CorPower Ocean

Case study – CorPower Ocean is a Cisco Investments portfolio company

Powering West Coast data centers with 24/7 wave energy

Completing the clean energy puzzle with wave energy

Wave power.
To power the planet.

corpowerocean.com
info@corpowerocean.com

The impossible choice

California's clean energy gap

In California, efforts to increase the availability and use of cleaner energy are well underway. As of 2024, renewable sources supplied 54% of the state's total in-state electricity generation, with solar alone accounting for 28%, including both utility-scale and small-scale systems.[1] The state has committed to reaching 60% renewable electricity by 2030 and 100% zero-carbon electricity by 2045.[2] Major tech players are actively working to decarbonize and reduce Greenhouse Gas (GHG) emissions from operations in alignment with these goals. Yet, for flat-load facilities such as data centers, which operate 24/7 regardless of weather, relying solely on variable renewables like solar and wind remains a challenge for achieving true carbon-free electricity (CFE) around the clock.

Even in California, with its access to abundant renewable resources, data centers face a paradox:

- **Surplus generation during the daytime when solar peaks, leading to curtailment and under-utilized capacity.**
- **Shortfalls at night, requiring battery storage or grid purchases that may still include carbon-intensive generation.**
- **Higher infrastructure costs, due to the need to oversize renewable capacity to meet low-generation periods.**

The state's SB 100 goal[3], which calls for achieving 100% CFE by 2045, sets a high bar. Meeting it involves more than just installing solar panels and batteries. An innovative, balanced energy mix is essential for future data centers. To address this challenge, CorPower Ocean conducted a techno-economic optimization study exploring the role of wave energy in achieving a 95–100% clean electricity mix at minimum system cost for a hypothetical 100MW data center in the San Jose area. The model evaluated combinations of solar, wind (onshore and offshore), wave energy, batteries, and grid interaction to identify the most cost-effective mix.

Case study

Framework & assumptions

Methodology & tools

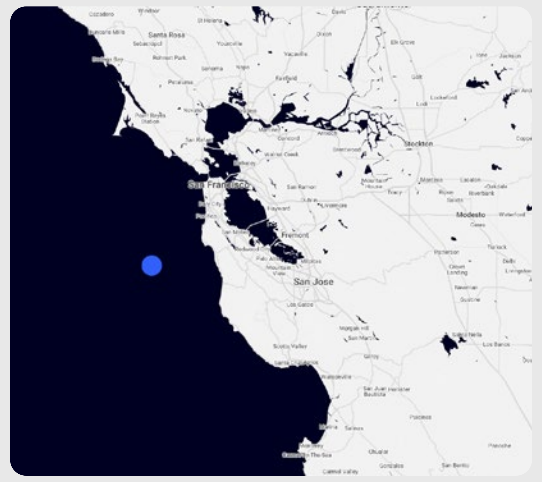
The study used Python for Power Systems Analysis (PyPSA)—an internationally recognized, open-source optimization platform—developed and maintained by the Technical University of Berlin.

The optimization goal was to minimize the levelized cost of electricity (LCOE) while delivering 90–100% clean energy to the data center. The model accounted for hourly generation and load balancing using time-series data and technology-specific performance inputs.

Location & scope

The case study considers an indicative 100MW flat-load data center in California. The model covers three planning horizons: 2032, 2040, and 2050.

Approximate location of the modeled wave farm (Pacific Ocean off San Jose)



Data inputs & assumptions

Renewable generation profiles were developed using high-resolution data from Renewables.ninja and the Copernicus platform. In the optimization model, all candidate energy sources, and storage technologies were able to contribute freely to the mix, with no pre-set limits on their share or installed capacity. No additional capacity constraints were applied to onshore projects to account for onshore land use or permitting constraints; these could be considered in future analyses.

Wave energy

- Location: 37.4°N, -122.8°E (Pacific Ocean off San Jose)
- Source: Copernicus global reanalysis data (1980–2023)
- Technology: CorPower G12 WEC (power matrix applied)
- Losses assumed for G12:

- Availability: 5%
- Array interaction: 3%
- Electrical farm: 4%
- Auxiliary consumption: 2.1%
- **Total: 13.4%**

Wind energy

- Offshore: Morro Bay WEA (35.55°N, -121.53°E), Vestas V172 7200,
- Onshore: Summit Wind (37.73°N, -121.68°E), GE2.75-120
- Assumed 10% transmission and conversion losses

Geographic scope of modeled offshore renewable energy resources

Solar PV

- Source: Solar Star Palo Alto I (37.41°N, -122.15°E)
- 35° tilt with 10% system losses

Batteries

- 3h batteries with 81% round-trip efficiency

Load profile and system optimization framework

Data center load profile: Scaled from 2024 historical data

The optimization study is anchored in real-world electricity consumption data, using anonymized operational 2024 records from a commercial hyperscale data center. The raw profile reflects high-availability computing workloads with limited variability, minimal curtailment potential, and consistent performance throughout the year.

- **Scaling:** For the purpose of modeling hypothetical future data centers, the profile was linearly scaled to 100 MW peak.

Such a profile is typical for mission-critical infrastructure, where uptime, reliability, and uninterrupted power supply are key requirements.

