NOVEMBER 2026

Existing Power Plants Sharing Grid Access with New Resources Can Accelerate Energy Deployment and Lower Costs in California

Umed Paliwal

UC Berkeley · umed@berkeley.edu

82.3 GW of projects wait in California's queue

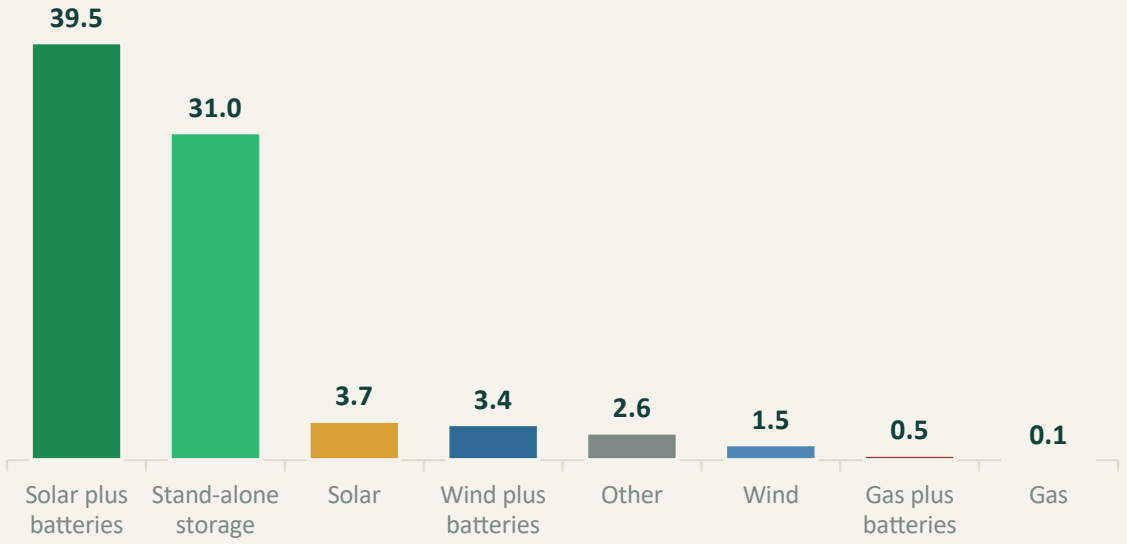
82.3 GW
CALIFORNIA ACTIVE QUEUE

297
CALIFORNIA ACTIVE PROJECTS

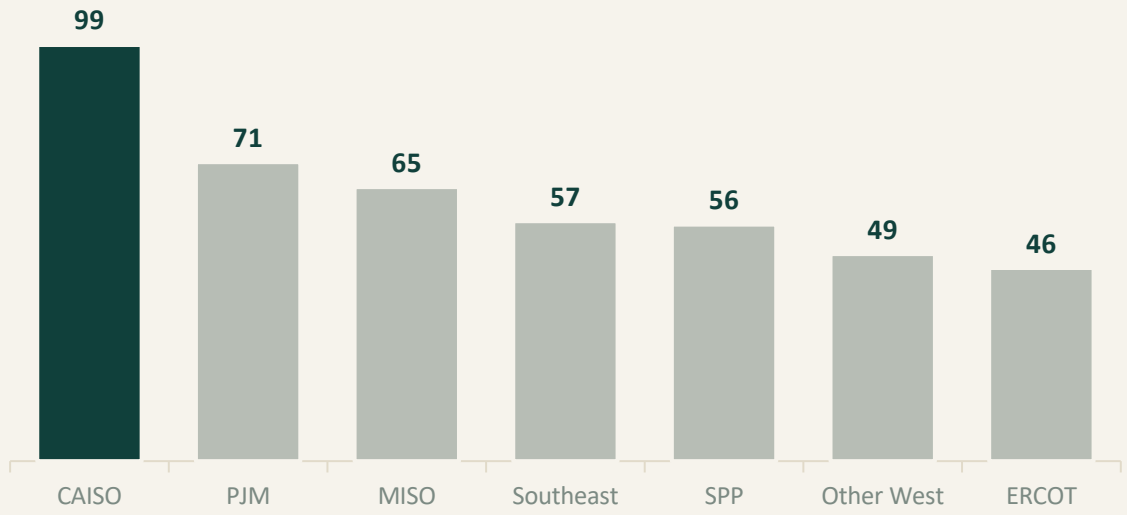
99 months
CAISO MEDIAN, REQUEST TO OPERATION

Solar plus batteries and stand-alone storage lead California's queue. But about four in five California projects that applied to CAISO have dropped out. Projects in CAISO's queue also take longer to reach operation than in other regions.

CALIFORNIA ACTIVE QUEUE BY TECHNOLOGY (GW)



MEDIAN MONTHS FROM REQUEST TO OPERATION, PROJECTS BUILT 2023 TO 2025



Sources: CAISO Public Queue Report, 26 September 2026, and Cluster 15 Queue Report, 16 July 2026: active requests at California sites, net MW at the point of interconnection; LBNL, Queued Up: 2026 Edition, June 2026, and its data file: our medians for projects that reached operation from 2023 to 2025.

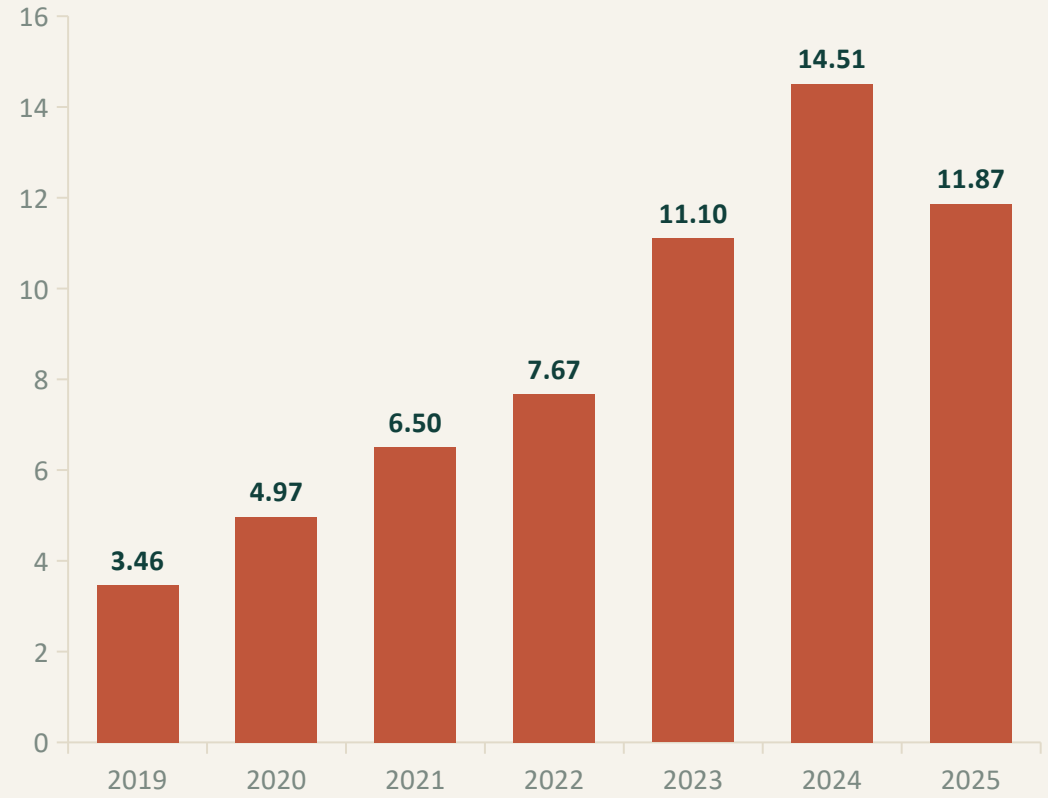
California's resource adequacy price more than tripled from 2019 to 2025

RESOURCE ADEQUACY IN CALIFORNIA

- **California utilities buy capacity through bilateral contracts.** There is no central auction. The CPUC requires the utilities and other retail suppliers it regulates to contract enough capacity each month to cover forecast peak demand plus a reserve.
- **Capacity requirements rose while supply tightened.** The CPUC says higher load forecasts and a higher reserve margin raised what retail suppliers must buy, while lower capacity ratings and few new dispatchable resources tightened supply. The average contract price rose from $3.46 per kW-month in 2019 to $14.51 in 2024.
- **Retail suppliers must procure 21,500 MW of new accredited capacity.** CPUC orders from 2021 to 2026 require the 21,500 MW, in steps due from 2023 to 2032.
- **In 2024 capacity cost $174 per kW-year.** The $174 per kW-year is the $14.51 per kW-month price over 12 months. In 2025 California's price was $142 per kW-year, above PJM's $99 and MISO's $79. In 2026 California's price is about level with PJM's capped price of $120.

The CPUC's planning reserve margin is now 18 percent above forecast peak demand, up from 15 percent before 2023.

SYSTEM RESOURCE ADEQUACY PRICE (DOLLARS PER KW-MONTH)



The price rose every year from 2019 to 2024, then eased in 2025.

Sources: CPUC Resource Adequacy Reports, 2019 to 2023, average price of system capacity-only contracts, with early prices for 2024 and 2025; CPUC Market Price Benchmarks, 2026; PJM and MISO capacity auction results, 2024 to 2026; CPUC Integrated Resource Plan procurement track, 2026; CAISO 2026 summer assessment.

California households pay $722 a year more than at 2019 prices

31.35 cents
RESIDENTIAL PRICE PER KWH, 2025

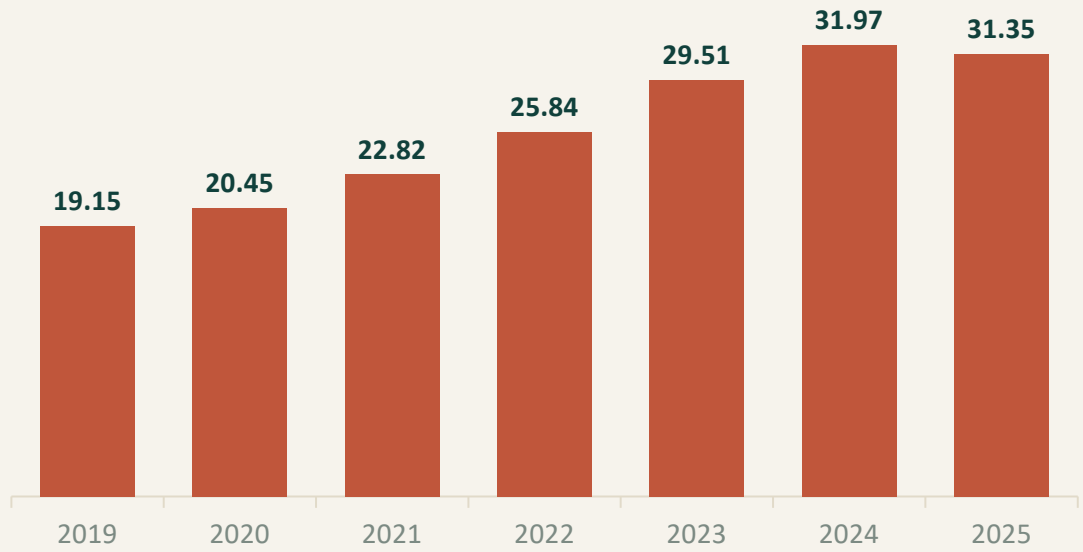
64 percent
PRICE INCREASE SINCE 2019

$722
ADDED TO A YEARLY HOUSEHOLD BILL

HOUSEHOLD BILLS

- **Residential prices rose 64 percent from 2019 to 2025.** The average price went from 19.15 cents per kWh to 31.35 cents. The higher price adds $722 a year to a household's bill.
- **Electricity prices rose faster than inflation.** Consumer prices rose 26 percent from 2019 to 2025, against 64 percent for residential electricity prices. After inflation, residential prices from 2021 to 2025 were the highest since at least 1970.
- **Capacity prices reach household bills.** The CPUC says the rising cost of resource adequacy contracts pushed up the generation part of household bills.

AVERAGE RESIDENTIAL PRICE (CENTS PER KWH)



The residential price rose every year from 2019 to 2024, fastest from 2021 to 2023. In 2025 the price was 1.9 percent lower than in 2024.

Sources: EIA Form 861 annual state data, 1970 to 2025, with final 2025 data released October 2026; BLS consumer price index for all urban consumers, 2019 to 2025; CPUC 2025 SB 695 Report.

CAISO's gas plants still supply 6.8 GW at 9 PM

3.7 GW
GAS AT NOON

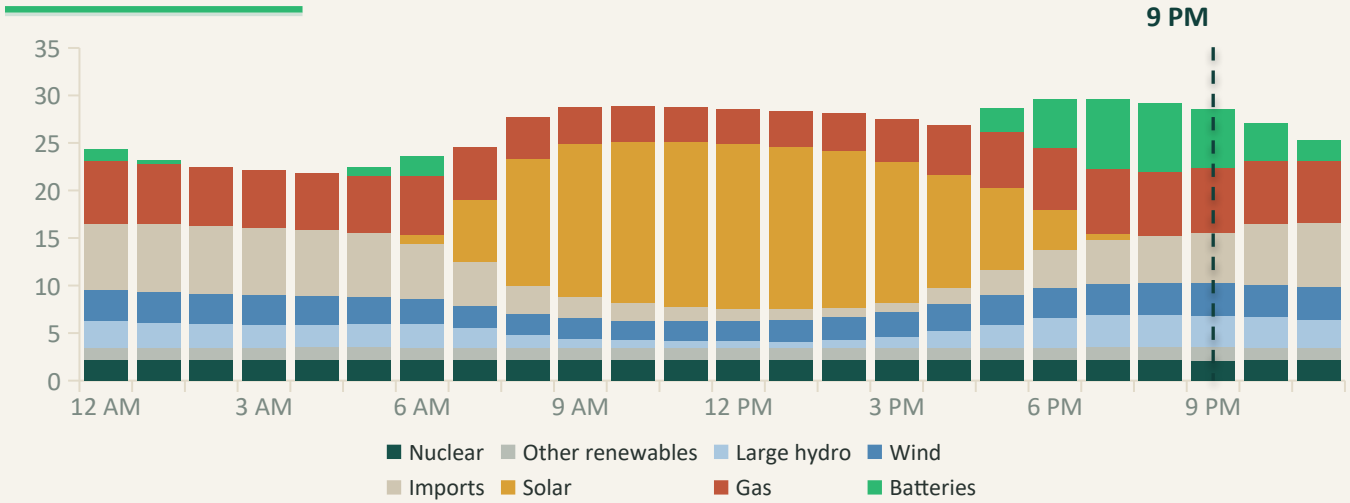
6.8 GW
GAS AT 9 PM

6.2 GW
BATTERIES AT 9 PM

6.0 GW
GAS AT 3 AM

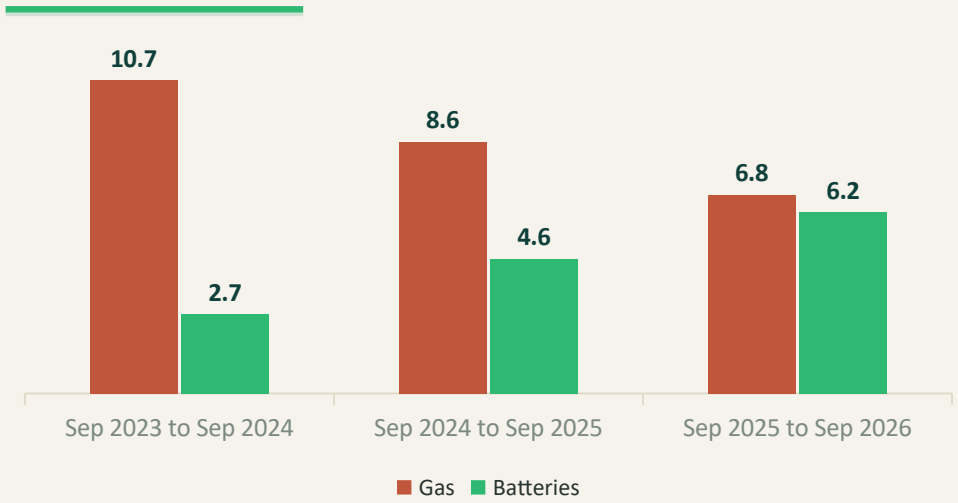
Over the 12 months to September 2026, gas in CAISO's area ran through the afternoon and the night. Batteries now supply part of the evening. On the evening of 9 September 2026 gas reached 22.3 GW, its highest of the year.

AVERAGE SUPPLY BY HOUR, 12 MONTHS TO SEPTEMBER 2026 (GW)



At noon solar leads and batteries charge. Gas output is highest from 7 to 10 PM. At 9 PM gas is the largest source, ahead of batteries.

