversees the RA requirements for utilities and energy providers in its jurisdiction. While CAISO is not a state agency, its board is appointed by the Governor and confirmed by the State Senate, and it works closely with the California Public Utilities Commission and California Energy Commission.
- **CPUC:** The California Public Utilities Commission regulates utilities under its jurisdiction (mainly investor-owned utilities and community choice aggregators), ensuring compliance with reliability standards and supporting the state's renewable energy goals.
- **CEC:** The California Energy Commission forecasts energy demand and oversees publicly owned utilities' compliance with some regulatory requirements.
- **CARB:** The California Air Resources Board monitors and enforces air quality regulations and issues penalties for non-compliance with the state's Renewable Portfolio Standard (RPS).

Appendix 2: Elements of Resource Adequacy Programs

As per CAISO's Business Practice Manual, the seven basic elements of a resource adequacy program include³³:

- A procedure to forecast demand and peak demand.
- A specified reserve margin (a certain capacity above demand to account for reliability and planning issues).
- Deliverability to ensure contracted capacity is not constrained by transmission limitations when serving load.
- Criteria for determining resource eligibility and counting resource capacity.
- LSE must develop a plan for showing they are meeting resource adequacy requirements.
- Rules under which resources are made available to ISO operators to balance supply and demand.
- Compliance program to ensure LSE is following the RA program and not relying on other market participants.

³³ RajaShekar Thappetaobula, "Business Practice Manual for Reliability Requirements Version 75" (CAISO, November 12, 2024), <https://bpmcm.caiso.com/Pages/BPMDetails.aspx?BPM=Distributed%20Generation%20for%20Deliverability>.

Appendix 3: Methods for Calculating Resource Adequacy Revenue and Capital Expenditures for Example Project

To calculate the **monthly weighted average RA revenues** (\$/MW-month) for a utility-scale solar project in 2022, multiply the CPUC's 2022 Weighted Average Price for System RA (\$/kw-month)³⁴ by the CPUC's 2022 Solar Effective Load Carrying Capacity (ELCC)³⁵. Then, convert the price from \$/kw-month to \$/MW-month by multiplying by $\frac{1000 \text{ kw}}{1 \text{ MW}}$. See Table 2 for the monthly calculations.

Table 2. 2022 Monthly RA Value for Utility-Scale Solar Project

Month Number	2022 Weighted Average Price for System RA (\$/kw-month)	CY 2022 Solar Effective Load Carrying Capacity (ELCC)	Conversion from \$/kw-month to \$/MW-month	2022 Monthly Weighted Average Price (\$/MW-month)
1	5.87	4%	$\frac{\$}{\text{kw-month}} \times \frac{1000 \text{ kw}}{1 \text{ MW}}$	234.80
2	5.46	3%		163.80
3	5.07	18%		912.60
4	5.46	15%		819.00
5	5.92	16%		947.20
6	6.79	31%		2104.90
7	9.33	39%		3638.70
8	12.36	27%		3337.20
9	13.48	14%		1887.20
10	8.5	2%		170.00

³⁴ Sasha Cole et al., "2022 Resource Adequacy Report."

³⁵ "2022 Net Qualifying Capacity and Effective Flexible Capacity Values for Resource Adequacy Resources," accessed April 14, 2025, <https://www.caiso.com/documents/2022netqualifyingcapacity-effectiveflexiblecapacityvalues-resourceadequacyresources.html>.

11	5.77	2%		115.40
12	6.02	0%		0.00

To estimate **capital expenditures** in 2023 dollars for a utility-scale solar project built in 2022, convert the capacity-weighted mean project cost (2023 \$/watt) for AC solar projects built in CAISO to \$/megawatt by multiplying by $\frac{1,000,000 W}{1 MW}$. Finally, multiply by 5 megawatts.³⁶

³⁶ Seel et al., "Utility-Scale Solar."