System modeling framework: 2032 scenario

To determine a cost-effective pathway to meet this flat load with at least 95% clean energy, CorPower Ocean deployed a system-level optimization model using the PyPSA platform.[4] The objective was to identify the least-cost clean energy portfolio capable of supporting round-the-clock coverage with minimal curtailment and reliance on batteries.

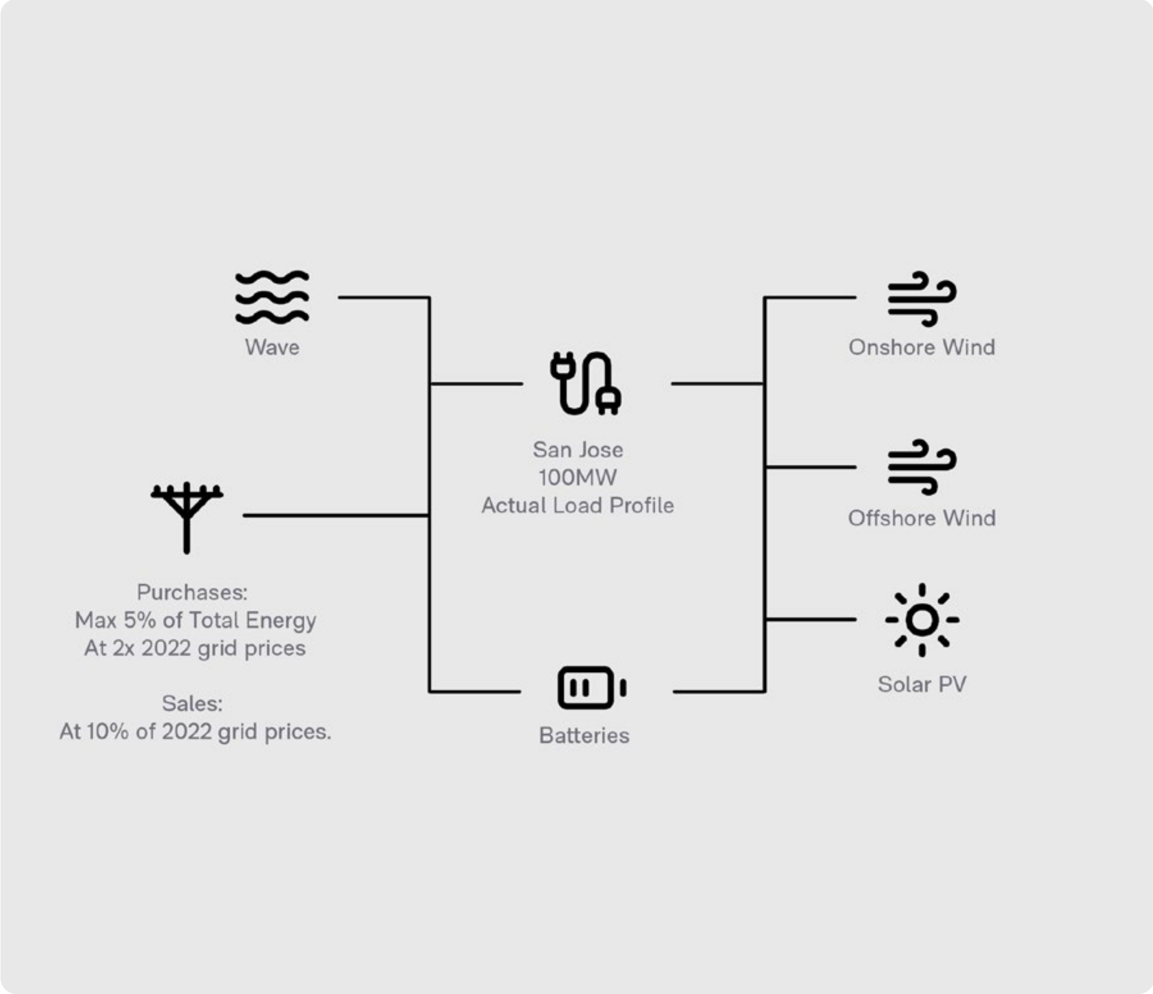


Diagram 1: Energy System Framework – Inputs, Storage, and Load for 2032 Scenario

Diagram 1 above illustrates the system architecture used to evaluate the cost-optimal pathway for supporting 24/7 carbon-free electricity to a hypothetical 100 MW data center in California, simulating hourly operations in 2032.

The optimization framework integrates multiple renewable electricity sources—wave, solar PV, onshore wind, offshore wind—alongside battery storage and a constrained grid interface. These components collectively serve the data center's continuous demand while minimizing overall electricity delivery cost.

Objective function:

The model minimizes the total system cost using the formula:

```
MIN(CAPEX + OPEX + GRID PURCHASES - GRID SALES)
```

Key elements of the system model:

- **Wave energy:** Offers hourly and seasonal complementarity to solar and wind. Installed capacity is optimized based on cost and load-matching performance.
- **Solar PV:** Provides abundant daytime energy but is limited by intermittency and curtailment risks when used in isolation.
- **Onshore & offshore wind:** Adds diversity and supports production during overcast or non-daylight hours, with offshore wind generally offering higher capacity factors.
- **Battery storage:** Helps with short-term variability and aligns generation with demand. Its capacity is minimized through complementary resource integration.
- **Grid purchases:** Represent a limited fallback mechanism. Electricity may be imported at 2022 California grid prices, but is capped at 5% of total demand, reflecting an objective to maintain at least 95% carbon-free sourcing.
- **Grid sales:** Excess generation may be exported to the grid at a low assumed resale value of 10% of historical average market prices, incentivizing system efficiency rather than overbuilding.