AVERAGE OUTPUT AT 9 PM, 12-MONTH PERIODS (GW)



At 9 PM, average battery output rose from 2.7 GW to 6.2 GW in two years. Average gas output fell from 10.7 GW to 6.8 GW.

Gas still runs at midday because some plants must stay online to meet reliability standards and to be ready to raise output in the evening.

Sources: CAISO Today's Outlook, fuel-source history, five-minute MW by source, 26 September 2023 to 25 September 2026; EIA-930 hourly generation by source, 2023 and 2024; EIA, Today in Energy, 28 May 2025.

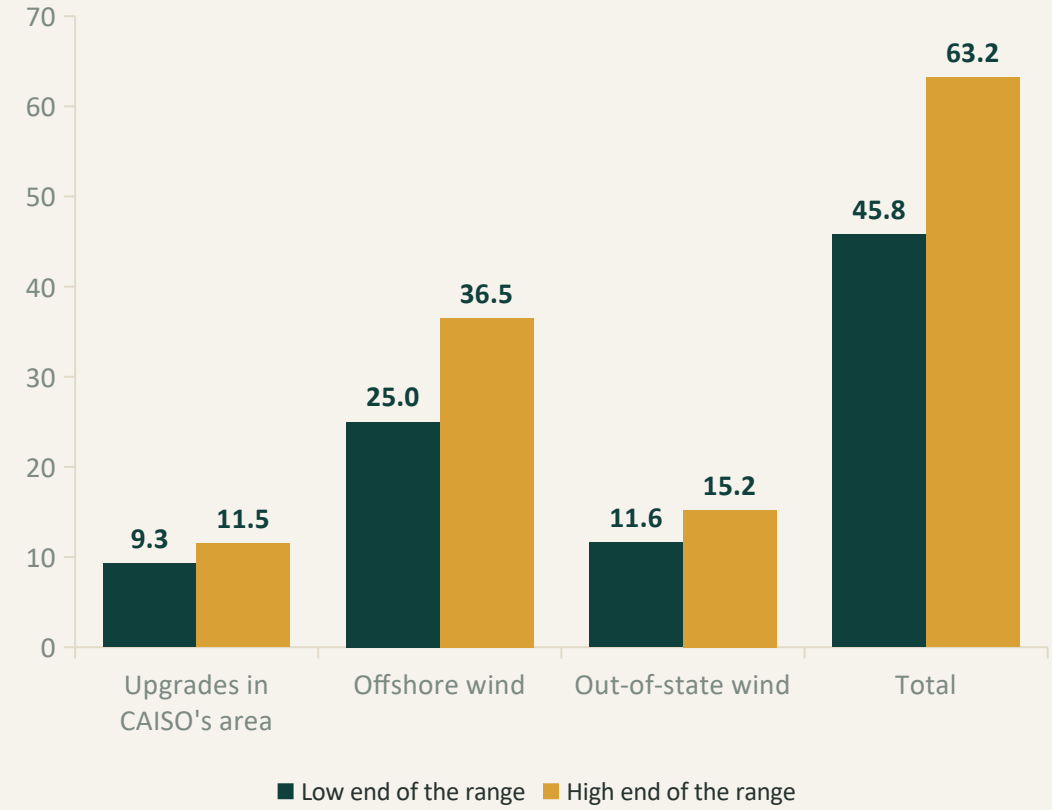
CAISO expects $45.8 to $63.2 billion of new transmission by 2045

TRANSMISSION PLANS IN CALIFORNIA

- **The expected cost of new transmission has risen.** CAISO's estimate rose from about $30.5 billion in its 2022 outlook to $45.8 to $63.2 billion in its 2024 outlook. The transmission in the 2024 outlook would connect about 165 GW of new resources by 2045.
- **Lines to connect 20 GW of offshore wind are the largest part of CAISO's planned transmission cost.** Most of the offshore wind is off the North Coast, which CAISO says has almost no lines to carry that power to cities today. The outlook's 20 GW is a step toward California's goal of 25 GW by 2045. The CEC says offshore wind can generate power overnight and in winter, when solar output drops.
- **CAISO approved $6.7 billion of new transmission in May 2026.** A year earlier CAISO approved $4.8 billion.
- **New transmission adds to customers' bills.** CAISO says the cost of its May 2026 plan comes to about 0.5 cents per kWh over the life of the projects. We estimate that the outlook's $63.2 billion high end adds about 2.3 cents per kWh to transmission rates by 2045, using projections by the CPUC's Public Advocates Office.
- **Local grid upgrades come on top of CAISO's transmission outlook.** CAISO's outlook covers only high-voltage lines. A CPUC study finds upgrades to the local distribution grid could reach about $50 billion by 2035.

CAISO says newly approved transmission can take 8 to 10 years to complete.

CAISO OUTLOOK, COST BY PART (BILLION DOLLARS)



Lines to connect offshore wind are more than half of the total, whether it is $45.8 billion or $63.2 billion.

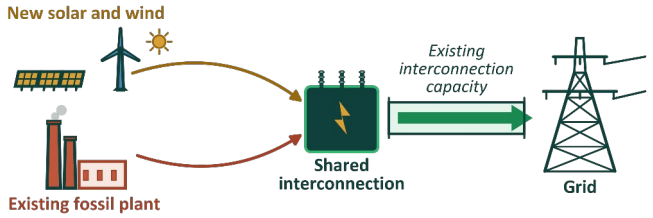
Sources: CAISO 2024 20-Year Transmission Outlook, Table ES-1, and 2024-2025 and 2025-2026 Transmission Plans; CPUC Public Advocates Office, Transmission Data Dashboard, December 2025; CPUC Electrification Impacts Study, Part 1, 2023; CEC offshore wind strategic plan, July 2024. Totals may not add because of rounding.

New projects can share an existing plant's interconnection under FERC Order 845

Surplus interconnection service introduced by FERC in 2018 allows new generation and storage to be added at underutilized existing interconnections.

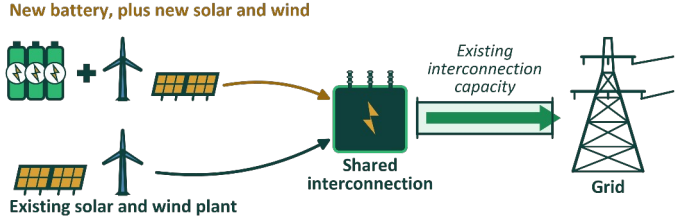
Surplus projects in other regions signed an agreement a median of 12 months after their request. Projects in CAISO's queue took a median of 53 months to sign one.

RENEWABLES AT FOSSIL PLANTS



- A large share of California's fossil capacity runs at very low capacity factors, leaving interconnection capacity unused.
- The owner has already paid for that interconnection, and a new project can share it under a bilateral agreement.
- Order 845 requires CAISO and other grid operators under FERC to offer that unused capacity to a new project.
- New solar or wind uses only the interconnection capacity the plant leaves unused each hour.
- The plant's output stays the same, and together the two never exceed the interconnection capacity.

BATTERIES AND NEW GENERATION AT RENEWABLE PLANTS



- U.S. solar plants run at about a 24 percent capacity factor and wind plants at about 34 percent.
- So solar and wind plants leave most of the interconnection they paid for unused. In some hours solar and wind output is also curtailed.
- Solar and wind plants are also underutilized for capacity. The CPUC gives solar and wind low capacity value, because their output varies with the weather and solar fades in the evening peak hours.
- A battery at a solar or wind plant can store the plant's output and send it out in the evening peak hours. The battery raises the site's accredited capacity.
- With the battery in place, more solar and wind can be added. The battery stores the extra output and sends it out when the grid needs power.

Sources: FERC Order No. 845, 19 April 2018; CAISO tariff, Appendix KK, section 3.4, 5 August 2026; EIA Electric Power Monthly, Table 6.07.B, 2025; surplus agreements filed at FERC or posted by MISO; LBNL, Queued Up: 2026 Edition, data file. Surplus rules change often, so the latest rules could differ.

PJM widened surplus interconnection, and three states passed surplus laws

THE POLICY RESPONSE IN PJM

- **PJM widened surplus interconnection in 2025.** More plants now qualify, including plants that have an interconnection agreement but are not yet built. A surplus project can also build new interconnection facilities. PJM aims to finish each study within 180 days.
- **PJM added a rule to transfer capacity interconnection rights in 2026.** A new project at an existing plant's substation can now take over the plant's capacity interconnection rights.

SURPLUS BILLS IN SIX STATES

State	Bill	Status	What the bill does
Indiana	SEA 240 (2026)	**Signed**	Utilities must analyze surplus interconnection at their own plants in resource plans filed from 2030. From 2030, regulators must also weigh surplus interconnection when a utility asks to build a plant.
Virginia	HB 1065 and HB 429 (2026)	**Signed**	Utilities must evaluate surplus interconnection in resource plans. Dominion and Appalachian Power must report how much surplus interconnection their solar sites have. Each must also run a battery pilot that uses surplus interconnection, up to 500 MW for Dominion and 100 MW for Appalachian Power.
Oregon	HB 4076 (2026)	**Signed**	A project that uses an existing plant's surplus interconnection can be allowed on land zoned for other uses if its new power lines stay within two miles of the plant.
California	AB 1408 (2025)	**Vetoed**	Would have required utilities to use surplus interconnection where feasible and to evaluate it in resource plans. CAISO would have included surplus interconnection in transmission planning.
Utah	HB 413 (2026)	**Did not pass**	Would have required Rocky Mountain Power to analyze surplus interconnection at its own plants in every resource plan.
Pennsylvania	HB 500 (2025)	**Passed House**	Would give projects that use surplus interconnection a state tax credit for new clean generation, worth up to $300,000 per MW.

Sources: FERC dockets ER25-778, effective 7 March 2025, and ER26-403, effective 30 January 2026; PJM Manual 14H, Revision 07; state legislatures' bill records, 9 November 2026. This analysis takes no position on any enacted, pending or failed bill. Surplus rules change often, so the latest rules could differ.

The market response

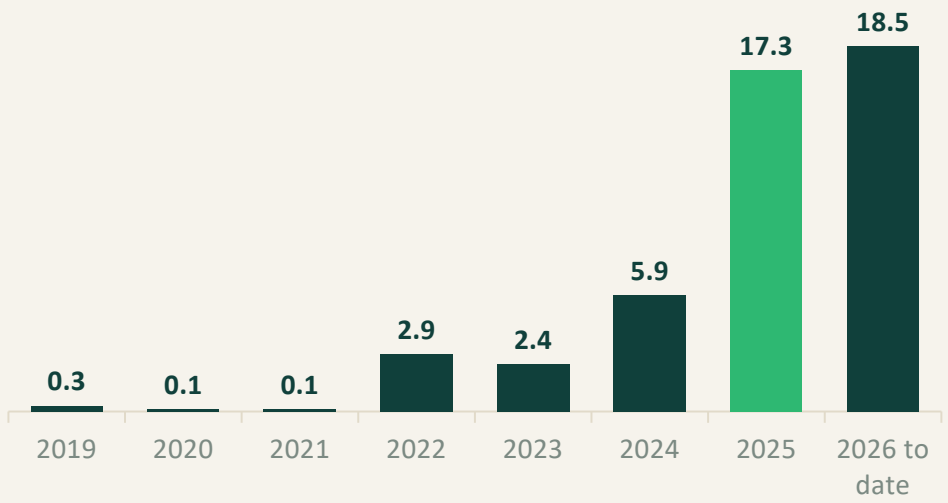
325
ACTIVE SURPLUS REQUESTS, U.S.

47.7 GW
CAPACITY IN ACTIVE SURPLUS REQUESTS

74 percent
BATTERIES' SHARE OF REQUESTED MW

2.4 GW
OPERATING

ACTIVE SURPLUS REQUESTS BY FILING YEAR (GW)



Active requests filed in 2026 already exceed the 2025 total. The 2026 requests come to 18.5 GW so far, against 17.3 GW for 2025. Both figures include PJM's active surplus requests.

WHO'S ALREADY BUILDING IT

> *Our extensive portfolio of existing operating sites ... means we can dramatically speed up our deployments.*
>
> John Ketchum, chief executive, NextEra Energy, fourth quarter 2024 earnings call

- **Large developers already hold surplus projects.** NextEra has the most surplus MW in service. Clearway, DESRI and Earthrise also hold surplus projects.
- **Google buys capacity from surplus batteries.** NextEra added the batteries at two existing Oklahoma wind farms, Breckinridge and Minco.
- **Surplus projects in SPP reached operation far faster than queue projects.** Seven surplus projects in SPP took 17 to 30 months from request to operation, against a median of 61 months for queue projects that began operating in 2025. SPP's surplus requests reached an agreement in a median of 12 months.
- **PJM lists 18 active surplus requests.** The 18 requests total 2.3 GW, and none operates yet.

Sources: SPP, MISO and PJM surplus queues, 3 to 5 November 2026, with PJM's filing year read from each request number; PacifiCorp surplus queue, 15 October 2026; other utilities' surplus queues and filings in the West and Southeast, September to November 2026; FERC Electric Quarterly Reports; SPP surplus agreements at FERC, 2022 to 2026; LBNL, Queued Up: 2026 Edition. Undated requests (299 MW) are not shown. Totals may not add because of rounding.

At least 2.4 GW already operates under surplus interconnection

Project	Interconnection shared	Region	Request to signing (months)	Signing to operation (months)
Hawthorn Solar I, 10 MW solar	Evergy Metro's Hawthorn Power Plant	SPP	6	10
Breckinridge Energy Storage, 65 MW battery	NextEra's Breckinridge Wind	SPP	9	17
Minco II Energy Storage, 65 MW battery	NextEra's Minco Wind I and II	SPP	9	13
Woodward Energy Storage, 40 MW battery	NextEra's Oklahoma Wind Energy Center	SPP	11	13
Skeleton Creek battery, 200 MW	NextEra's Skeleton Creek Energy Center	SPP	11	8
Cunningham battery, 36 MW	Southwestern Public Service's Cunningham Solar	SPP	10	11
Boot Hill Solar, 150 MW solar	Sunflower Electric's Fort Dodge gas plant	SPP	14	17
Searcy Solar battery, 10 MW	Searcy Solar	MISO	5	14
Cavalry battery, 5 MW	Cavalry Solar	MISO	14	9
Pine River Solar Park, 80 MW solar	DTE's Pine River Wind Park	MISO	6	32
Paris Solar battery, 60 MW	Paris Solar	MISO	13	37
Polaris Solar Park, 100 MW solar	DTE's Polaris Wind Park	MISO	6	33
Grant County battery, 100 MW	Grant County Solar	MISO	30	12
Wood County battery, 75 MW	Wood County Solar	MISO	30	13
Wever battery, 99 MW	Alliant's Wever Solar	MISO	7	8
Archtop Solar, 270 MW solar	Earthrise Energy's Gibson City gas peaker	MISO	17	19
Foothills Solar battery, 35 MW	Arizona Public Service's Foothills Solar	West	15	13
Red Rock Solar battery, 41 MW	Arizona Public Service's Red Rock Solar	West	11	18
Babbitt Ranch wind, 60 MW	NextEra's Babbitt Ranch Energy Center	West	15	Before signing
Franklin battery, 60 MW	Franklin Solar	West	2	10
Four Clearway batteries, 320 MW	Four Clearway solar plants in Utah	West	24	25
Seven FPL batteries, 522 MW	Seven FPL solar plants in Florida	Southeast	Not public	Not public
Stony Brook Solar, 6 MW solar	Stony Brook Generating Station, Massachusetts	ISO-NE	33	2

Operating surplus projects reached a signed agreement a median of 12 months after their request and began operating a median of 14 months after signing. None of these projects is in California.

Sources: surplus interconnection agreements filed at FERC or posted by MISO; SPP and MISO queues, 5 November 2026; FPL Ten Year Site Plan, April 2026; EIA Form 860M, September 2026; owner reports. Projects operating as of 5 November 2026.

2.1 GW of batteries were added at existing California solar and wind plants

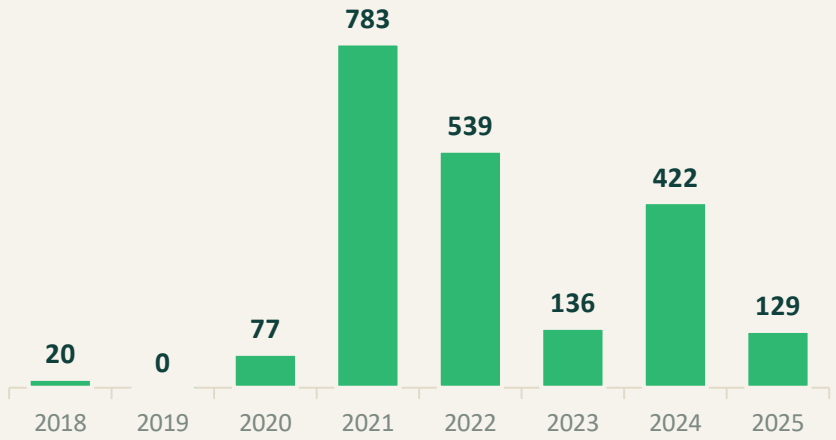
2.1 GW
BATTERIES ADDED AT SOLAR AND WIND PLANTS

1.7 GW
THROUGH CAISO'S MODIFICATION PROCESS

18.5 months
BATTERIES' MEDIAN, REQUEST TO OPERATION

99 months
CAISO QUEUE MEDIAN, REQUEST TO OPERATION

BATTERIES ADDED BY YEAR (MW)



Most of the 2.1 GW was added in 2021 and 2022.