References

- “2022 Net Qualifying Capacity and Effective Flexible Capacity Values for Resource Adequacy Resources.” Accessed April 14, 2025.
<https://www.caiso.com/documents/2022netqualifyingcapacity-effectiveflexiblecapacityvalues-resourceadequacyresources.html>.
- “2025 Resource Adequacy and Slice of Day Guide.” California Public Utilities Commission, September 25, 2024.
<https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/resource-adequacy-homepage/resource-adequacy-compliance-materials/guides-and-resources/2025-ra-slice-of-day-filing-guide.pdf>.
- “AB 1373 Draft Regulations for Capacity Payments,” May 29, 2024.
<https://efiling.energy.ca.gov/GetDocument.aspx?tn=256584>.
- CAISO. “Resource Adequacy.” Computer-based training, March 28, 2024.
<https://www.caiso.com/content/cbt/resource-adequacy/story.html>.
- California Public Utilities Commission. “Decision Determining Need For Centralized Procurement Of Long Lead-Time Resources,” August 29, 2024.
<https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M539/K202/539202613.PDF>.
- “California’s Constrained Resource Adequacy Market: Ratepayers Left Standing in a Game of Musical Chairs.” CalCCA, January 16, 2024.
https://cal-cca.org/wp-content/uploads/2024/02/CalCCA-Stack-Analysis-2023-2026-updated-01_16_24-.pdf.
- “California’s Resource Adequacy Reforms Are Here.” Accessed November 27, 2024.
<https://www.orrnick.com/en/Insights/2024/07/Californias-Resource-Adequacy-Reforms-Are-Here>.
- Commission, California Energy. “SB 100 Joint Agency Report.” California Energy Commission, current-date. <https://www.energy.ca.gov/sb100>.
- “Extended Day-Ahead Market Fact Sheet.” California ISO, November 2024.
<https://www.caiso.com/documents/extended-day-ahead-market-edam-fact-sheet.pdf>.
- “FERC Approves CAISO Interconnection Reform Plan | Utility Dive.” Accessed April 14, 2025.
<https://www.utilitydive.com/news/ferc-california-caiso-interconnection-reform-plan/728633/>.
- “Fixing California’s Resource Adequacy Woes | Utility Dive.” Accessed October 23, 2024.
<https://www.utilitydive.com/news/california-resource-adequacy-puc-caiso-Kahr/631720/>.
- Gundlach, Justin, and Romany Webb. “Distributed Energy Resource Participation in Wholesale Markets: Lessons from the California ISO” 39 (2018).
<https://climate.law.columbia.edu/sites/default/files/content/docs/others/Gundlach-and-Webb-2018-05-DER-in-Wholesale-Markets.pdf>.
- “Issue Brief: Electric Reliability, Resource Adequacy, and California’s Electric Grid.”

- California Municipal Utilities Association, February 2024.
https://www.cmua.org//Files/2024_Capitol_Day/CMUA_IB_Electric_Reliability_2024.pdf.
- Lee, Jen-Ann. "California Municipal Utilities Association Comments - on AB 209 POU PRM Workshop." California Energy Commission, n.d.
<https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=21-ESR-01>.
- "Managing the Evolving Grid | California ISO." Accessed April 11, 2025.
<https://www.caiso.com/about/our-business/managing-the-evolving-grid>.
- NP Energy. "Renewables and Exceedance – A Primer." 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.
- RajaShekar Thappetaobula. "Business Practice Manual for Reliability Requirements Version 75." CAISO, November 12, 2024.
<https://bpmcm.caiso.com/Pages/BPMDetails.aspx?BPM=Distributed%20Generation%20for%20Deliverability>.
- Rand, Joseph, Nick Manderlink, Will Gorman, Ryan Wisner, Julie Mulvaney Kemp, Seongeun Jeong, and Fritz Kahrl. "Characteristics of Power Plants Seeking Transmission Interconnection As of the End of 2023," n.d.
- Reliability Analysis Branch Energy Assessments Division. "California Energy Resource and Reliability Outlook, 2024." California Energy Commission, August 14, 2024.
<https://efiling.energy.ca.gov/GetDocument.aspx?tn=258494>.
- Resource Adequacy Modeling and Program Design Working Group. "CAISO RA Processes and CPUC's Slice of Day." California ISO, January 2024.
<https://stakeholdercenter.caiso.com/InitiativeDocuments/White-Paper-Resource-AdequacyProcesses-CPUC-Slice-of-Day-Jan09-2024.pdf>.
- Sasha Cole, Narissa Petchumrus, Elijah Cohen, Oscar Alonso Guerra, Lily Chow, Simone Brant, Jaime Rose Gannon, and Molly Sterkel. "2022 Resource Adequacy Report." California Public Utilities Commission, May 2024.
https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/resource-adequacy-homepage/2022-ra-report_05022024.pdf.
- Seel, Joachim, Julie Mulvaney Kemp, Anna Cheyette, Dev Millstein, Will Gorman, Seongeun Jeong, Dana Robson, Rachman Setiawan, and Mark Bolinger. "Utility-Scale Solar," 2024.
<https://emp.lbl.gov/sites/default/files/2024-10/Utility%20Scale%20Solar%202024%20Edition%20Slides.pdf>.
- "SLICE IT UP: CALIFORNIA's Slice-of-Day RA Approach and Impact on Energy Storage." Accessed December 20, 2024.
<https://www.tyba.ai//blog/slice-it-up-caisos-slice-of-day-ra-approach-and-impact-on-energy-storage>.
- "SMUD Unveils First Large Utility-Scale Battery Storage." Accessed February 5, 2025.
<https://www.smud.org/Corporate/About-us/News-and-Media/2022/2022/SMUD-unveils-first-large-utility-scale-battery-storage>.
- The Equation. "ELCC Explained: The Critical Renewable Energy Concept You've Never Heard Of," October 12, 2020.
<https://blog.ucsusa.org/mark-specht/elcc-explained-the-critical-renewable-energy>

-concept-youve-never-heard-of/.

Weinstein, Haley. "Creating a Pathway for Front-of-Meter Distributed Resource Adequacy to Fix California's Stunted Capacity Market." Clean Coalition, March 29, 2025.

<https://clean-coalition.org/news/creating-a-pathway-for-front-of-meter-distributed-resource-adequacy-to-fix-californias-stunted-capacity-market/>.

Yee Yang, Chie Hong, and Kristen Widdifield. "Assembly Bill 1373 Report Assessment of Publicly Owned Utilities' Resource Adequacy." California Energy Commission, April 2024.