This integrated system design supports each technology to balance the data center's demand profile and support high renewable penetration at the lowest feasible cost.

Technology cost assumptions – 2032 scenario

Standardized cost & performance inputs

A core component of the modeling approach involves applying standardized, forward-looking cost and performance metrics for each renewable energy and storage technology under consideration. These inputs underpin the system-level optimization, adopting an accurate comparison of trade-offs across technologies.

The assumptions presented below reflect best-available estimates for the year 2032, sourced from a combination of public databases and internal modeling work:

Table 1: Cost and capacity factor assumptions – 2032[5]

Technology	Capacity factor (CF)	CAPEX ($M/MW)	OPEX ($K/MW/YR)	Lifetime (YRS)	WACC (%)	LCOE ($/MWH)
Solar PV	21%	0.5	9.7	30	5.2%	23.4
Onshore wind	25%	1.3	44	25	5.2%	63.1
Offshore wind	39%	3.6	61	25	7.0%	94.5
Wave energy	52%	3.1	73	25	5.2%	65.3
Battery storage	~17%	0.8	21	10	6.5%	N/A[6]

"We're excited to invest in CorPower Ocean and their wave-energy technology to complement other energy sources, creating 24/7 renewable power needed by data centers and smart buildings worldwide."

Jon Koplin
Senior Director, Cisco Investments

Table 1 above presents assumptions applied across all modeled technologies. These values provide a consistent basis for comparing trade-offs between solar PV, wind, wave, and storage options.

Seasonal resource comparison

Complementarity drives system efficiency

Comparing costs alone does not fully capture the value of each technology in a 24/7 CFE mix. The temporal generation patterns of each resource—and how well they align with a flat, around-the-clock demand—are equally critical.

Using historical 2022 data from NASA MERRA and Copernicus reanalysis models, Figure 2 below illustrates each renewable source's normalized weekly capacity factors across the calendar year.

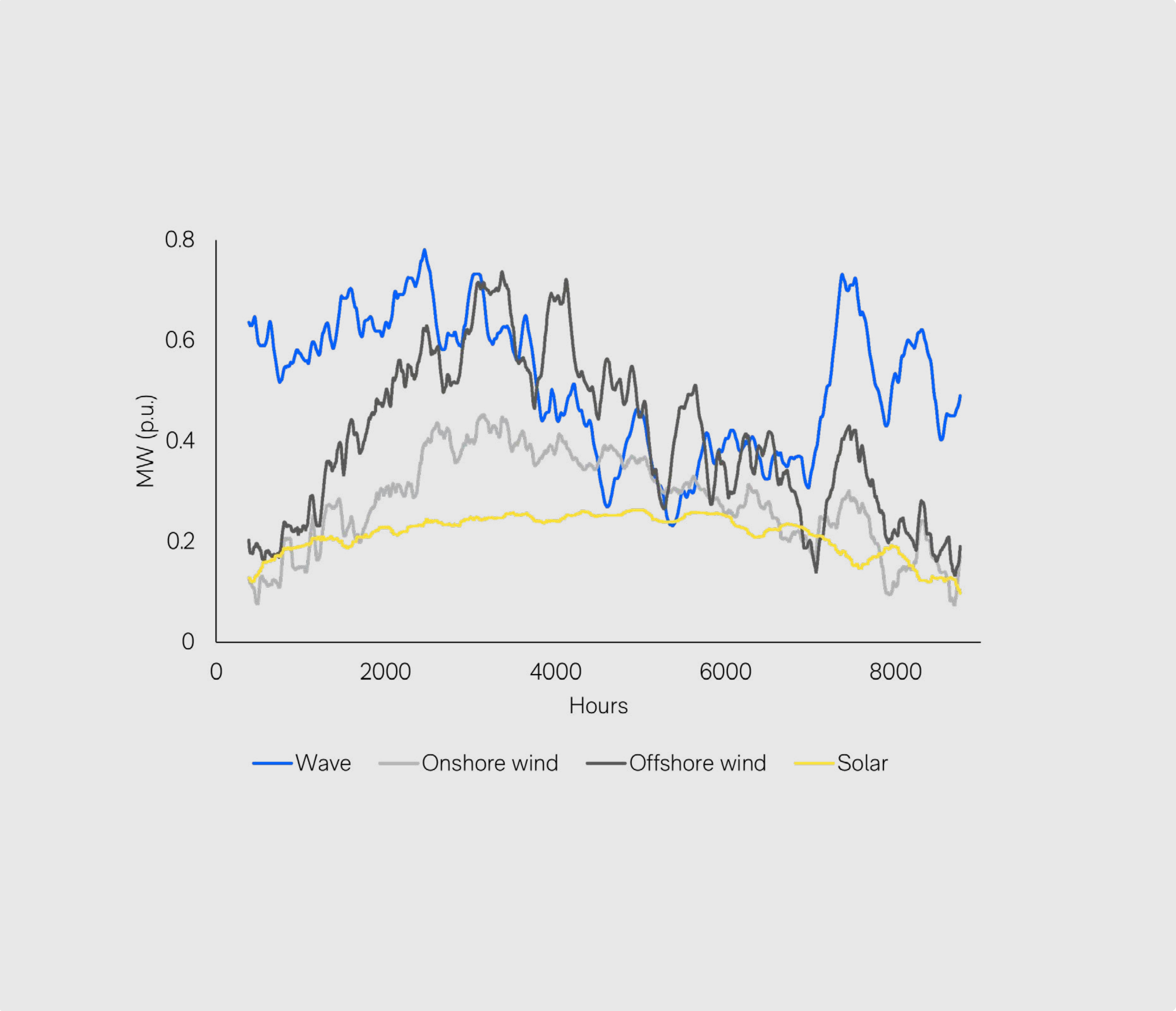


Figure 2: Renewable resource comparison – 2022 historical data

Key findings from resource profiles:

- **Wave energy** exhibits the highest and most stable annual capacity factor at 51.9%, with strong winter and nighttime performance. This makes wave energy suited to filling the gaps left by solar and wind.
- **Offshore wind** shows strong spring and early summer output, averaging 39.2% annual capacity factor. While more consistent than onshore wind, it remains highly seasonal.
- **Onshore wind** reaches a 24.9% annual capacity factor, with notable dips in late summer and early autumn, when load remains steady but production falls.
- **Solar PV** has the lowest cost and averages a 21.0% annual capacity factor, producing primarily between 9 a.m. and 4 p.m.

This analysis indicates that no single renewable source alone can cost-effectively meet the 24/7 demand of data centers. Instead, complementarity between diverse resources comes forward, particularly the steady, off-peak contributions of wave energy, which smooths seasonal and daily volatility.

Grid price dynamics

The cost of uncertainty

While the primary focus of this study is to explore a largely self-sufficient renewables-based system for California data centers, the grid continues to serve a vital balancing function. However, as shown in Figure 3, the grid introduces price volatility and exposure risk.

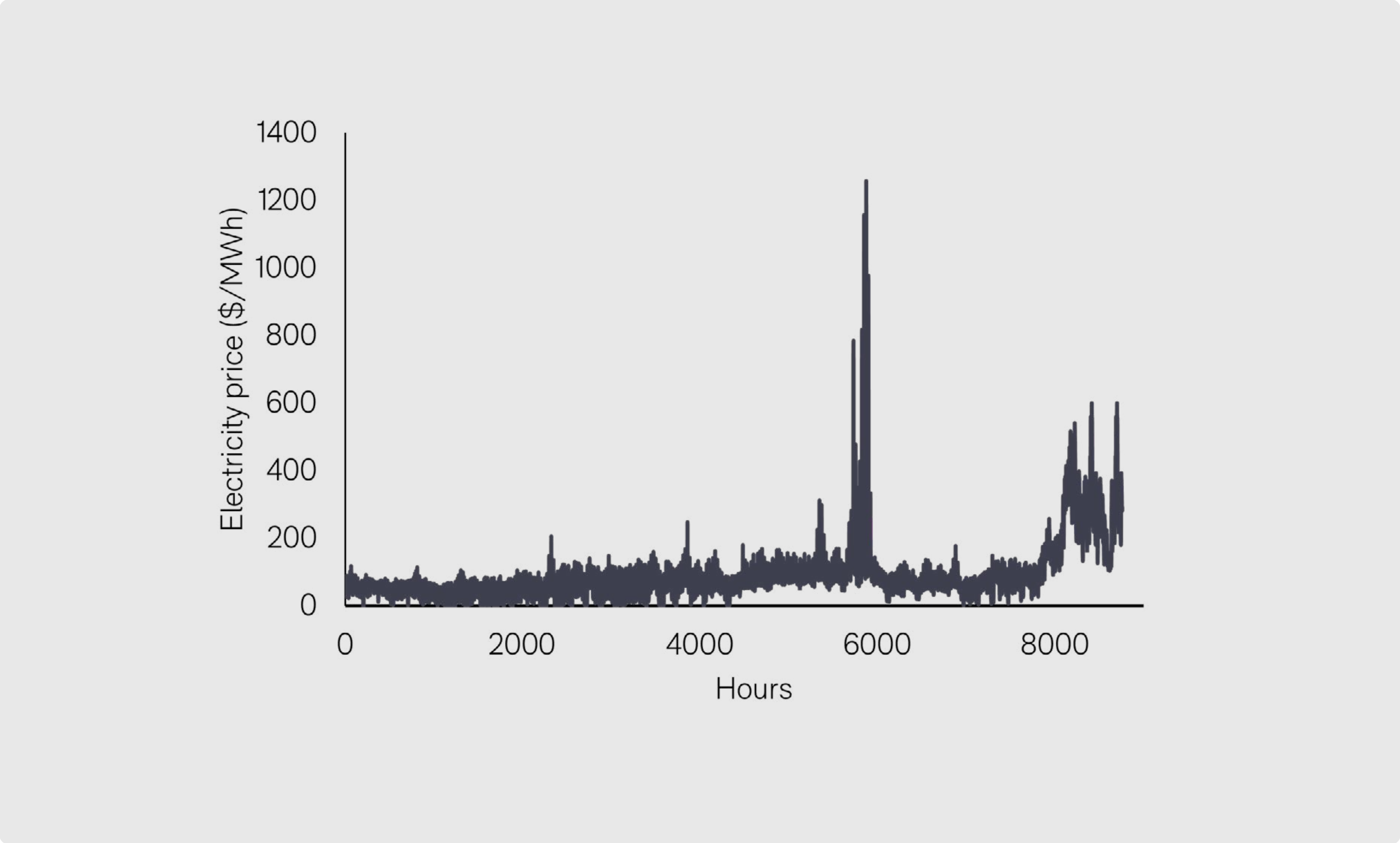


Figure 3: California grid prices – 2022 historical data[7]

Summary of grid price behavior (2022):

- **Average wholesale price:** $85.76/MWh
- **Extreme peaks:** Surges above $1,200/MWh occurred during late summer heatwaves
- **Seasonality:** Prices spiked during August–September, coinciding with tight supply and high demand.
- **Volatility:** Hour-to-hour and day-to-day fluctuations make it difficult to plan reliable procurement strategies for flat-load facilities.