ADDING BATTERIES AT EXISTING PLANTS IN CAISO

- **CAISO's tariff has included surplus interconnection service since 2020.** A plant can let a new project use the interconnection capacity it leaves unused. The plant and the new project share the point of interconnection and together stay within the plant's interconnection capacity.
- **Developers use CAISO's modification process instead.** CAISO told FERC in May 2024 that developers generally skip surplus interconnection service because CAISO's modification rules make adding generation or storage easier than other grid operators' rules do. CAISO publishes no count of surplus requests.
- **Most batteries added at California's solar and wind plants came through CAISO's modification process.** The batteries' owners modified the solar or wind plant's existing interconnection agreement. Of the 2.1 GW, 1.7 GW came this way and most of the rest through new requests in CAISO's yearly cluster studies. We found no battery among the 2.1 GW that came through surplus interconnection service.
- **A modification keeps the site within existing limits.** Combined output of the plant and the battery cannot exceed the site's interconnection limit. CAISO counts the battery as capacity only on deliverability the solar plant passes to it. The plant can pass about 6 to 15 MW for each 100 MW of solar. A request needs 90 days' notice and a $30,000 deposit. CAISO answers within 60 days, or up to 120 if the utility's equipment must be restudied.
- **CAISO's modification process is fast.** Batteries added this way reached operation a median of 18.5 months after their request. SPP's surplus projects were about as fast, taking 17 to 30 months. Projects in CAISO's queue took a median of 99 months.

Sources: CAISO tariff, Appendices DD and KK and Section 25, as of 5 August 2026; CAISO filing at FERC, 16 May 2024; utility filings at FERC, 2019 to 2024; CAISO generator management manual; EIA-860M, September 2026; LBNL, Queued Up: 2026 Edition. Surplus rules change often, so the latest rules could differ.

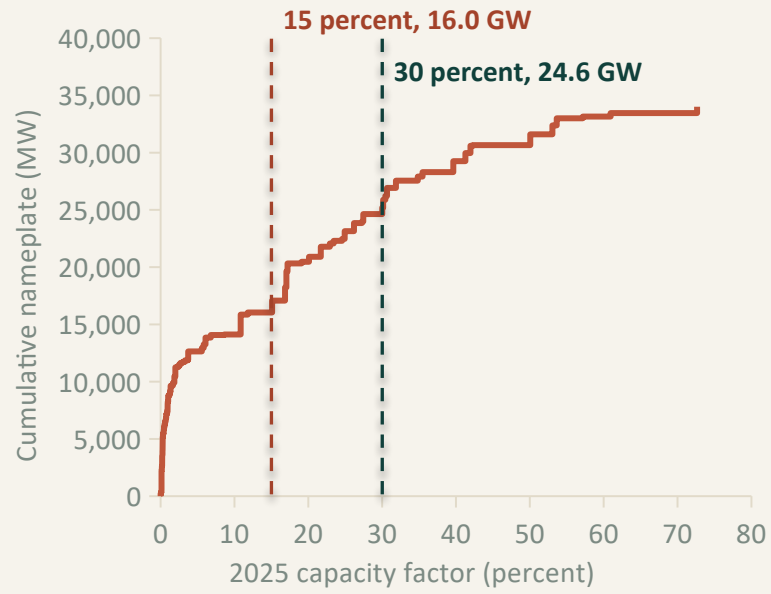
Nearly half of California's fossil capacity runs below a 15 percent capacity factor

34.1 GW
NAMEPLATE, 120 FOSSIL PLANTS

24.6 GW
BELOW 30 PERCENT CAPACITY FACTOR

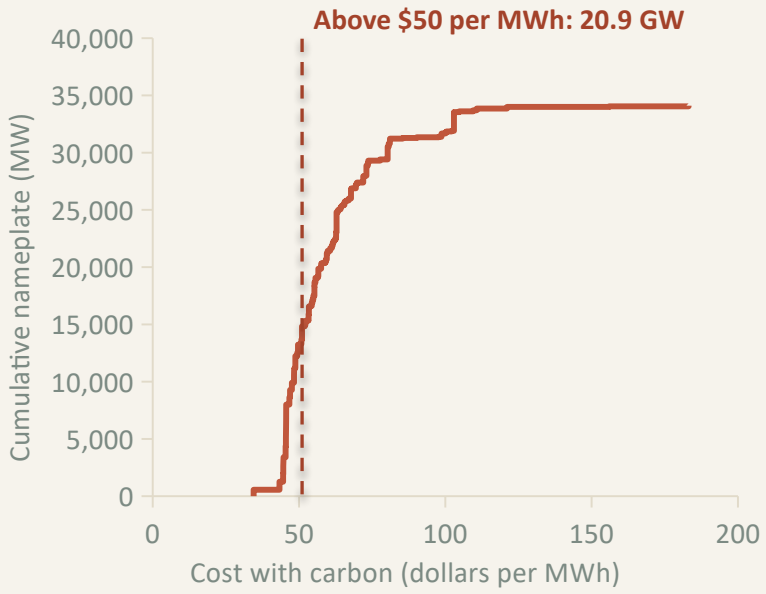
16.0 GW
BELOW 15 PERCENT CAPACITY FACTOR

FOSSIL CAPACITY BY 2025 CAPACITY FACTOR (MW)



Most of California's fossil capacity ran below a 30 percent capacity factor in 2025.

FOSSIL CAPACITY BY VARIABLE COST OF RUNNING (MW)



Most of California's fossil capacity costs more than $50 per MWh to run.

CALIFORNIA'S FOSSIL PLANTS

- **California's fossil plants are underutilized.** In 2025, 72 percent of California's fossil capacity ran below a 30 percent capacity factor. New solar can use the interconnection capacity these plants leave unused, without a new interconnection.
- **Combustion turbines and oil and gas steam units had the lowest capacity factors.** Gas combustion turbines averaged a 2.9 percent capacity factor, and oil and gas steam units 0.6 percent. Gas combustion turbines total 10,456 MW and oil and gas steam units 4,168 MW.

Sources: EIA-923 net generation and EIA-860 nameplate capacity, 2021 to 2025; EIA-923 fuel receipts and fuel use, 2025; EPA hourly emissions data; California and Quebec carbon allowance auction, August 2026. Nuclear plants are excluded.

Renewable plants are underutilized for both energy and capacity

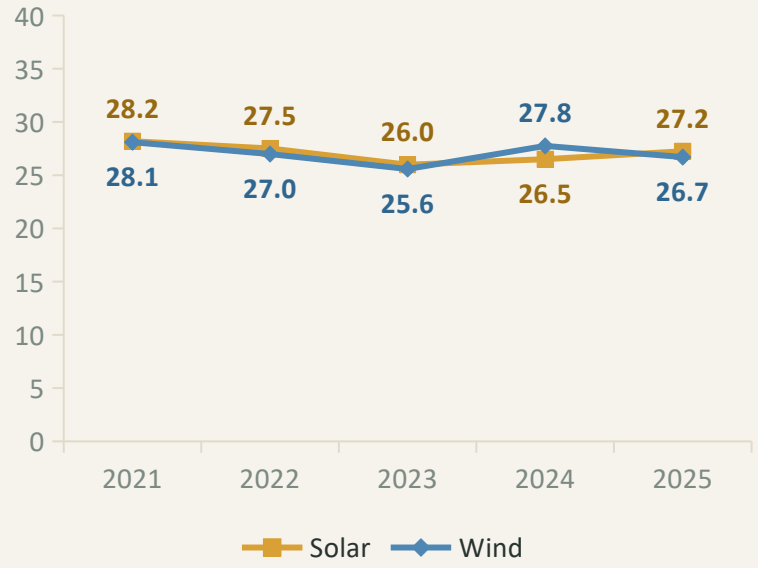
22.3 GW
SOLAR, 283 PLANTS

6.4 GW
WIND, 77 PLANTS

2.0 GW
SOLAR ACCREDITED CAPACITY, 2028 RATINGS

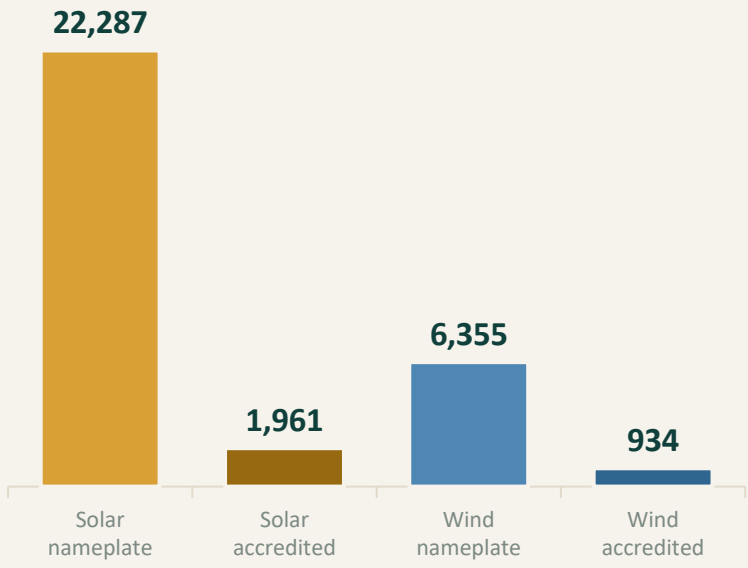
0.9 GW
WIND ACCREDITED CAPACITY, 2028 RATINGS

FLEET CAPACITY FACTOR BY YEAR (PERCENT)



Solar and wind plants ran at capacity factors between 25 and 29 percent every year from 2021 to 2025.

NAMEPLATE AND ACCREDITED CAPACITY (MW)



Solar's 22.3 GW of nameplate carries 2.0 GW of accredited capacity. Wind's 6.4 GW of nameplate carries 0.9 GW.

CALIFORNIA'S RENEWABLE PLANTS

- **California's renewable plants are underutilized in two ways.** Renewable plants underutilize their interconnection for both energy and capacity. A new battery or new generation can use what renewable plants leave unused.
- **Renewable plants leave most interconnection capacity unused.** In 2025 solar plants ran at a 27.2 percent capacity factor and wind plants at 26.7 percent. Both figures count only plants that ran all of 2025.
- **Renewable plants are also underutilized for capacity.** Under the CPUC's 2028 ratings, the 22.3 GW of existing solar carries only 2.0 GW of accredited capacity. The ratings put solar at 8.8 percent and wind at 14.7 percent.

Sources: plants of 10 MW and above, from EIA Form 860M, July 2026; EIA-923 net generation and EIA-860 nameplate capacity, 2021 to 2025; the CPUC's 2028 ELCC ratings. Each year counts only plants that ran the whole year.

Methodology

1 RESOURCE ASSESSMENT

- Assessed solar and wind resources within a 6-mile buffer around each fossil and renewable plant in California.
- Applied more than 50 exclusion criteria: physical limits such as land cover and slope, environmental protections, protected areas such as national parks, and local ordinances, including setbacks from buildings, roads and power lines.
- Estimated local solar and wind potential from the suitable area and the average solar and wind capacity density.

2 ECONOMIC ANALYSIS

- Estimated hourly solar and wind generation near each plant with 2019 weather data from ERA5 for solar and MERRA-2 for wind.
- Estimated local solar and wind LCOE with BloombergNEF capital costs and compared it with each fossil plant's variable cost to find the economic crossover points.
- Solar and wind costs do not include the ITC or PTC, but battery costs include the ITC.

3 PORTFOLIO OPTIMIZATION

- Estimated the mix of solar, wind and storage that maximizes interconnection utilization while keeping curtailment below 5 percent.
- For fossil plants, estimated the solar and wind capacity that can be added.
- For renewable plants, estimated the additional solar and wind capacity that a 4-hour battery enables.
- Added solar and wind only where the resource is good, about a 20 percent capacity factor for solar and 30 percent for wind, so the additions are economic.

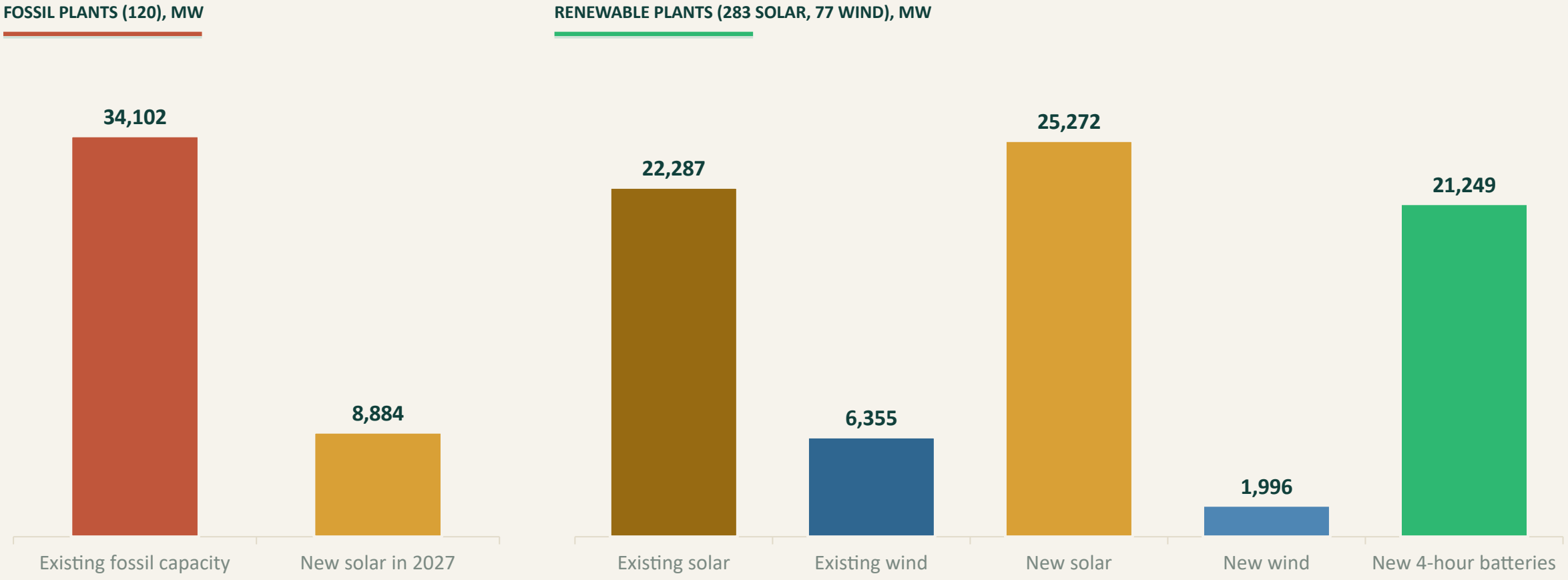
4 ACCREDITED CAPACITY AND SAVINGS

- We rate the additions with the CPUC's 2028 ELCC ratings.
- A 4-hour battery is rated at 76.5 percent. Solar is rated at 8.8 percent and wind at 14.7 percent.
- We count the batteries' accredited capacity in three cases: CAISO's rule today, a rule change and new deliverability. The rule change would let a battery use its plant's unused deliverability.
- We estimate the one-time interconnection cost the additions avoid by sharing existing interconnections.

Sources: our hourly dispatch model, weather year 2019; EIA-860 and EIA-923, 2025; our siting screen with standard local setback rules; Lopez et al. 2025, NREL/TP-6A20-91900; BloombergNEF 2026; the CPUC's 2028 ELCC ratings; CAISO Net Qualifying Capacity list, 2027.

57.4 GW of solar, wind and batteries could be added at existing plants

California's existing plants can add 34,156 MW of solar and 1,996 MW of wind, and renewable plants can add 21,249 MW of batteries. In total, California's existing plants can add 57.4 GW of new nameplate capacity.



Sources: our hourly dispatch model, weather year 2019; EIA-860 and EIA-923, 2025; BloombergNEF 2026 levelized costs. Totals may not add because of rounding.