These findings highlight the value of grid resilience and energy-supply reliability, particularly for mission-critical users. While the optimization model supports up to 5% of load to be sourced from the grid, this is strictly an energy-capped fallback, not a core energy strategy.

Economic assumptions in modeling:

To reflect conservative planning principles and incentivize self-sufficiency, the following assumptions were applied in the cost model:

- **Grid purchases:** Capped at 5% of annual load, priced in 2022 historical wholesale prices
- **Grid sales (Surplus Energy Export):** Discounted to 10% of historical wholesale prices, ~$8.58/MWh on average, to reflect limited market value for excess generation

These assumptions mean that exporting surplus energy is not a viable financial strategy, and that overbuilding generation should be in favor of well-balanced portfolios, where technologies such as wave energy offer relatively steady year-round output that can help stabilize system costs.

How wave energy balances the mix

Completing the puzzle

The 2032 modeling results illustrate the economic and operational benefits that could arise from integrating wave energy into California's clean-energy mix. With grid purchases limited to 5% of total load, and surplus energy valued at 10% of historical prices, the study compares two scenarios - one including wave energy and one without.

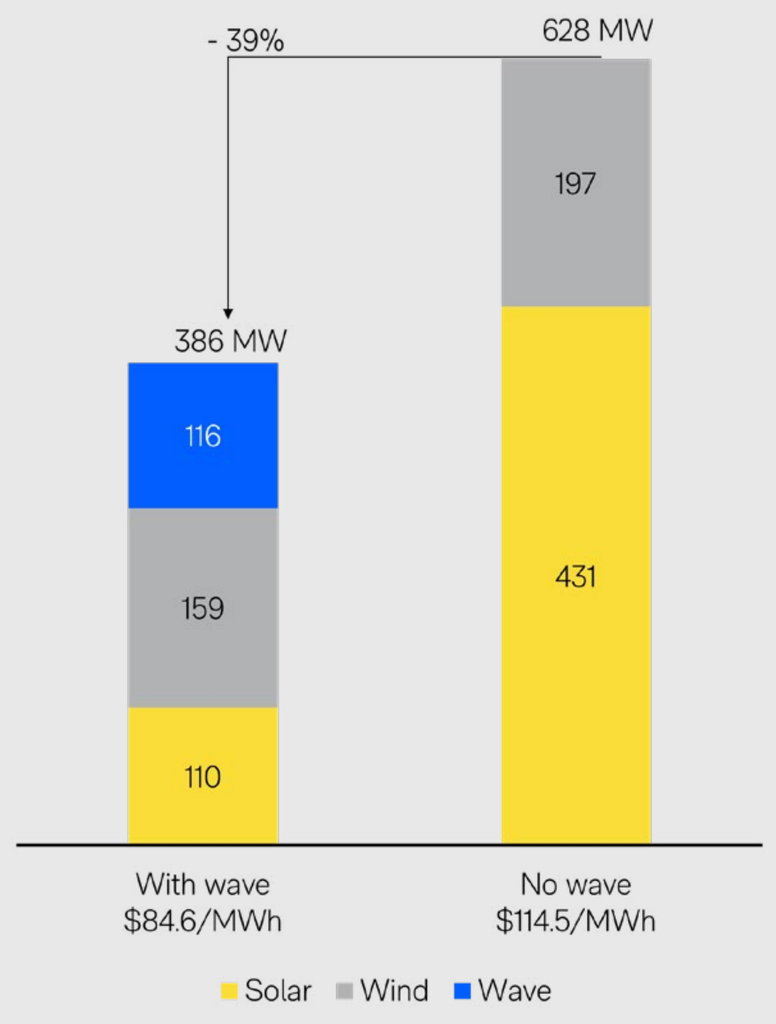


Chart 1: Cost and capacity comparison – wave vs. No wave scenario

Chart 1 illustrates how integrating wave energy reduces total capacity needs while lowering overall system costs, compared to a system without wave.

Metric	With wave	Without wave
Installed Capacity (MW)	386 MW	628 MW
– Solar	110 MW (29%)	431 MW (69%)
– Wind (Onshore)	159 MW (41%)	197 MW (31%)
– Wave	116 MW (30%)	0 MW
Storage Requirement	32.3 MW / 14.6 GWh	306.5 MW / 158.3 GWh
Grid Purchases	43.8 GWh (5% Of Demand)	43.8 GWh (5% Of Demand)
Surplus Energy Sold	324 GWh (37%)	433 GWh (49%)
LCOE	**$84.6/MWh**	**$114.5/MWh**
LCOE DELTA	–	**+$29.9/MWh**

Table 2: Summary of results: With vs. Without wave energy

Table 2 summarizes the modeling results, highlighting the impact of wave energy on capacity mix, storage, surplus sales, and overall LCOE.

Installed capacity

Smaller, smarter system design

1. Wave reduces total system size

The scenario including wave energy results in a smaller overall installed capacity, about 242 MW less, mainly due to reduced solar overbuild. Without wave energy, the system relies more heavily on solar generation, leading to more overcapacity.

2. Major decline in storage needs

A notable result is the impact on storage: the wave-enabled system requires over 90% less energy-storage capacity. This reflects wave energy's steady generation potential during nighttime hours and winter months when solar and wind output tend to be lowest.

3. Improved curtailment and system efficiency

Curtailment is reduced from 49% to 37%, supporting more renewable electricity to be utilized effectively. Integrating wave energy improves overall system efficiency in addition to reducing capacity requirements.

4. Substantial cost savings

With wave energy in the mix, the levelized cost of electricity (LCOE) drops by approximately $30/MWh, corresponding to a 26% cost reduction. This system-wide benefit reflects reduced capital outlay, lower storage investments, and more efficient generation scheduling.

Strategic insight

These results underscore a key point: wave energy can enable cost-effective, resilient, round-the-clock clean energy. Its ability to flatten the net load curve, displace storage, and limit overbuild makes it economically advantageous compared with solar-wind-only approaches, particularly for flat-load consumers such as data centers.

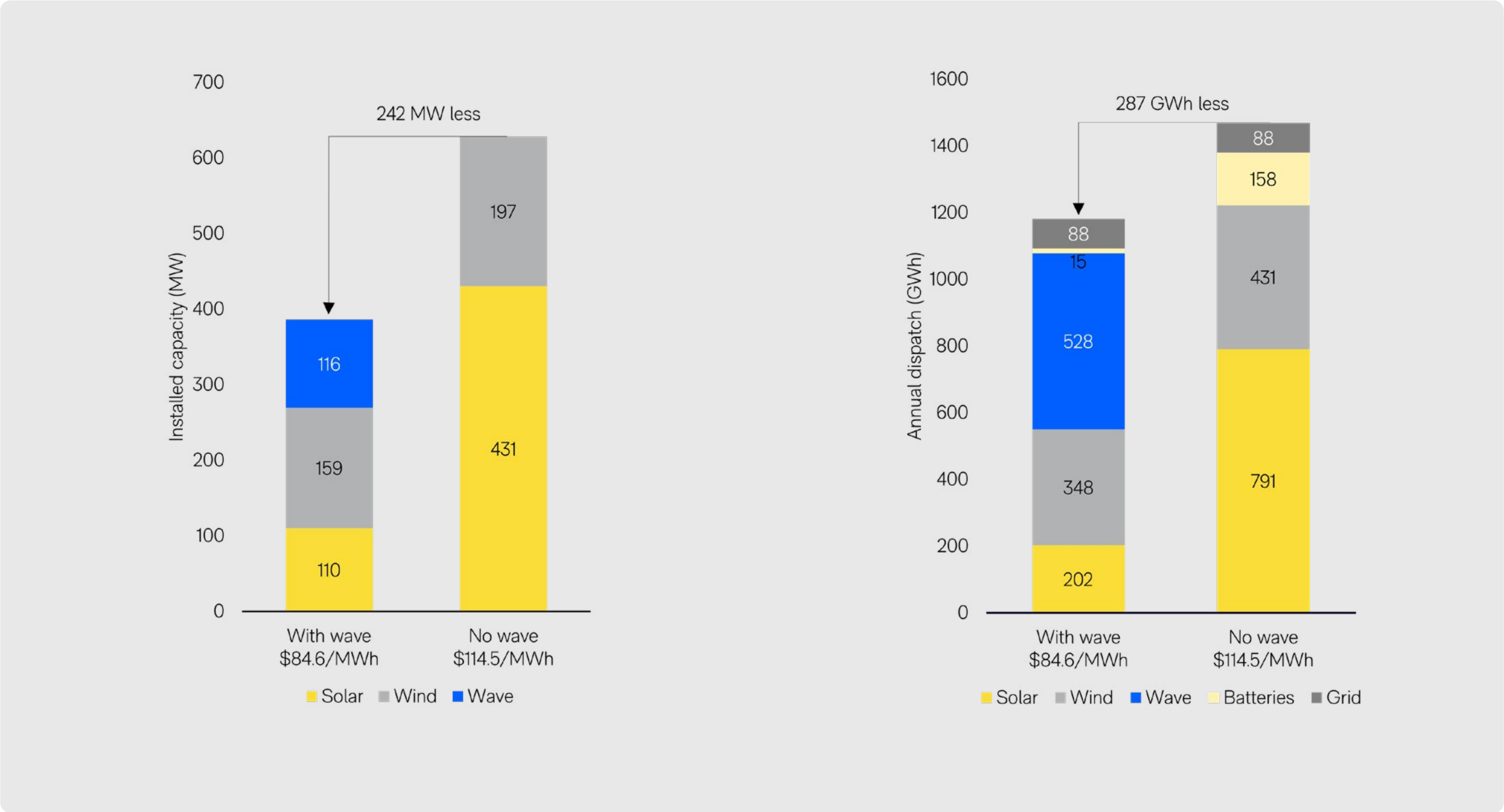


Chart 2, 3: Installed Capacity Comparison – With vs. Without Wave & Annual Dispatch Comparison – GWh per Source

"Wave energy can be a very consistent power profile. Adding wave energy to a mix of wind and solar brings us closer to a 24/7 supply."