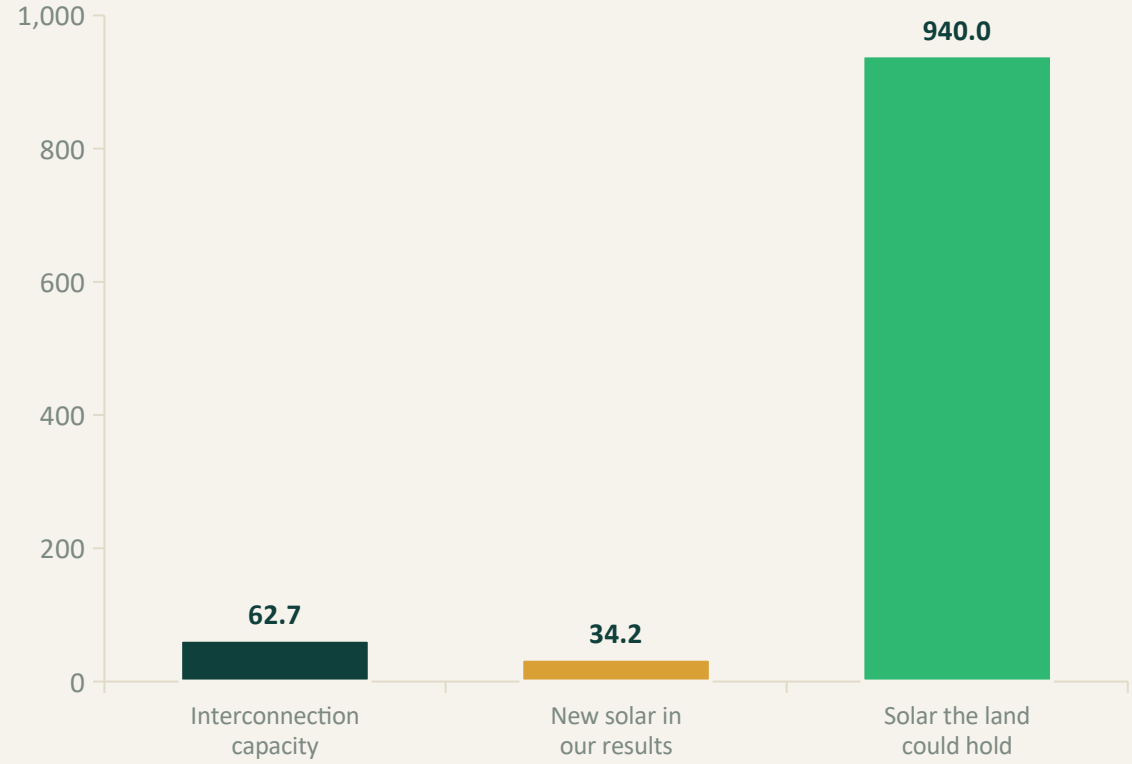
93 percent of California's plants have land for solar five times the interconnection

LAND NEAR EXISTING PLANTS

We estimated the buildable land in a square about 12 miles on a side, centered on each plant. We screen out protected and steep land, water and towns. Local setbacks take out more.

- **Land near California's existing plants could hold 940 GW of solar.** The 940 GW is 15 times the interconnection capacity of these plants. Land near 93 percent of the plants could hold at least five times their interconnection capacity in solar.
- **New solar would use 4 percent of the buildable land near existing plants.** Existing plants can add 34.2 GW of new solar, and the buildable land near them could hold 940 GW.
- **Some gas plants in cities lack the land to fill each plant's interconnection with solar.** At 12 gas plants the nearby land cannot hold solar as large as the plant's interconnection capacity. Ten of the 12 gas plants are in Los Angeles and Orange counties, and together the 12 hold 8.1 GW of interconnection capacity.
- **A battery fits at gas plants where land is short.** A battery needs far less land than solar. A battery can be added while the gas plant runs. The 57.4 GW of additions in our results includes no battery at gas plants, so batteries there would come on top.

CAPACITY AT EXISTING PLANTS (GW)



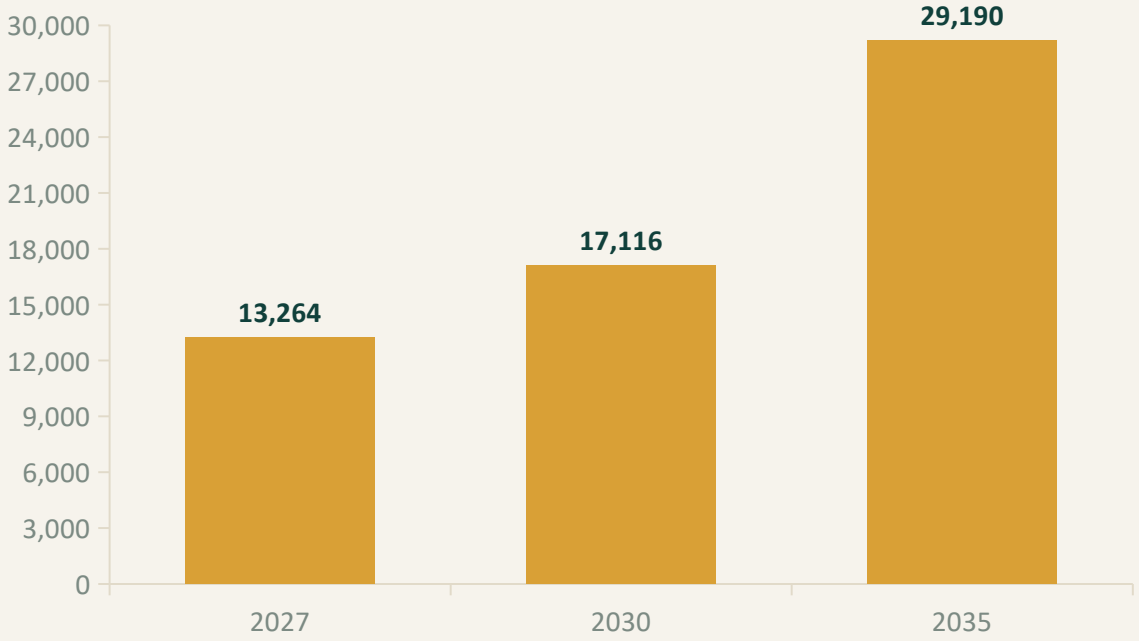
At most plants the interconnection limits the new solar, because the land could hold far more.

Sources: our siting screen with standard local setback rules; capacity densities from Lopez et al. 2025, NREL/TP-6A20-91900; EIA-860 and EIA-923, 2025; our hourly dispatch model, weather year 2019.

Gas plants can add 11,860 MW of new solar by 2030

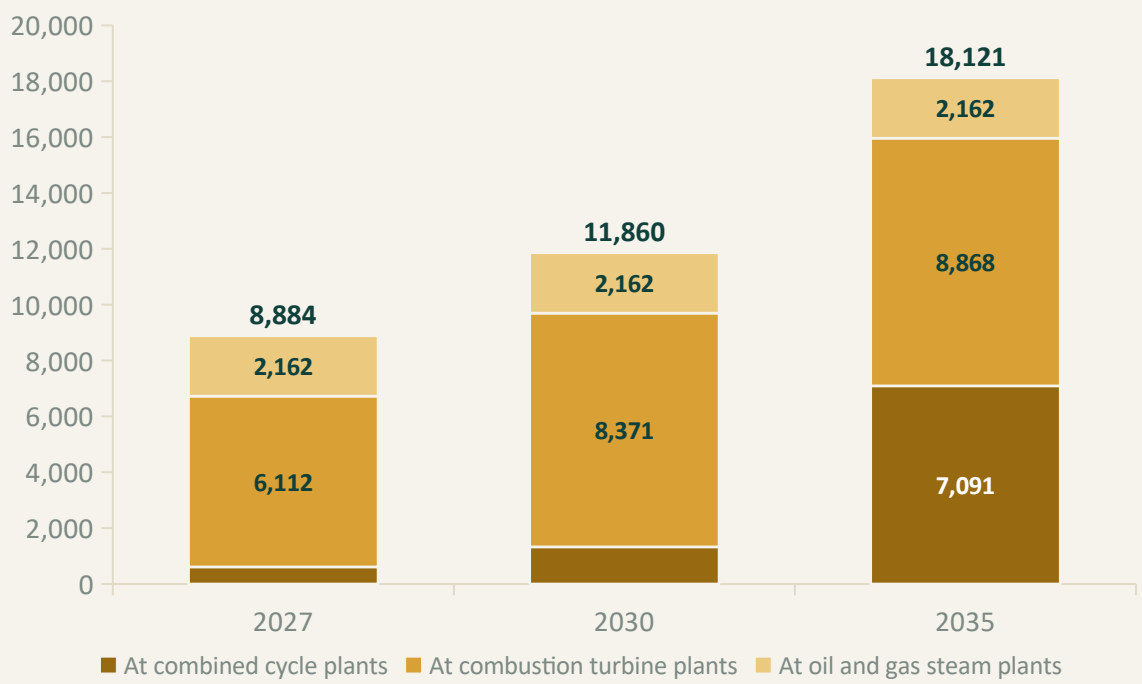
By 2030 new solar costs less than running 17.1 GW of California's gas plants, which can add 11,860 MW of new solar.

GAS CAPACITY WHERE SOLAR IS CHEAPER (MW)



In 2027 new solar costs less than running 13.3 GW of gas plants. By 2035 new solar costs less than running 29.2 GW.

NEW SOLAR AT GAS PLANTS (MW)



Gas plants where solar is cheaper can add 8,884 MW of new solar in 2027 and 11,860 MW by 2030. By 2035 new solar at gas plants reaches 18,121 MW, 49 percent of it at combustion turbine plants.

Sources: BloombergNEF 2026 levelized cost update; EIA-923 fuel prices, 2025, and net generation, 2021 to 2025; EIA variable operating costs, 2025 and 2026; California carbon allowance auction, August 2026; our hourly dispatch model, weather year 2019.

Renewable plants can add 21.2 GW of 4-hour batteries

21.2 GW
4-HOUR BATTERIES ADDED

25.3 GW
SOLAR ADDED

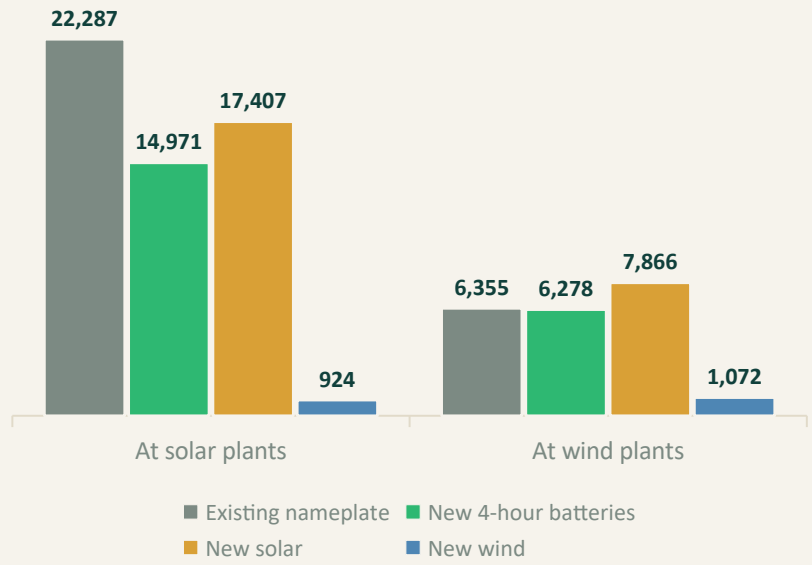
2.0 GW
WIND ADDED

Up to 6.9 GW
BATTERIES' ACCREDITED CAPACITY, WITH NEW DELIVERABILITY

BATTERIES AND NEW GENERATION AT RENEWABLE PLANTS

- **Renewable plants can add 21.2 GW of 4-hour batteries.** Each battery is sized to its plant's nameplate capacity, less any battery already there. So the 21.2 GW comes on top of the 7.5 GW of batteries already at renewable plants.
- **Renewable plants can also add 25.3 GW of new solar and 2.0 GW of new wind.** With a battery in place, new solar charges the battery when the interconnection is full. The battery sends the stored power out when solar and wind are not generating and the grid needs power. New wind is added only where the wind resource is good.
- **New batteries let renewable plants add far more solar.** A battery charges when its site's solar and wind produce more than the interconnection can carry, so less power is curtailed. Without new batteries renewable plants could add only 5.3 GW of new solar, against 25.3 GW with batteries.
- **New batteries could add up to 6.9 GW of accredited capacity.** A battery counts as capacity only if the grid can carry its power at the peak, which CAISO calls deliverability. The 6.9 GW counts the batteries at CAISO plants that fit under each plant's interconnection limit beside the capacity the plant sells, at the CPUC's 76.5 percent rating for 2028. Under CAISO's rule today new batteries would add about 1.4 GW.

ADDITIONS AT SOLAR AND WIND PLANTS (MW)



Solar plants can add most of the new batteries and new solar.

Sources: our hourly dispatch model, weather year 2019; EIA-860 and EIA-923, 2025; the CPUC's 2028 ELCC ratings; CAISO Net Qualifying Capacity list, 2027. Totals may not add because of rounding.

Today the 21.2 GW of new batteries add only 1.4 GW of accredited capacity

DELIVERABILITY AT EXISTING PLANTS

- **New batteries can get deliverability from existing solar and wind plants.** CAISO's rule lets an existing plant transfer deliverability to a battery added at the plant. A plant gets deliverability when it connects, if CAISO's deliverability study shows that the grid can deliver the plant's power at peak demand. CAISO's solar plants hold deliverability on 16.2 GW, and CAISO's wind plants on 5.9 GW.
- **For each 100 MW a solar plant transfers, a battery gets only 6 to 15 MW.** A plant keeps the deliverability it got when it connected, but CAISO values a transfer by today's deliverability study. Today's study tests the summer evening peak. The study assumes that a 100 MW solar plant, existing or new, sends out 6 to 15 MW at the evening peak, so it sets aside 6 to 15 MW of transmission capacity for the plant. A battery sends out all of its power at the evening peak. So the transmission capacity set aside for 100 MW of solar is enough for only a 6 to 15 MW battery. The study assumes that a 100 MW wind plant sends out 35 to 50 MW, so the transmission capacity set aside for 100 MW of wind is enough for a 35 to 50 MW battery.
- **Solar plants built before 2020 were studied at the afternoon peak.** The study then assumed that a 100 MW solar plant sends out about 90 MW, and it set aside about 90 MW of transmission capacity for the plant. The plant's owner financed the grid upgrades for that transmission capacity. In 2020 CAISO moved the study to the evening peak. The existing solar plants kept their deliverability. But the transmission capacity the study sets aside for 100 MW of solar fell from about 90 MW to 6 to 15 MW, and CAISO offered the difference to new projects.
- **Only 4.4 GW of the 21.2 GW of new batteries get deliverability today.** Solar plants transfer 12.3 GW of deliverability. The batteries at solar plants get 1.6 GW, an average of 13 MW for each 100 MW. Wind plants transfer 5.8 GW. The batteries at wind plants get 2.8 GW, an average of 48 MW for each 100 MW. At the CPUC's 76.5 percent rating the 4.4 GW counts as 3.3 GW of accredited capacity. A plant stops counting as capacity on the deliverability it transfers, so the plants lose 1.9 GW of their own accredited capacity. The CPUC rates solar at 8.8 percent and wind at 14.7 percent for the whole year. The 3.3 GW less the 1.9 GW leaves the 1.4 GW.

WHAT THE NEW BATTERIES ADD UNDER CAISO'S RULE TODAY (MW)

	Solar plants	Wind plants	Total
Deliverability the plants hold	16,152	5,881	22,033
New batteries	13,381	6,143	19,524
Deliverability the plants transfer	12,291	5,847	18,138
Deliverability the batteries get	1,598	2,780	4,378
Batteries' accredited capacity, at 76.5 percent	1,222	2,127	3,349
Accredited capacity the plants lose	1,082	859	1,941
Accredited capacity added	**141**	**1,267**	**1,408**

Solar plants hold 16,152 MW of deliverability. Batteries already at the plants use 2,824 MW of it, and 1,026 MW is at plants that add no battery. The plants transfer 12,291 MW of the other 12,302 MW. Of the 13,381 MW of new batteries at solar plants, 1,346 MW are at plants with no deliverability to transfer. The 21.2 GW of new batteries include 1.7 GW at plants outside CAISO, whose rules we did not assess.

Sources: CAISO Net Qualifying Capacity lists, 2026 and 2027; EIA-860, 2025; the CPUC's 2028 ELCC ratings; CAISO filing at FERC, January 2020; CAISO 2025-2026 Transmission Plan, Appendix F; CAISO stakeholder call on storage at existing sites, November 2019; CAISO generator management manual; CAISO tariff Appendix A. Surplus rules change often, so the latest rules could differ. Totals may not add because of rounding.

A rule change could let new batteries add 4.9 GW of accredited capacity

DELIVERABILITY FOR THE NEW BATTERIES

- **CAISO could let a battery get 100 MW for each 100 MW of deliverability a plant transfers.** Today a battery gets only 6 to 15 MW for each 100 MW a solar plant transfers. A battery at a wind plant gets 35 to 50 MW.
- **A plant could transfer the deliverability it never uses and still sell as much capacity as today.** A plant can sell capacity only up to the deliverability it holds. For July the CPUC counts what solar plants produce at 4 to 5 PM, before the evening peak. A solar plant sells the most in July, about 67 MW of each 100 MW, so about 33 MW of each 100 MW is never used. If each plant transfers only that part, 6.4 GW of the new batteries get deliverability. The plants keep all of their own accredited capacity. The CPUC rates a battery at 76.5 percent, so the 6.4 GW counts as 4.9 GW of accredited capacity, against 1.4 GW today.
- **A transfer set month by month would give more batteries deliverability outside the summer.** A transfer is one amount for the whole year, so the 6.4 GW is what each plant leaves unused in its own best month. The existing solar and wind plants sell 12.0 GW of capacity in July and only 1.2 GW in December. If the transfer changed by month, the plants could transfer 15.3 GW in December against 6.4 GW as one amount.
- **New deliverability from CAISO could raise the 4.9 GW of accredited capacity to 6.9 GW.** Another 2.6 GW of the new batteries need new deliverability, because their plants hold none or less than their interconnection limit. A plant and its battery together can hold deliverability only up to the interconnection limit. CAISO gives new deliverability once a year, and only from transmission capacity that exists or is already planned. A battery that needs new grid upgrades has to enter CAISO's interconnection queue as a new project. The 6.4 GW and the 2.6 GW make 9.0 GW. The 9.0 GW counts as 6.9 GW of accredited capacity.
- **A short surplus study could give each battery the deliverability the grid can carry.** The new batteries add the 4.9 GW only where the grid can still carry the batteries' power. The study would find out whether a new battery needs grid upgrades. CAISO offered the transmission capacity that solar no longer needed to new projects after 2020, so the grid can carry a battery's power at some plants and not at others. MISO aims to finish a surplus study in 90 days, SPP in 60 and PJM in 180.

CAPACITY BY MONTH (MW)

Month	Plants sell today	Batteries with deliverability, one amount all year	Batteries with deliverability, amount set each month
January	1,291	6,412	15,166
February	1,857	6,412	14,607
March	2,107	6,412	14,358
April	3,102	6,412	13,398
May	3,407	6,412	13,068
June	9,398	6,412	8,745
July	11,968	6,412	6,651
August	10,115	6,412	8,305
September	7,930	6,412	10,085
October	3,920	6,412	13,298
November	1,188	6,412	15,267
December	1,196	6,412	15,260
Average	**4,790**	**6,412**	**12,351**

MW at CAISO plants. A battery counts at the CPUC's 76.5 percent rating, so 6,412 MW of batteries is 4,905 MW of accredited capacity. We did not assess the rules outside CAISO, where 1.7 GW of the new batteries are.

Sources: CAISO Net Qualifying Capacity lists, 2026 and 2027; CAISO 2025-2026 Transmission Plan, Appendix F; CAISO generator management and reliability requirements manuals; CAISO tariff Appendix KK; CAISO filing at FERC, January 2020; the CPUC's 2028 ELCC ratings and 2027 hourly profiles; MISO Attachment X, SPP Attachment V and PJM tariff section 414. Surplus rules change often, so the latest rules could differ.

Existing interconnections avoid $9.4 billion of one-time interconnection cost

TOTAL POTENTIAL SAVINGS

$9.4 billion

- The CPUC's 2021 planning values put interconnection at $200 per kW for solar and $100 per kW for batteries. At those rates the 57.4 GW of new solar, wind and batteries avoid about $9.4 billion.

- The new projects avoid this cost because they share an interconnection that is already built. Customers share the saving, because in CAISO they repay much of the interconnection cost through transmission rates.

At other grid operators' costs the saving would be $9.6 billion. Five other grid operators averaged $168 per kW for requests studied from 2019 to 2023, up from $45 per kW for 2014 to 2018. The $9.4 billion and the $9.6 billion are both upper bounds, because a surplus request can still trigger network upgrades.

SHARED BENEFITS ACROSS STAKEHOLDERS

Renewable developer	Reduced interconnection costs; Faster development
Existing plant owner	Additional revenue streams; Diverse portfolio; More use of the owner's existing plant
Consumer	Local tax revenue; Less pollution; Low-cost power
Power system	Reliability; Higher transmission utilization; Faster supply

Surplus projects in other regions signed an agreement a median of 12 months after their request. Projects in CAISO's queue took a median of 53 months to sign one.

Sources: CPUC, RESOLVE updates, August 2021; LBNL interconnection cost data at MISO, PJM, SPP, NYISO and ISO-NE, 2014 to 2023 studies, 2025 dollars; CAISO tariff Appendix KK; FERC Docket ER24-2671; LBNL, Queued Up: 2026 Edition.

Policy options

Steps California agencies and CAISO could take	Modeled on
1 Examine existing plants before planning new ones. The CPUC could require every resource plan to examine surplus interconnection at existing plants before proposing new plants. Surplus interconnection can be cheaper, because it uses infrastructure that already exists. California's existing plants can add 34.2 GW of new solar and 21.2 GW of batteries.	Under Indiana's 2026 law, regulators consider this analysis when a utility asks to build a plant. Indiana and Virginia also require the analysis in utility resource plans.
2 Procure batteries at existing plants. The CPUC could order utilities to procure batteries at existing plants. In February 2026 the CPUC ordered 6 GW of new capacity that counts toward resource adequacy. Batteries can still earn the federal tax credit if construction starts by the end of 2033.	In 2026 Virginia required Dominion and Appalachian Power to run battery pilots of up to 500 MW and 100 MW at surplus interconnection sites.
3 Speed up permitting inside a plant's boundary. The California Energy Commission could offer a shorter opt-in review for batteries and solar added inside an existing plant's boundary.	In 2026 a separate Virginia law let a battery be added at an approved solar site without a new local land use approval. Oregon made using an existing plant's surplus interconnection a reason for a land use exception.
4 Let new batteries use more of an existing plant's deliverability. Today a solar plant gives up 100 MW of deliverability for a battery to get 6 to 15 MW. CAISO could let each battery use the deliverability its plant leaves unused. A short surplus study would find out whether a new battery needs grid upgrades. The 21.2 GW of new batteries could then add 4.9 GW of accredited capacity, against 1.4 GW today.	MISO and SPP let a battery added at a solar plant share the plant's full interconnection and deliverability. MISO aims to finish a surplus study in 90 days, SPP in 60 and PJM in 180.
5 Let owners replace a plant with any technology on an existing interconnection. When an owner replaces a plant, the new plant keeps the interconnection and deliverability only if it uses the same fuel. CAISO's rule makes an exception for batteries. So a battery can replace a gas plant on its interconnection, but new solar or wind must file a new interconnection request. CAISO could allow any technology.	MISO, PJM and SPP let a new project of any technology replace a plant on its interconnection, studied in about six months.

Publicly owned utilities outside CAISO could take these steps too, including the Los Angeles Department of Water and Power.

Sources: Public Utilities Code 454.52 and 454.53; CPUC Decision 26-02-057; Public Resources Code 25545 and 25545.1; CAISO tariff Section 25 and Appendix KK; 26 U.S.C. 48E; Indiana Public Law 126-2026; Virginia 2026 Acts Chapters 607, 608, 1011, 1013, 1076 and 1089; Oregon Laws 2026 Chapter 46; MISO, PJM and SPP tariffs. Surplus rules change often, so the latest rules could differ.

The 10 renewable plants where batteries add the most accredited capacity

WHAT EACH PLANT CAN ADD

Rank	Plant	Operator	County	Type	Nameplate (MW)	Capacity factor, 2021 to 2025	New battery (MW)	New solar (MW)	Accredited, CAISO's rule today (MW)	Accredited, with a rule change (MW)
1	**Topaz Solar Farm**	Topaz Solar Farms LLC	San Luis Obispo	Solar	586	22%	586	436	15	**169**
2	**Ocotillo Express**	Pattern Operators LP	Imperial	Wind	265	20%	265	297	32	**119**
3	**AV Solar Ranch One**	AV Solar Ranch 1 LLC	Los Angeles	Solar	253	26%	253	222	3	**93**
4	**Manzana Wind**	Avangrid Renewables LLC	Kern	Wind	189	32%	189	259	42	**85**
5	**Solar Star 1**	Solar Star California XIX, LLC	Kern	Solar	318	32%	318	291	4	**78**
6	**California Valley Solar Ranch**	Clearway Energy Operating LLC	San Luis Obispo	Solar	250	27%	250	178	7	**77**
7	**Alta Wind Energy Center V**	Alta Wind Energy Center V	Kern	Wind	168	18%	168	234	37	**76**
8	**Stateline Solar**	Southern Power Co	San Bernardino	Solar	300	24%	300	187	3	**74**
9	**Pinyon Pine I**	Pinyon Pines Wind I, LLC	Kern	Wind	168	20%	168	224	36	**74**
10	**North Sky River Energy**	North Sky River Energy LLC	Kern	Wind	162	29%	162	224	35	**72**
	Total (10 plants)				**2,659**		**2,659**	**2,552**	**213**	**915**

The figures for CAISO's rule today are after the plant gives up part of its own accredited capacity. Today a battery gets only 6 to 15 MW for each 100 MW a solar plant transfers. A battery at a wind plant gets 35 to 50 MW.

WHERE THE PLANTS ARE



Each new battery is sized at its plant's nameplate, less any battery already there. None of these plants has a battery today.

We ranked CAISO's operating solar and wind plants by the accredited capacity a battery could add with a rule change. The rule change would let each battery use the deliverability its plant holds but does not use.

Under CAISO's rule today the 10 batteries would add 213 MW. With a rule change the 10 batteries would add 915 MW.

Sources: CAISO Net Qualifying Capacity list, 2027; CAISO 2025-2026 Transmission Plan, Appendix F; CAISO generator management manual; EIA-860 and EIA-923, 2021 to 2025; our hourly dispatch model, weather year 2019; the CPUC's 2028 ELCC ratings. Totals may not add because of rounding.

PLANT RANKING

The 10 gas plants that can add the most new solar

WHAT EACH PLANT CAN ADD

Rank	Plant	Operator	County	Nameplate (MW)	Capacity factor, 2021 to 2025	Running cost, 2025 ($ per MWh)	New solar cost, 2027 ($ per MWh)	New solar cost, 2030 ($ per MWh)	New solar (MW)
1	**Marsh Landing Generating Station**	Marsh Landing LLC	Contra Costa	828	2%	$67.8	$61.0	$55.4	**847**
2	**Sentinel Energy Center**	CPV Sentinel LLC	Riverside	800	6%	$55.3	$55.6	$50.5	**453**
3	**Valley**	Los Angeles Department of Water & Power	Los Angeles	691	24%	$53.4	$58.6	$53.2	**434**
4	**Carlsbad Energy Center**	NRG California Peaker Operations LLC	San Diego	659	5%	$56.6	$59.2	$53.7	**421**
5	**Pio Pico Energy Center**	Pio Pico Energy Center LLC	San Diego	395	2%	$55.6	$58.2	$52.8	**394**
6	**Panoche Energy Center**	Panoche Energy Center, LLC	Fresno	432	22%	$57.5	$58.4	$53.0	**389**
7	**Canyon Power Plant**	City of Anaheim - (CA)	Orange	200	5%	$55.3	$59.9	$54.4	**240**
8	**Riverside Energy Resource Center**	City of Riverside - (CA)	Riverside	196	3%	$62.7	$58.6	$53.2	**233**
9	**Almond Power Plant**	Turlock Irrigation District	Stanislaus	224	12%	$73.5	$60.0	$54.4	**232**
10	**Mariposa Energy Project**	Diamond Generating Corporation	Alameda	200	5%	$61.5	$60.4	$54.8	**228**
	Total (10 plants)			**4,624**					**3,872**

WHERE THE PLANTS ARE



We ranked California's gas plants by the new solar that fits within each plant's interconnection. The list counts plants where new solar costs less than running the plant by 2030.

In 2027 new solar already costs less than running the plant at 4 of the 10: Marsh Landing, Riverside Energy Resource Center, Almond and Mariposa.

Sources: EIA-860 and EIA-923, 2021 to 2025; BloombergNEF 2026; California carbon allowance auction, August 2026; our hourly dispatch model, weather year 2019. Totals may not add because of rounding.

Imperial Solar Energy Center West in Imperial County

FACILITY INFORMATION

LOCATION
Imperial County, California

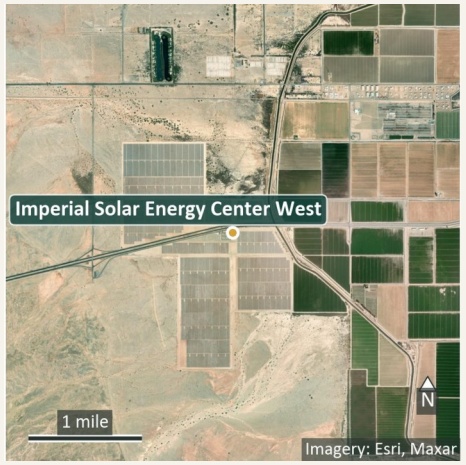
INTERCONNECTION CAPACITY
149 MW at 230 kV

OWNER AND OPERATOR
CSOLAR IV West LLC

IN SERVICE
Since 2016

CAPACITY FACTOR
27.4 percent in 2025

SATELLITE VIEW OF THE PLANT



LAND AROUND THE PLANT

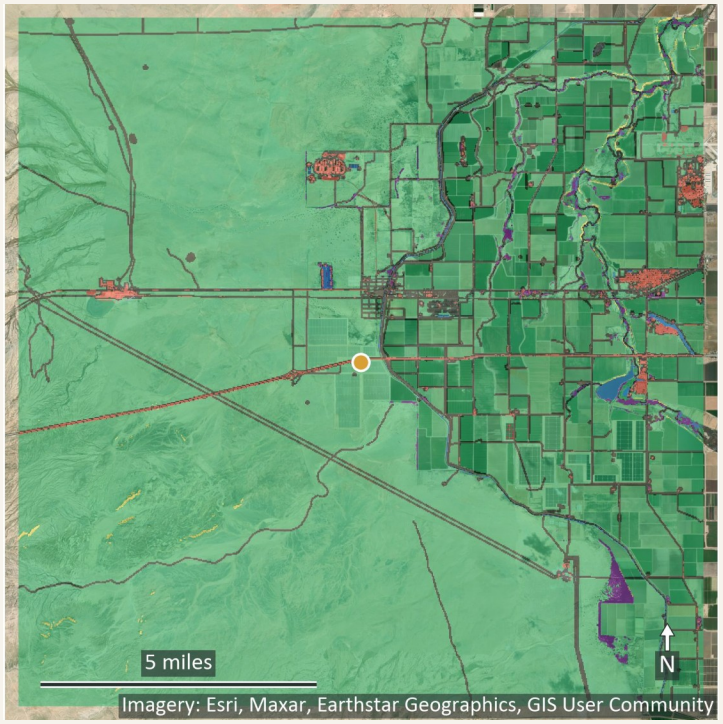


The plant's interconnection is rated 149 MW, the same as its solar nameplate. So the plant's capacity factor is also the share of the interconnection it uses. The plant ran at a 27.4 percent capacity factor in 2025.

Sources: EIA Form 860 and Form 923, final 2025, via PUDL; imagery from Esri, Maxar, Earthstar Geographics and GIS User Community.

Imperial Solar Energy Center West: land use around the plant

LAND-USE CLASSIFICATION



- Buildable
- Sensitive habitat
- Urban area
- Unfavorable topography
- Permanent water and wetland
- Removed by local solar setbacks

LAND SCREENING

The map shows a square of land about 12 miles on a side, centered on the plant. The map's colors show which land is buildable and why the rest is removed. Our screen applies more than 50 exclusion criteria, including setbacks. The screen removes 40 kinds of protected area and 6 kinds of land cover, such as towns and water. The screen also removes steep slopes. The setbacks remove land near buildings, roads and power lines.

- **Most of the land around the plant can be built on.** After the screen and setbacks, 89.2 percent of the land remains buildable.
- **Buildable land around the plant could carry 11,617 MW of solar.** We apply published capacity densities to the buildable land. Wind needs wider setbacks, and the land left after them could carry 1,356 MW of wind.