Patrik Möller
CorPower Ocean, CEO & Co-founder

Future-proofed performance

Wave energy across time horizons

To assess how wave energy's benefits might evolve over time, the model was extended to 2040 and 2050, incorporating projected cost declines and technological improvements. The findings remain consistent—and increasingly favorable for wave energy—as the grid decarbonizes and marginal flexibility becomes more valuable.

Key takeaways

1. Wave remains essential at every time horizon

Even as solar, wind, and storage costs decline, wave energy consistently appears in the data center's optimal mix, increasing from about 30% in 2032 to roughly 46% by 2050. This suggests that the wave energy provides both cost benefits and strategic long-term system-balancing value.

2. Persistent reductions in installed capacity

Across all modeled years, including wave energy, total installed capacity is reduced by approximately 39-46%. This efficiency extends beyond technical aspects and lessens capital expenditure, land use, permitting, and operations and maintenance requirements.

3. Strong LCOE gains over time

Integrating wave energy lowers the levelized cost of electricity for the system by approximately:

- 26% in 2032
- 39% in 2040
- 45% in 2050

These results reflect compounding savings from reduced overbuild, smaller storage needs, and a closer match between generation and demand as grid conditions evolve.

Strategic insight

Despite having a higher technology-specific LCOE than solar and onshore wind, wave energy consistently earns its place in the optimal mix because of when and how it provides. It helps fill the generation gaps left by other renewables, particularly during evening hours, winter months, and periods of low wind. This positions wave energy as a cornerstone of a cost-efficient, highly decarbonized, and forward-looking energy system beyond 2032.

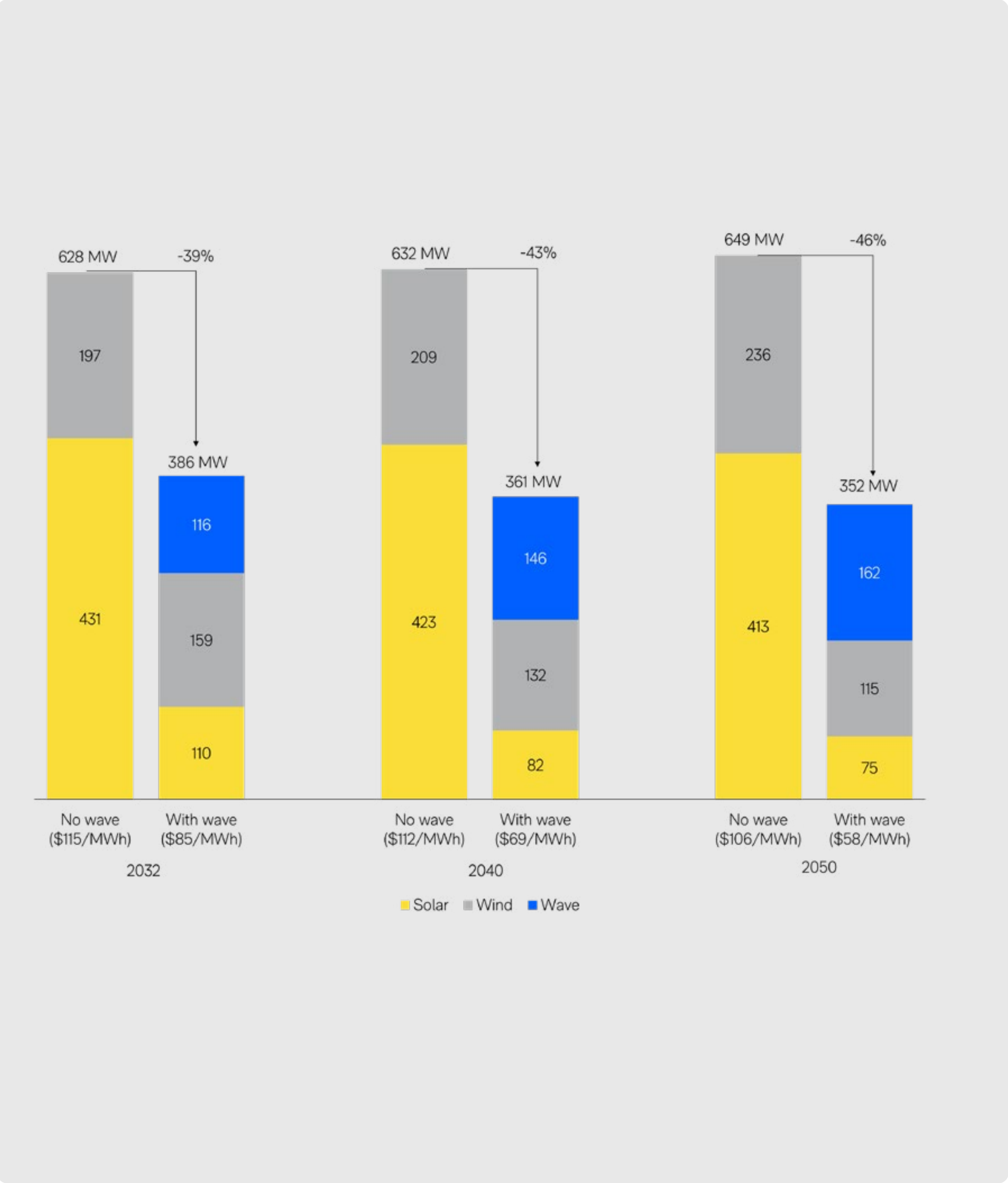


Chart 4: Optimal Mix Across 2032–2050 – With vs. Without Wave Energy

As shown in Figure 2, the complementary value extends not only on an hourly scale but also seasonally: wave energy tends to peak when wind and solar are weakest and vice versa, creating a natural counterbalancing effect.