SITE CHARACTERISTICS

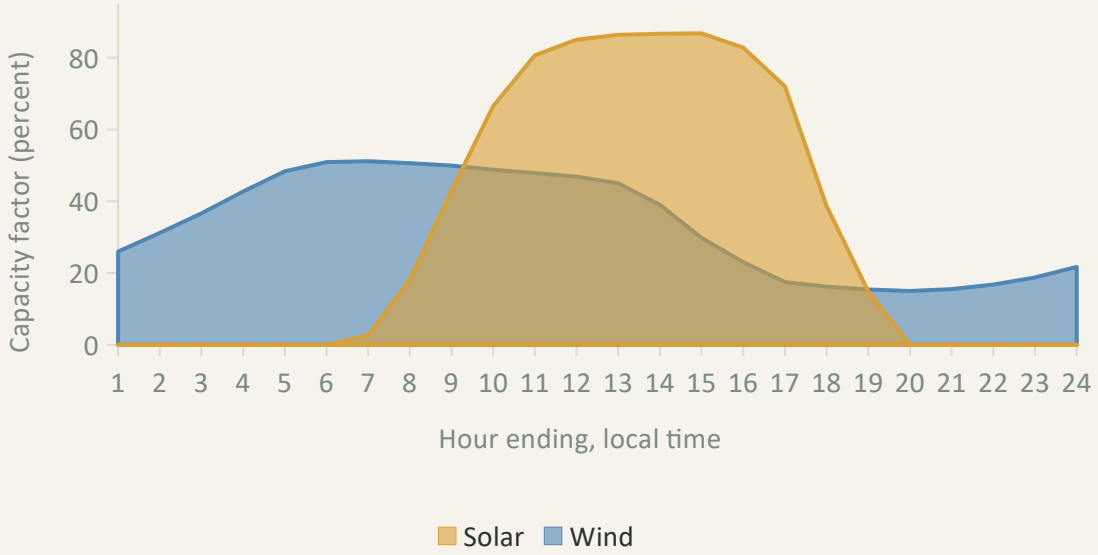
89.2 percent	149 MW	11,617 MW	1,356 MW
BUILDABLE SHARE OF THE 12-MILE SQUARE	INTERCONNECTION CAPACITY	SOLAR POTENTIAL IN THE 12-MILE SQUARE	WIND POTENTIAL IN THE 12-MILE SQUARE

Land is not the constraint here. The land in the 12-mile square could hold about 78 times the plant's 149 MW interconnection in solar. The interconnection limits how much power the site can send in any hour.

Sources: our siting screen with standard local setback rules; capacity densities from Lopez et al. 2025, NREL/TP-6A20-91900; imagery from Esri, Maxar, Earthstar Geographics and GIS User Community.

Imperial Solar Energy Center West: solar and wind resource

CAPACITY FACTOR BY HOUR



On an average day, solar here runs above 80 percent of its capacity for six hours.

CAPACITY FACTORS

31.8 percent

NEW SOLAR HERE, 2019 WEATHER

33.5 percent

NEW WIND HERE, 2019 WEATHER

LEVELIZED COST OF ENERGY, 2030

New solar — **$50 per MWh**

Capital cost $1,494 per kW.

New wind — **$72 per MWh**

Capital cost $1,871 per kW.

We model new solar and new wind here hour by hour with 2019 weather, as for every plant in this study. Our model gives new solar here a 31.8 percent capacity factor. The plant itself averaged 29.9 percent over 2021 to 2025 and ran at 27.4 percent in 2025. The 2030 solar and wind costs include no federal tax credit.

Sources: BloombergNEF 2026 LCOE Update (2H 2025 data), California, 2025 dollars; hourly solar and wind profiles, weather year 2019.

CASE STUDY, RENEWABLE PLANT

Imperial Solar Energy Center West: Optimal Build

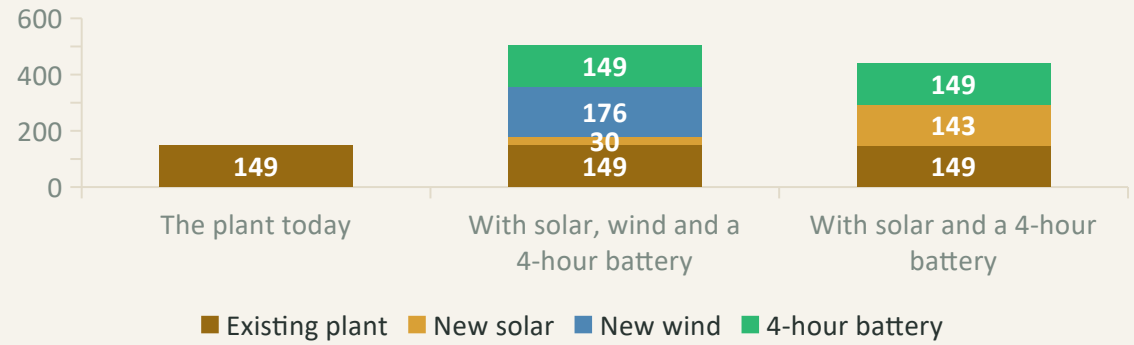
3.39x	40.3 pp	$164	$68
CAPACITY INCREASE	CF GAIN (PERCENTAGE POINTS)	ESTIMATED BATTERY REVENUE PER KW-YEAR	BATTERY COST PER KW-YEAR

The battery earns most of this revenue by selling capacity, which needs deliverability.

We added a 149 MW battery and sized new solar and wind to send the most energy through the interconnection.

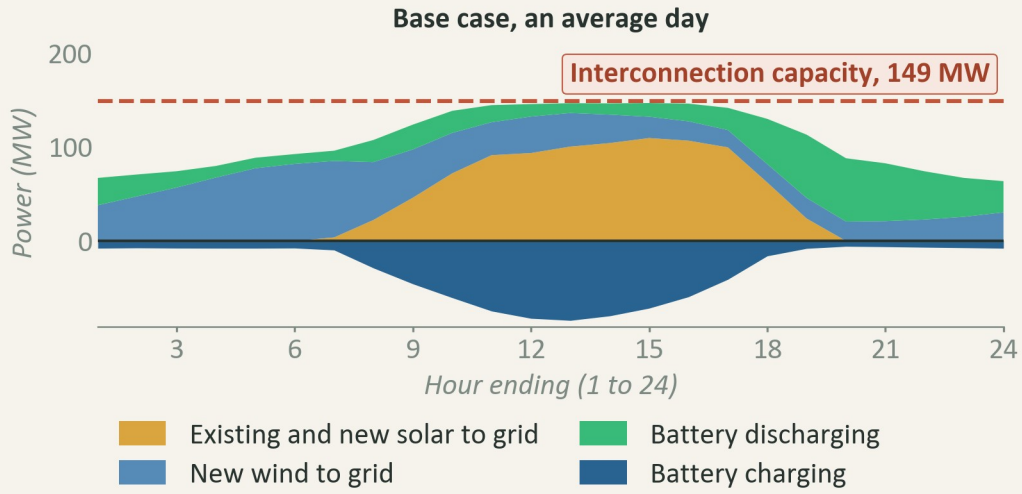
The new solar is 30 MW and the new wind 176 MW. Installed capacity rises from 149 MW to 504 MW. The modeled capacity factor rises from 31.8 to 72.1 percent.

OPTIMAL CAPACITY CONFIGURATION (MW)



The new solar, wind and battery all share the plant's 149 MW interconnection. The three additions fit because solar peaks at midday and wind at night, and the battery moves midday power into the evening. In our model the site's output rises from 415 GWh to 939 GWh a year.

24-HOUR ENERGY FLOW PATTERN



On an average day the battery charges most at midday and discharges most in the evening. At midday the solar and wind produce more than the 149 MW interconnection can carry, so the battery stores the extra. The site fills its 149 MW interconnection in 4,778 hours of the year. Over the year 5.0 percent of the site's solar and wind output is curtailed.

Sources: our hourly dispatch model, weather year 2019.

CASE STUDY, RENEWABLE PLANT

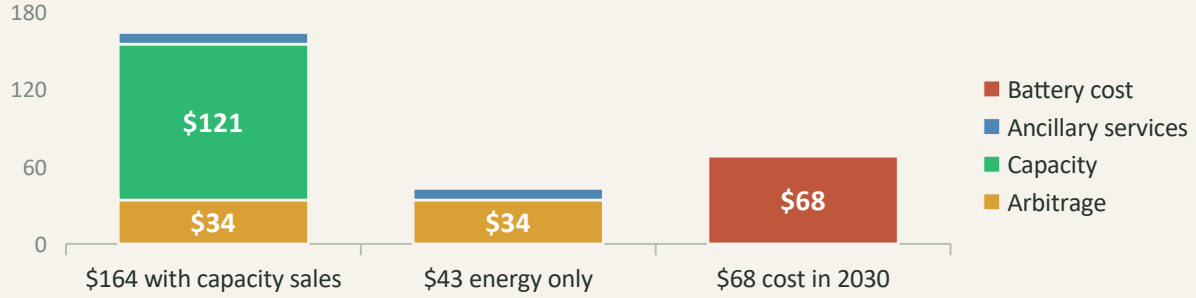
Imperial Solar Energy Center West: battery revenue and cost

$34	$121	$9	$68
ARBITRAGE REVENUE PER KW-YEAR	CAPACITY REVENUE PER KW-YEAR	ANCILLARY SERVICES PER KW-YEAR	BATTERY COST PER KW-YEAR

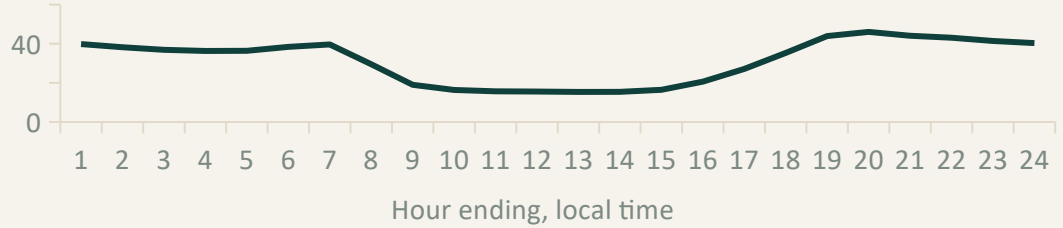
BATTERY REVENUE AND COST

With deliverability, a battery at Imperial Solar Energy Center West could earn more than twice the battery's cost.

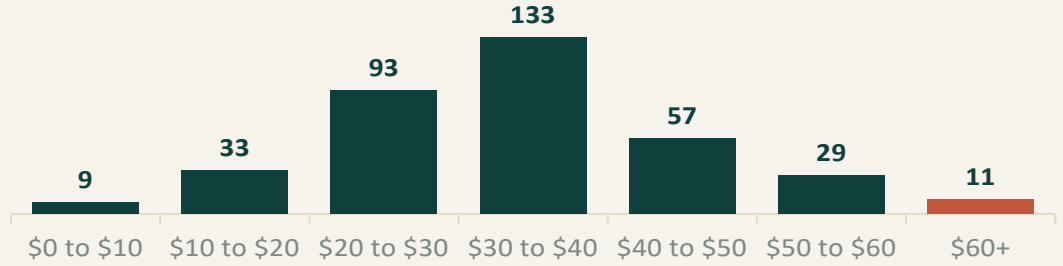
The battery could earn about $164 per kW-year with deliverability and $43 without, against a 2030 cost of $68. The $121 of capacity revenue assumes the whole 149 MW battery is deliverable, because resource adequacy contracts pay a deliverable 4-hour battery for its full rated capacity. The CPUC's 76.5 percent rating is for planning, not for these contracts. Under CAISO's rule today only 9 MW of the battery could use the solar plant's deliverability. CAISO's studies count this solar at about 6 percent of its 149 MW in the evening. The other 140 MW would need its own deliverability allocation. The $68 cost is after the 30 percent federal tax credit for storage, which new solar and wind no longer get.



HOURLY PRICE ($ PER MWH)



DAYS BY DAILY PRICE SPREAD



The daily spread was most often $30 to $40, on 133 days.

Sources: CAISO OASIS prices at the plant, 26 September 2025 to 25 September 2026; CPUC Market Price Benchmarks, 2026; CAISO market monitor, 2025 Annual Report; BloombergNEF 2026; CAISO generator management manual.

Imperial Solar Energy Center West: build options compared

CONFIGURATION COMPARISON

Configuration	New solar (MW)	New wind (MW)	Battery (MW / hours)	Output (GWh per year)	Site capacity factor	Capacity increase	Additional energy (GWh per year)
Existing plant only	0	0	0	415	31.8%	1.00x	0
Solar only	32	0	0	478	36.7%	1.21x	+64
Wind only	0	67	0	580	44.5%	1.45x	+165
Solar and 4-hour battery	143	0	149 MW / 4 hr	740	56.8%	2.96x	+325
Solar, wind and 4-hour battery	**30**	**176**	**149 MW / 4 hr**	**939**	**72.1%**	**3.39x**	**+524**
Solar and 6-hour battery	185	0	149 MW / 6 hr	846	64.9%	3.25x	+431
Solar, wind and 6-hour battery	86	154	149 MW / 6 hr	1,016	78.0%	3.61x	+601

Each option in the table stays within the plant's 149 MW interconnection. Within that limit new solar, wind and a 4-hour battery more than double the site's output. The 6-hour rows send more energy, but the Optimal Build keeps the 4-hour battery used in the statewide results. All options are modeled with 2019 weather, which gives the plant alone 31.8 percent. The plant ran at 27.4 percent in 2025.

Sources: our hourly dispatch model, weather year 2019.

Appendix

Detailed Methodology

Methodology

Step	Method
Gas plants counted	We count gas plants where new solar costs less per MWh than running the plant by 2030. The running cost is the plant's fuel and variable operating cost plus California's carbon allowance, $28.40 per short ton of CO2 in 2025 dollars. Fuel prices are 2025 prices from EIA-923, held flat in real terms. Most plants use California's average gas price, and the rest use their own fuel records. The test counts 17.1 GW of gas capacity at 88 plants. The 88 plants' five-year capacity factors range from 0.0 to 35.8 percent, and 71 of the 88 are below 5 percent. The test counts 13.3 GW at 76 plants in 2027 and 29.2 GW at 114 plants by 2035. Each year's plants include all of the earlier year's.
Solar at gas plants	Solar is added only at the gas plants where it is the cheaper source of energy. In each hour the new solar uses only the interconnection capacity the plant's own output leaves unused. The model adds no batteries at these plants. At nearly all of them new wind would run below a 30 percent capacity factor, which makes it uneconomic. So the fossil plants add solar only. Our build adds batteries only at solar and wind plants, a choice made for every state in this study. So the 57.4 GW of additions includes no battery at a gas plant, and a battery there would come on top of it. The 88 gas plants counted are 10 combined cycle plants, 73 combustion turbine plants and 5 oil and gas steam plants. The combined cycles have 2,990 MW, the combustion turbines 10,922 MW and the oil and gas steam plants 3,204 MW. Each plant is classed by its main technology, with Humboldt Bay's 167 MW of gas engines among the combustion turbines. In 2025 the combined cycles ran at a 16.9 percent capacity factor, the combustion turbines at 4.2 percent and the oil and gas steam plants at 0.2 percent. All three are averages weighted by nameplate. Classing by plant differs from the unit classes on the fossil fleet page, where combustion turbines averaged 2.9 percent in 2025.
Wind and solar plants	At 360 existing solar and wind plants the model adds a 4-hour battery, new solar and new wind. Each battery is sized to its plant's nameplate, less any battery already there. The model then sizes the new solar and wind to send the most energy through each interconnection, without comparing costs. Curtailment is capped at 5 percent of each site's solar and wind output over the year. New wind is added only where its capacity factor is 30 percent or more after losses. The 25.3 GW of new solar is 17.4 GW at 283 solar plants and 7.9 GW at 77 wind plants. The 2.0 GW of new wind is 0.9 GW at 30 solar plants and 1.1 GW at 69 wind plants. Without the new batteries the same 5 percent limit would let these plants add 5.3 GW of new solar and 1.7 GW of new wind. The 283 solar and 77 wind plants are utility-scale plants of 10 MW and above that began operating by 2025. They are across California, including areas outside CAISO. We leave out five solar thermal plants of 923 MW.
Batteries already at the plants	The 21.2 GW of new batteries leaves out the 7,544 MW of batteries already at the solar and wind plants. EIA lists 6,239 MW of them under 67 solar plants' own records. The other 1,305 MW is in 12 batteries listed by EIA as separate plants. CAISO's Net Qualifying Capacity lists or EIA's own records tie each of the 12 to a solar or wind plant. The 12 are Sunlight Storage I and II, Sanborn BESS 1 to 4, Lancaster Area Battery, Luna Storage, Mojave 16/17/18 BESS, Cal Flats BESS, Lockhart ESS and Beacon BESS 1. Each of the 12 shares an interconnection with one or more plants. In all, 83 plants already have a battery: 81 of the 283 solar plants and 2 of the 77 wind plants. That is the 67 plants with a battery of their own and 16 more that share one of the 12. The model first sizes a battery at each plant's nameplate, 28,642 MW in all. At each plant it then takes out the batteries already there, down to zero where they are larger than the nameplate. That leaves 21,249 MW. At 18 solar plants the batteries already there are at least as large as the nameplate, so these plants get no new battery. We do not subtract the 9.9 GW of batteries EIA lists as planned in California.