> "Given the intermittent nature of some clean energy sources, Cisco became interested in using technology to harness the power of waves, with their potential to provide clean energy 24/7, at utility scale."

Kelsi Doran
Cisco's Head of Sustainability Strategy and Transformation

Conclusion and next steps for policymakers and industry

Conclusion: Wave energy is the missing piece

The modeling presented in this study indicates that solar and wind alone are unlikely to provide 24/7 clean electricity for flat-load facilities such as data centers in a cost-effective manner. Even under conservative assumptions and limited grid reliance, wave energy consistently emerges as a key contributor to round-the-clock decarbonization. By complementing solar and wind with reliable, off-peak wave energy generation, operators could avoid the extremes of overbuilding and overspending. The outcome is a more cost-effective and more innovative system, aligned with the operational demands of hyperscale computing and California's SB 100 climate goals.

This represents more than cost optimization; it provides a potential blueprint for a more resilient, resource-efficient, and dispatch-aligned energy future.

Next steps

For investors and developers:

1. **Explore potential strategic partnerships:** Engage with wave energy technology developers such as CorPower Ocean to gain deeper insight into investment opportunities, expected returns, and emerging market trends.
2. **Conduct site-specific feasibility studies:** Evaluate coastal sites and energy needs to assess opportunities for integrating wave energy.
3. **Create diversified renewable portfolios:** Incorporate wave energy alongside existing solar and wind investments to improve overall energy stability and potential financial returns.
4. **Engage with data centers and energy-intensive industries:** Explore private power-purchase agreements (PPAs) that use wave energy's reliability characteristics.

For policymakers:

1. **Consider establishing clear national targets for marine energy:** Define national wave and tidal energy deployment targets within the broader renewable energy mix to signal long-term policy direction and stimulate private sector investment.
2. **Implement market-based support mechanisms:** Introduce targeted government-backed mechanisms (e.g., Contracts for Difference) to support early-stage wave energy projects. These mechanisms can help cost reductions through scale and learning, providing a pathway to future subsidy-free competitiveness.
3. **Boost funding for commercial-scale projects:** Prioritize national funding for commercial wave energy deployments to help de-risk capital investment, strengthen domestic supply chains, and support leadership in the USA's marine energy sector.
4. **Streamline permitting processes:** Establish fast-track consenting pathways for wave energy projects, supported by clear and consistent environmental assessment guidelines to help reduce delays and build investor confidence.

The future is here

The future of clean energy is not only about expanding solar and wind—it's about achieving balance, timing, and system optimization. Wave energy offers a complementary pathway toward a reliable, clean, and scalable energy supply that can contribute to cost efficiency over time.

Stakeholders pursuing 24/7 clean-energy goals for data centers are encouraged to carry out optimal-mix studies to identify cost-effective renewable combinations. The CorPower Ocean team is ready to support you on this journey, so don't hesitate to reach out.

References

1. U.S. Energy Information Administration. (2024, May 16). California State Profile and Energy Estimates. Retrieved May 22, 2025, from https://www.eia.gov/state/analysis.php?sid=CA

2. Senate Bill 100 (SB 100), also known as the 100 Percent Clean Energy Act of 2018, commits California to sourcing 60% of its electricity from renewables by 2030 and 100% from carbon-free sources by 2045, including renewables, large hydro, and other non-emitting technologies. The law applies to all load-serving entities and forms a key legal foundation for 24/7 carbon-free energy strategies in the state.

3. California State Legislature. (2018, September 10). Bill text – SB-100: California Renewables Portfolio Standard Program: Emissions of greenhouse gases. Retrieved October 20, 2025, from https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100

4. International Institute for Sustainable Development (IISD). (2018, September 10). California governor signs 100% renewables into law as the state aims for carbon neutrality – SDG Knowledge Hub. Retrieved October 20, 2025, from https://sdg.iisd.org/news/california-governor-signs-100-renewables-into-law-as-the-state-aims-for-carbon-neutrality

5. This modelling framework aligns with best-practice methodologies used by the International Energy Agency, Joint Research Center, and academic institutions such as Stanford and Aarhus University. PyPSA is a validated tool for techno-economic modelling of high-renewables energy systems.

6. Data Sources: NREL Annual Technology Baseline (ATB) 2022, NREL Storage Futures Study, THEMA Consulting, WindEurope (AURES II project), Renewables.ninja, CorPower Ocean internal techno-economic analysis.LCOE is not calculated for battery storage, as it functions as a balancing resource rather than a primary generator.

7. Data Source: U.S. Energy Information Administration (EIA), CAISO wholesale market data (2022). https://www.eia.gov/electricity/wholesalemarkets/caiso.php

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