Sources: our hourly dispatch model, weather year 2019; EIA-860, EIA-860M (July and September 2026) and EIA-923, 2021 to 2025; CAISO Net Qualifying Capacity lists, 2026 and 2027, and completed queue report; LBNL hybrid plant data, 2025; BloombergNEF 2026; NLR Annual Technology Baseline 2025; Lopez et al. 2025, NREL/TP-6A20-91900; the CPUC's 2028 ELCC ratings.

Methodology

Topic	Detail
Queue	California's queue means CAISO's queue for projects at California sites. California's other grid operators run their own queues, which are not counted. They include the Los Angeles Department of Water and Power, the Balancing Authority of Northern California and the Imperial and Turlock Irrigation Districts. In CAISO's queue for California, solar with batteries is 39,542 MW and wind with batteries 3,449 MW. Stand-alone storage is 30,955 MW in 109 requests. The queue chart's Other bar is geothermal, hydro and hydrogen. It also includes projects with solar, wind and batteries together. CAISO's whole queue is 102.6 GW, because it also has projects in Arizona, Nevada and Mexico. Stand-alone gas projects total 55 MW in two requests. Four requests would add 181 MW of batteries at California gas plants. These plants would still send at most 458 MW to the grid, the same as today. Of the 2,076 California requests through Cluster 14, 1,622 have dropped out and 231 reached operation. The 99 months is the median for the 40 CAISO projects that reached operation from 2023 to 2025 in LBNL's data. CAISO's own list gives a similar median for California. The 81 California projects on it that reached operation from 2021 to 2026 took a median of 97 months. MISO's median covers 2023 and 2024 only. The other regions' medians cover 2023 to 2025, like CAISO's. Other West covers the utilities in the West outside CAISO. The chart leaves out NYISO, at 87 months from only 5 projects. LBNL's data give no figure for ISO-NE. The 53 months from request to a signed agreement in CAISO's queue is the median for the 147 CAISO projects that signed one from 2023 to 2025 in LBNL's data.
Resource adequacy	Resource adequacy is the capacity the CPUC requires the retail suppliers it regulates to contract for each month's forecast peak plus a reserve. They are the utilities, community choice aggregators and electric service providers. They serve about 90 percent of CAISO's peak load, and publicly owned utilities set their own rules. The CPUC's reports say bilateral contracts make up most of their capacity buying. Since 2023 PG&E and SCE also buy local capacity for all customers in their areas, and CAISO can buy uncontracted capacity as a backstop. The prices are averages of capacity-only contracts in the CPUC's yearly reports. The latest report covers 2023 and was updated in September 2026. It also lists contracts signed through September 2024 for 2024 and 2025, which set its prices for those years. Early prices like these can change once a year's own report comes out. The 2022 report put the 2024 price at $9.04 per kW-month, against $14.51 in the 2023 report. The CPUC's market price benchmarks use a wider set of trades. They give $11.21 per kW-month for 2025 and $10.11 for 2026. The comparison with PJM and MISO is in dollars per kW-year. California's figure is the average contract price times 12. More capacity is bought in the summer months when prices are higher. So the average leans toward summer prices. Times 12, it runs about 4 percent above the cost of holding 1 kW for all 12 months. PJM's figure is its capacity auction price for the year from June, and its 2026 price is the auction's cap. MISO's is the annual price of its North and Central zones. In 2024 PJM's price was $10.56 per kW-year and MISO's $7.33 per kW-year. In 2026 MISO's is $46.06 per kW-year. California's 2026 figure is the CPUC's benchmark, since no report gives a 2026 contract price yet. Each market counts a kW of capacity its own way. The CPUC's orders since 2021 call for 21,500 MW, counted at the ELCC ratings each order set. Since 2025 the CPUC's slice-of-day rules require each supplier to show capacity for every hour of each month's peak day.
Household bills	The $722 added to a yearly household bill is the 2019 to 2025 rise in the residential price times 5,922 kWh. That is the average use per residential account in 2025. The $722 assumes the same use each year and is in nominal dollars. EIA's average price is revenue over sales. The 2025 price is EIA's final annual figure, released in October 2026. Final sales came in higher than in EIA's preliminary monthly data, so the final price is lower. Consumer prices are the BLS consumer price index for all urban consumers, U.S. city average: 255.657 in 2019 and 321.943 in 2025. The 2025 index averages 11 months, as BLS collected no October 2025 data. After inflation the residential price rose 30 percent from 2019 to 2025. EIA's state price series starts in 1970. After inflation, each year from 2021 to 2025 is higher than any year from 1970 to 2020, and 2024 is the highest. The CPUC puts most of the 2019 to 2025 rise on wildfire costs, distribution spending and rooftop solar credits.

Sources: CAISO queue, 26 September 2026; LBNL, Queued Up: 2026 Edition, data file; CPUC Resource Adequacy Reports, 2019 to 2023, Slice-of-Day report, 2024, and Market Price Benchmarks, 2025 and 2026; PJM and MISO capacity auction results; EIA Form 861 annual state data, 1970 to 2025; BLS consumer price index; CPUC SB 695 Report, 2025.

Methodology

Topic	Detail
Generation by source	CAISO publishes output by source every five minutes for its own area in Today's Outlook. CAISO's area leaves out the Los Angeles Department of Water and Power and other utilities. The average-day chart covers 26 September 2025 to 25 September 2026. The 9 PM figure averages the readings from 9:00 to 9:55 PM. The average-day chart shows supply only, so it leaves out batteries while they charge and power sent out of CAISO's area. Other renewables are geothermal, biomass, biogas and small hydro. Gas averaged 6.82 GW at both 8 PM and 9 PM and stayed above 6.7 GW from 7 to 10 PM. Batteries were the largest source at 7 and 8 PM, and gas at 9 and 10 PM. Battery output peaked at 7.3 GW at 7 PM. CAISO changed how it counts gas on 13 December 2023, from what remained after the other sources to the plants registered as gas plants. EIA's hourly data show the old count put gas at 9 PM about 0.6 GW too high. The 9 PM chart's first period, September 2023 to September 2024, has 78 days before the change. Cutting gas by 0.6 GW on those days lowers the period's average from 10.8 GW as published to 10.7 GW. Batteries averaged 0.2 GW at 9 PM in 2021.
Transmission plans	CAISO plans new transmission in a 20-year outlook and in yearly transmission plans. The 2024 outlook's $45.8 to $63.2 billion is in constant dollars and leaves out transmission CAISO had approved by July 2024. The May 2026 plan's 38 projects cost $6.7 billion in all and are to be built over the next 10 years. Of the 38, 33 are for reliability and cost $4.2 billion. Four serve state policy goals and cost $2.4 billion. One is an economic project costing $150 million. The May 2025 plan had 31 projects. CAISO says the May 2026 projects are consistent with its 20-year outlook. Other California utilities make their own transmission plans. CAISO printed the same 0.5 cents per kWh for its $4.8 billion plan of May 2025, so that figure is rounded. CAISO gives no bill estimate for the outlook. The Public Advocates Office modeled only the outlook's high end, without the projects CAISO had approved and with load growing 2.18 percent a year. Its December 2025 dashboard puts the high-voltage transmission charge at $40.18 per MWh in 2045 with the outlook, against $13.95 in April 2025. Without the outlook its chart reaches about $17.5 per MWh in 2045, so the difference from $40.18 is about $22.7 per MWh. That is about 2.3 cents per kWh. These are charges per kWh of load, not the change in any one bill. The outlook plans for 20 GW of offshore wind, 5.4 GW at Morro Bay and 14.6 GW on the North Coast, toward California's goal of 25 GW by 2045 under AB 525. CAISO says the North Coast has "virtually no capacity to export offshore wind to load centers today". Offshore wind is 55 percent of the cost at the outlook's low end and 58 percent at its high end. The CPUC's Electrification Impacts Study by Kevala, 2023, puts distribution upgrades at about $50 billion by 2035 if load growth is not managed. That is $27.6 billion at PG&E, $20.3 billion at SCE and $3.1 billion at SDG&E. In 2024 distribution made up 11.2 to 13.8 cents per kWh of the three utilities' average bundled rates, against 1.4 to 3.9 cents for transmission.

Sources: CAISO Today's Outlook; EIA-930, 2023 and 2024; CAISO transmission outlook and plans, 2024 to 2026; CPUC Public Advocates Office, Transmission Data Dashboard, 2025; CPUC Electrification Impacts Study, 2023, and utility costs report, 2025; CEC offshore wind strategic plan, 2024; surplus queues, September to November 2026; SPP surplus agreements at FERC; surplus agreements at FERC and MISO; FPL Ten Year Site Plan, April 2026; EIA-860M, September 2026.

Methodology

Topic	Detail
State bills	The table lists the state bills of 2025 and 2026 whose main subject is surplus interconnection, from each legislature's records as of 9 November 2026. Maryland and New Jersey laws that mention PJM's surplus service only inside storage programs are left out. Governor Newsom vetoed AB 1408 on 3 October 2025, writing that it 'risks constraining energy resource procurement and interconnection options, likely increasing customer electric costs and undermining electric grid reliability.'
Surplus request counts	The 325 requests come from the surplus queues of SPP, MISO and PJM and of utilities in the West and the Southeast. They hold no CAISO requests, because CAISO's queue does not mark surplus requests. They leave out withdrawn requests and projects already operating. Of their 47.7 GW, 42.2 GW has a published technology, and batteries are 74 percent of it. MISO does not publish the technology of the other 48 requests, 5.5 GW in all. SPP's 12-month median covers its 41 surplus agreements filed at FERC.
Operating projects	A project is listed when it was filed or studied as surplus interconnection and its owner or its utility reports it as operating. The list counts 32 projects in 23 rows. Four Clearway batteries in Utah share one row, and seven FPL batteries in Florida share another. At Skeleton Creek, Paris and Cavalry only part of each battery uses surplus interconnection, and only that part counts. Six more are left out because records disagree on whether they operate or use surplus interconnection. We found no California battery added through surplus interconnection, so none is listed. FPL has not published request dates or agreements for its seven batteries. At Babbitt Ranch the wind began operating a month before its agreement was signed. Leaving out the seven FPL batteries and Babbitt Ranch, a signed agreement took 2 to 33 months from request across the other 24 projects. Their median is 12 months. Operation took 2 to 37 months more. Months are rounded, so a row's columns can be a month off the total.

Sources: CAISO Today's Outlook; EIA-930, 2023 and 2024; CAISO transmission outlook and plans, 2024 to 2026; CPUC Public Advocates Office, Transmission Data Dashboard, 2025; CPUC Electrification Impacts Study, 2023, and utility costs report, 2025; CEC offshore wind strategic plan, 2024; surplus queues, September to November 2026; SPP surplus agreements at FERC; surplus agreements at FERC and MISO; FPL Ten Year Site Plan, April 2026; EIA-860M, September 2026; state legislatures' bill records, 9 November 2026; Governor's veto message on AB 1408, 3 October 2025.

Methodology

Topic	Detail
Fossil fleet	We take each plant's interconnection capacity as its nameplate. Interconnection capacity is the most power a plant may send to the grid. A plant's capacity factor is a year's output divided by what it would generate at full nameplate in every hour. So its capacity factor is also the share of its interconnection capacity it uses. The fossil capacity factor chart covers 34,012 MW. Another 90 MW reported no output in 2025, and together they make the 34.1 GW fleet. On the 2021 to 2025 average, 21.8 GW ran below a 30 percent capacity factor. We leave out combined heat and power plants (5,608 MW), plants below 10 MW and plants behind a customer's meter. The combustion turbines include 310 MW of engines. Gas combined cycles had the highest capacity factor. The 19,388 MW of combined cycles averaged 30.2 percent in 2025, down from 38.7 percent in 2021. The variable cost of running is each plant's heat rate times its 2025 delivered fuel price, plus variable operating cost and the cost of carbon allowances, in 2025 dollars. Carbon is priced at $28.40 per short ton, from the California and Quebec allowance auction of August 2026. Without carbon, 8.1 GW would cost more than $50 per MWh to run, against 20.9 GW with it. Weighted by capacity, the fleet averages $59.72 per MWh. Combined cycles average $49.24, combustion turbines $66.15 and oil and gas steam units $92.61. Four oil and jet fuel turbines are counted with the oil and gas steam units. They total 245 MW. They are priced at the gas price, so their costs are understated. California's delivered gas price to power plants was $4.29 per MMBtu in 2025, against $3.87 for the U.S. The comparison with new solar at gas plants uses this variable cost of running.
Land	We screen a square of land 20 km (12.4 miles) on a side, centered on each plant. Its edges are 6.2 miles from the plant and its corners 8.8 miles. The screen applies 53 exclusion criteria: 48 land tests plus 5 setbacks. The 48 land tests are 40 kinds of protected area from PAD-US 3.0, 6 land covers from ESA WorldCover 2021, slopes above 10 degrees and elevation above 4,000 m. The land covers are tree cover, built-up land, snow and ice, permanent water, herbaceous wetland and mangroves. The 5 setbacks keep projects away from buildings, roads, railroads, power lines and water. Solar setbacks are 61 m from buildings and 30 m from the other four. Wind setbacks are 400 m from buildings and 220 m from the other four. Local ordinances apply where they exist. Cropland stays buildable. Airports, tribal land, floodplains, parcels and zoning are not screened.

Sources: EIA-860, EIA-860M and EIA-923; EPA hourly emissions data; California carbon allowance auction, August 2026; EIA natural gas prices, 2025; our siting screen; PAD-US 3.0; ESA WorldCover 2021.

Methodology

Topic	Detail
Accredited capacity	We use the CPUC's 2028 ELCC ratings from its 2023 study. Solar is rated at 8.8 percent and wind at 14.7 percent. A 4-hour battery is rated at 76.5 percent. Existing solar across California is accredited at 1,961 MW and existing wind at 934 MW. If every new battery were deliverable they would be rated at 16,255 MW. The CPUC's August 2026 study for its 2030 to 2031 procurement rates a 4-hour battery at 38 percent. At that rating the 21.2 GW would be rated at about 8.1 GW.
Totals	The new capacity at existing plants totals 57.4 GW of nameplate. Solar is 34.2 GW of it, with 8.9 GW at gas plants where new solar costs less than running the plant in 2027, and 25.3 GW at existing solar and wind plants. Batteries are 21.2 GW and wind 2.0 GW. 52.2 GW of the 57.4 GW is at plants in CAISO's area. At the CPUC's 2028 ratings the new solar, wind and batteries would carry up to 19.6 GW of accredited capacity. Batteries give 16.3 GW, solar 3.0 GW and wind 0.3 GW. The 19.6 GW counts every new project as deliverable, so how much of it counts depends on the deliverability each plant can give its new projects. A plant and its batteries together cannot hold more deliverability than the interconnection limit, so the batteries at CAISO plants could add up to 6.9 GW. Totals may not add because of rounding.
Deliverability at existing plants	Deliverability is the MW CAISO has found the grid can carry from a plant at the peak, and a plant counts as capacity only for those MW. We take each plant's status from CAISO's Net Qualifying Capacity lists for 2026 and 2027, matched to EIA plants. CAISO has 251 solar plants and 20.2 GW of solar nameplate. 138 of the plants, 9.4 GW in all, hold full deliverability. Another 33 hold it on 2.9 GW while network upgrades are built. 30 hold part of it on 4.8 GW, and 39 hold none on 2.4 GW. Ten of those 39, 1.9 GW in all, hold none because a battery on the same site holds the deliverability. The other 11 plants, 0.6 GW in all, are not on the lists or not matched. In all the solar plants hold 16.2 GW of deliverability. CAISO's list shows 13.3 GW, because where a battery shares a solar plant's interconnection the list shows the solar net of the battery's share. The 76 wind plants hold 5.9 GW of deliverability on 6.2 GW of nameplate. When solar's rating fell in 2020, CAISO's studies counted solar at less output in the peak, so the same lines could carry power from other plants. CAISO gave that room to other projects, and the 16.2 GW is what the plants hold today, after that. Solar's August capacity value was 80 percent of nameplate under the CPUC's method until 2017, 27 percent under its ratings for 2020 to 2022 and 12.4 percent for 2023. Under today's slice-of-day rules a solar plant sells a share of its monthly net qualifying capacity, which the buyer counts hour by hour on solar's output profile. On those profiles CAISO's solar plants together count 0.15 GW at 7 PM in August 2027. The CPUC's 2028 ratings accredit the solar plants in CAISO alone at 1.8 GW and the wind plants in CAISO at 0.9 GW.
Deliverability for the new batteries	We count the new batteries' accredited capacity in three cases, at the CPUC's 76.5 percent rating. Under CAISO's rule today a battery can take over part of its solar or wind plant's deliverability. CAISO counts that transfer at the share of the plant's capacity its evening study assumes, 6 to 15 percent for solar and 35 to 50 percent for wind. The plant then stops counting as capacity on the part it hands over, so the batteries add about 1.4 GW net, 1.3 GW of it at wind plants. A rule change letting each battery use the deliverability its plant holds but does not use gives about 4.9 GW. Each plant keeps the most it counts in any month on CAISO's 2027 list. The case caps each battery at its size and the room left in the interconnection. It does not test the evening grid, which a study at each plant would do. Set month by month, the transfer would let 6.7 GW of batteries count in July, 15.3 GW in December and 12.4 GW on average. With new deliverability a battery can count up to the room under its plant's interconnection limit beside the plant's best month. That is 9.0 GW of batteries, or 6.9 GW at the rating. The three cases cover the 19.5 GW of batteries at CAISO plants. We did not assess the rules for the 1.7 GW of new batteries at plants outside CAISO. New solar and wind also count only with deliverability. At the CPUC's newer 38 percent rating for 2030 to 2031, today's rule becomes a loss of 0.3 GW, the rule change a gain of 2.4 GW and new deliverability a gain of 3.4 GW. The rules are as of 9 November 2026.

Sources: the CPUC's 2023 ELCC study and its August 2026 study; CAISO Net Qualifying Capacity lists, 2026 and 2027; CAISO filing at FERC, January 2020; CPUC Decision 22-06-050; CAISO 2025-2026 Transmission Plan, Appendix F; CAISO generator management manual; CAISO tariff Appendix KK.

Methodology

Topic	Detail
Interconnection cost	The $9.4 billion of interconnection cost the new projects avoid uses the CPUC's planning values of August 2021, $200 per kW for solar and $100 per kW for batteries. The CPUC set the battery value lower because many batteries connect at existing solar or gas plants. It gives no wind value, so wind takes the solar value. These are 2021 planning inputs with no stated dollar year, and the CPUC does not say whether they include network upgrades. CAISO's study reports list upgrade costs only on its secure portal. Its published averages cover only parts of the cost, such as $60 per kW for reliability upgrades in 2012. The second estimate, $9.6 billion, uses LBNL's cost data at MISO, PJM, SPP, NYISO and ISO-NE. The 2,109 requests studied from 2019 to 2023 that were not withdrawn have a size-weighted average of $168 per kW in 2025 dollars, our computation from LBNL's data. On the same basis the average was $45 per kW for studies from 2014 to 2018. Counting only requests that finished their studies, it doubled from $41 to $81 per kW. Using each technology's own average from the same data instead, $179 per kW for solar, $234 for batteries and $137 for wind, gives $11.4 billion. Each avoided cost is an upper bound, because a surplus request can still trigger network upgrades. In CAISO the developer pays for network upgrades first. After operation the transmission owner repays reliability upgrades up to $104,947 per MW and local deliverability upgrades in full over five years. It recovers them through CAISO's transmission access charge, so customers pay for them. Interconnection facilities are never repaid. Surplus projects reached a signed agreement a median of 12 months after their request. CAISO's queue took a median of 53 months to a signed agreement, for agreements signed from 2023 to 2025 in LBNL's data.
Surplus interconnection in CAISO	In CAISO a plant can let a new project use the interconnection capacity it leaves unused, at the same point of interconnection and within the plant's installed capacity. This surplus interconnection service is in tariff Appendix DD section 3.4, in force since 20 February 2020, and Appendix KK section 3.4, since 17 May 2024. If the new project needs no new request, CAISO studies the hand-over as a modification. That takes a $30,000 deposit and an answer in 60 days, or up to 120. An operating plant adds a battery under tariff section 25.5. CAISO approves it only if the MW at the point of interconnection and the site's net qualifying capacity, its capacity value, do not rise. So a battery added this way counts as capacity only by taking part of the plant's own deliverability. CAISO publishes no count of surplus requests. The 2.1 GW of batteries added at existing plants counts batteries that started at least 12 months after the solar or wind beside them, at plants of 10 MW and up, from EIA-860M for September 2026. 2,086 MW of it is in CAISO and 20 MW at the Los Angeles Department of Water and Power. We class a battery as added by modification when CAISO's queue shows it on the plant's own queue position with the MW to the grid unchanged, or a utility filing names the modification. In CAISO, 1,685 MW came through a modification: 1,549 MW at operating plants and 136 MW added to a project still in CAISO's queue, before its solar ran. Another 401 MW came through new cluster requests. A surplus hand-over is studied the same way as a modification, but it is filed as surplus service. The batteries we found were filed as modifications of a plant's own agreement or request, and none as surplus service. The batteries' median of 18.5 months from request to operation covers the 10 batteries with dated filings by Southern California Edison, 1,342 MW in all. Seven of them took 10 to 20 months, and the range is 10 to 51 months. Five of their requests came in CAISO's one-time storage window of 2019 and were studied together. For comparison, SPP's seven surplus projects took 17 to 30 months from request to operation. The 99 months is LBNL's median for CAISO projects built from 2023 to 2025. CAISO's yearly modification reports count studies for projects before they start operating, so they do not measure additions at operating plants. They counted 93 modification requests in 2025 and 80 approvals, and they give no MW.

Sources: CPUC RESOLVE updates, August 2021; LBNL interconnection cost data, 2014 to 2023; CAISO tariff Appendices DD, KK and LL and Section 25; FERC Dockets ER24-2042 and ER24-2671; utility filings at FERC, 2019 to 2024; CAISO modification reports, 2019 to 2025; EIA-860M, September 2026; LBNL, Queued Up: 2026 Edition. Surplus rules change often, so the latest rules could differ.

Methodology

Topic	Detail
Hourly limit	Each plant and its additions stay within the existing interconnection in every hour. Over the year curtailment is capped at 5 percent of the site's solar and wind output. The model looks at one site at a time. It does not test curtailment across the whole grid.
Weather and costs	The model uses 2019 weather and 2030 costs. Solar and wind output follow 2019 weather hour by hour. Costs come from BloombergNEF's 2026 levelized cost update, with its California solar and wind costs. The National Laboratory of the Rockies (NLR) Annual Technology Baseline 2025 serves only as a cross-check. No federal tax credit is counted for solar or wind.
Land near the plants	The window is a 20 km square centered on each plant, 10 km or about 6 miles to each edge. We count solar on the buildable land left after the screens and standard local setbacks. 447 of the 480 plants have land in their own window for at least five times their interconnection capacity in solar: all 360 solar and wind plants and 87 of the 120 fossil plants. If land that neighboring windows share is counted for one plant only, 391 plants do. Land near the plants could hold 940 GW of solar, counted once, against 62.7 GW of interconnection capacity. The strictest setback rules give 729 GW and the loosest 1,142 GW. The 34.2 GW of new solar would use 3.6 percent of the 28,834 square km of buildable land, 4.3 percent near gas plants and 3.5 percent near solar and wind plants. The 12 gas plants without land to fill their interconnection with solar are Haynes, AES Alamitos, Scattergood, Harbor, El Segundo, Walnut Creek, Magnolia, Glenarm and Malburg in Los Angeles County, AES Huntington Beach in Orange County, Carlsbad in San Diego County and Russell City in Alameda County. Only 4 to 11 percent of their windows pass the screens. Some still add solar on the land they have, such as Carlsbad, which adds 421 MW within its 659 MW interconnection. A battery can be added at these plants while the plants run. Plants in CAISO's area can use CAISO's modification process or surplus interconnection service, and the Los Angeles Department of Water and Power's plants follow that utility's own process. Our results count no battery at gas plants. The same windows could hold 56.0 GW of wind. The land figures do not test ownership, parcels or willingness to lease, and cropland counts as buildable.
Policy options	On resource plans, Indiana's 2026 law makes a utility's analysis of surplus interconnection a factor that regulators shall take into account. Its resource plan duty applies to plans filed after 2029. Virginia's 2026 law requires utility plans to evaluate surplus interconnection. On procurement, Decision 26-02-057 orders 6,000 MW of net qualifying capacity, 2,000 MW online by 1 June of each of 2030, 2031 and 2032. The order covers utilities, community choice aggregators and electric service providers. A quarter must be clean firm or long-duration storage. Every resource must meet the resource adequacy rules, so a new battery needs deliverability to count. A battery at an existing solar plant can claim the 48E investment credit, 30 percent with prevailing wage and apprenticeship, in full if construction starts by the end of 2033. New solar and wind qualify only if construction began by 4 July 2026 or they enter service by the end of 2027. Batteries must also meet a foreign-entity test. For construction begun in 2026, at least 55 percent of the cost of their manufactured parts must come from suppliers that are not prohibited foreign entities, rising to 75 percent from 2030. The deliverability and replacement options need changes to CAISO's tariff or manuals, and CAISO files tariff changes at FERC. The deliverability option would change how CAISO counts a transfer of a solar or wind plant's deliverability to a battery. On 5 November 2026 MISO's queue marked 44 replacements as done, in which a new project replaced an existing plant on its interconnection. PJM has 5 active requests since 30 January 2026, and SPP has 5 in operation. The tariffs of MISO, PJM and SPP each give about 180 days for the replacement study. CAISO's repowering rules allow a new plant only of the same fuel, and they count storage as the same fuel. So a battery can replace a gas plant on its interconnection, but new solar or wind is a change of fuel and needs a new cluster request.

Sources: our hourly dispatch model, weather year 2019; BloombergNEF 2026 levelized cost update; NLR Annual Technology Baseline 2025; our siting screen and standard local setback rules; CPUC Decision 26-02-057; 26 U.S.C. 48E; Indiana Public Law 126-2026; Virginia 2026 Acts; MISO, PJM and SPP replacement rules and queues, October and November 2026; CAISO tariff Section 25.

Methodology

Topic	Detail
Top 10 plants	The solar and wind list counts CAISO's operating plants that EIA lists with no planned change to their units. The list counts only plants where a battery adds accredited capacity under CAISO's rule today. The rule leaves out Imperial Valley Solar, which would rank sixth. Each new 4-hour battery is the plant's nameplate less any battery already there, and none of the 10 has one. We rank by the accredited capacity the battery would add with a rule change that lets it use the deliverability its plant holds but does not use. That is the plant's deliverability less its highest monthly net qualifying capacity, up to the battery's size. Each MW the battery can use counts at the CPUC's 76.5 percent rating for a 4-hour battery. CAISO's rule today moves far less deliverability to the battery, so the 10 batteries would add 213 MW after the plants give up part of their own rating. Ties go to the larger battery, then to our suitability score, which weighs capacity factor, nearby land and size. The gas list covers all of California, and eight of its plants are in CAISO's area. It counts the gas plants where new solar in 2030 costs less than running the plant. In 2027 new solar costs less than running the plant at 4 of the 10. Each also has buildable land nearby and no planned change to its units in EIA's records. That leaves out Ormond Beach, AES Alamitos LLC, AES Huntington Beach LLC and Ellwood, where changes are planned at all units, and El Centro Hybrid and Scattergood, where changes are planned at some units. We rank by the new solar that fits within each interconnection, then by the gap between the two costs. Where plants sit close together their squares overlap, and each plant counts only its own share of the land they share. That share sets the solar at Marsh Landing, Sentinel, Valley, Carlsbad and Pio Pico, and the interconnection sets it at the other five. Only Carlsbad is among the 12 gas plants whose land cannot fill their interconnection with solar, but it has land for some. The 12 are counted on all the land in each square, which at Marsh Landing, Sentinel, Valley and Pio Pico could fill the interconnection. Valley's running cost is only $0.2 per MWh above new solar's. Running costs are 2025 costs with California's carbon allowance. Capacity factors are 2021 to 2025 averages. Operators are as EIA lists them, and owners can differ.
Imperial Solar Energy Center West	Imperial Solar Energy Center West has the most buildable land of the 110 solar and wind plants that are at least 100 MW and can add at least 100 MW. In the 12-mile square around it, the screen leaves 97.6 percent of the land and local setbacks leave 89.2 percent. Cropland counts as buildable and makes up 21.3 percent of the 12-mile square. Nearby plants share part of that land, so this plant's own share of the 11,617 MW of solar potential is 6,829 MW. The land in the 12-mile square could hold 78 times the plant's 149 MW interconnection in solar, and the plant's own share 46 times. Wind's 1,356 MW is 9 times. Solar and wind are alternatives on the same land. The plant's modeled 31.8 percent capacity factor uses 2019 weather. The plant ran at 27.4 percent in 2025.

Sources: CAISO Net Qualifying Capacity list, 2027; our hourly dispatch model, weather year 2019; our siting screen; EIA-860 and EIA-923, 2021 to 2025; California carbon allowance auction, August 2026; BloombergNEF 2026; CAISO OASIS prices, 2025 to 2026; CPUC Market Price Benchmarks, 2026; CAISO market monitor, 2025; CAISO generator management manual.

Methodology

Topic	Detail
Case study figures	The case study measures the site two ways, by capacity increase and by capacity factor gain. Capacity increase is the MW at the site, batteries included, divided by the plant's own 148.7 MW. 30 MW of new solar, 176 MW of new wind and a 149 MW battery take the site to 504 MW, 3.39 times. A site's capacity factor is a year's output over what the plant's 148.7 MW could generate running every hour. CF gain is the rise in that capacity factor, from 31.8 percent to 72.1 percent. The site's 939 GWh a year is an average output of 107 MW to the grid. The model sizes the new solar and wind to send the most energy through the interconnection. Like the statewide results, the Optimal Build uses a 4-hour battery. Solar, wind and a 6-hour battery would send more energy, 1,016 GWh a year. The energy flow chart averages each hour of the day over the year. Over the year the site curtails 5.0 percent of its solar and wind output, the model's cap.
Case study costs and prices	Costs are BloombergNEF's 2026 figures for California, and prices are CAISO's day-ahead prices at the plant's node, POD_IVWEST_2_SOLAR1-APND. The costs use 2H 2025 data in 2025 dollars. The solar and wind costs include no federal tax credit. Under current law a new solar or wind project gets one only if it began construction by 4 July 2026 or enters service by the end of 2027. The cost of capital is 6.7 percent for solar and 7.9 percent for wind. Solar has a 30-year life and wind a 25-year life. Fixed operating costs are $21.40 per kW a year for solar and $38.40 for wind. Over the year to 25 September 2026 prices averaged $31 per MWh, against $34.55 for the San Diego Gas & Electric load zone. New solar here would cost $50 per MWh, against the $31 average price. Its value rises when the battery moves its output into the evening, when prices averaged $45 per MWh from 6 to 9 PM. Prices fell below zero in 813 hours. The daily spread averaged $35 per MWh and topped $60 on 11 days. The largest was $134 per MWh. A 4-hour battery earns less than the daily spread, because it sells over four hours rather than only the top hour.
Case study battery	The battery is 149 MW and 4 hours, valued at the past year's prices. Arbitrage is $34 per kW-year. A battery with perfect foresight would earn $37 from the plant's day-ahead prices after variable operating cost, and we take 90 percent of that. Capacity is $121 per kW-year, the CPUC's 2026 resource adequacy benchmark of $10.11 per kW-month over 12 months. Resource adequacy contracts pay a deliverable 4-hour battery for its full rated capacity. Under its slice-of-day rules the CPUC rates it at 149 MW if it shows the energy to charge. The 76.5 percent ELCC on other pages is the CPUC's planning rating for the whole fleet, a different measure from how contracts count a battery. The CPUC's August 2026 study rates a 4-hour battery at 38 percent for 2030 to 2031. Resource adequacy prices for a battery built in 2028 to 2030 are not known, and they have fallen since 2024. Ancillary services add $9 per kW-year, what CAISO's batteries earned from regulation in 2025. On 52 sampled days of the past year, reserves paid about $1 per MW-hour. The battery costs $68 per kW-year in 2030 after the 30 percent federal tax credit for storage, and $95 without it. That uses BloombergNEF's 2030 capital cost of $734 per kW, raised 7 percent for rural California. It breaks even at a resource adequacy price of $2.15 per kW-month with the credit, or $4.33 without it. CAISO's studies assume the solar plant delivers about 6 percent of its capacity in the evening. So under CAISO's rule today only 9 MW of the battery could use the plant's deliverability, and the rest needs its own allocation. With a rule change that lets the battery use the deliverability the plant holds but does not use, 49 MW could count and revenue would be about $83 per kW-year. Without capacity sales the battery earns $43 per kW-year.

Sources: CAISO Net Qualifying Capacity list, 2027; our hourly dispatch model, weather year 2019; our siting screen; EIA-860 and EIA-923, 2021 to 2025; California carbon allowance auction, August 2026; BloombergNEF 2026; CAISO OASIS prices, 2025 to 2026; CPUC Market Price Benchmarks, 2026; CAISO market monitor, 2025; CAISO generator management manual.