Energy Storage & Regional Grid Reliability

Electricity Market Design Reforms to Unlock the Potential of Energy Storage

A Roadmap for Reliability: Reforms to Enable Energy Storage

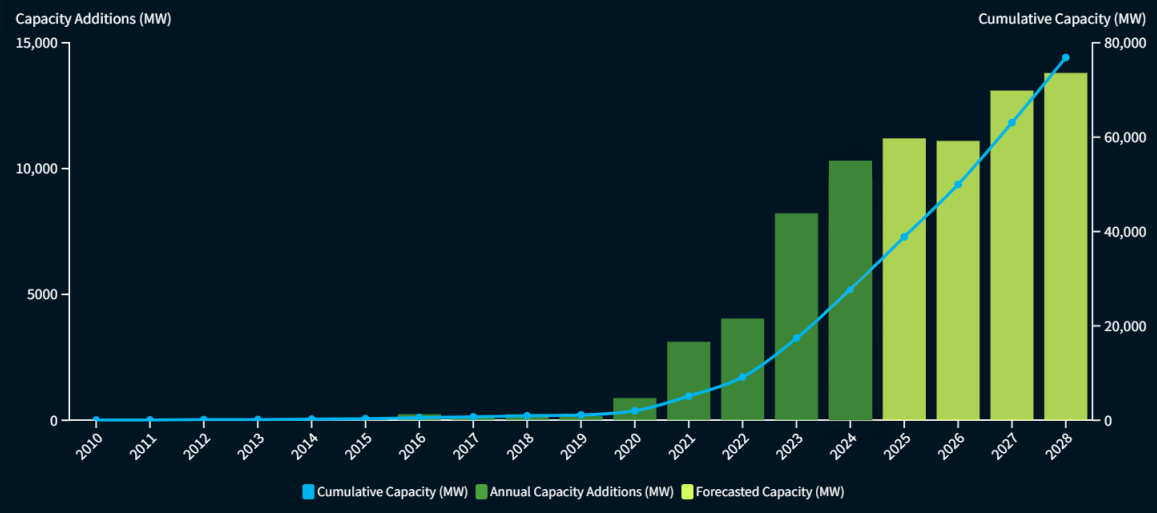
The American Clean Power Association and consultants from the Brattle Group have developed a roadmap designed to guide regional grid operators in maximizing the benefits of energy storage integration. Some markets only recently formalized the way modern storage resources participate in wholesale electricity markets, and additional market reforms are necessary to address barriers and ensure these resources can fully contribute to reliability and resource adequacy. Given energy storage's unique operational characteristics and flexibility, this **Energy Storage Market Reform Roadmap** outlines key reforms MISO, PJM, and NYISO can implement to enhance reliability and reduce costs for families and businesses by expanding energy storage participation in energy, capacity, and ancillary services markets.

Energy Storage is Designed to Boost Reliability and Lower Costs for Regional Electric Grids

Electricity markets that have evolved to integrate more energy storage are realizing significant benefits. Across the United States, energy storage facilities have become essential infrastructure, enhancing grid reliability and cost savings.

In Texas, energy storage has played a critical role in managing the state's rapidly rising electricity demand and volatile weather. During a single winter storm in Texas, energy storage helped keep the lights on and homes warm while saving the ratepayers more than $700 million in energy costs. Throughout the summer of 2024, energy storage resources enabled Texas to withstand historic electricity demand and summer heat – providing reliability services that saved families and businesses more than $750 million compared to 2023. In California, energy storage has reduced the risk of blackouts and brown outs – and in 2022, played a key role in preventing a costly grid failure.

Communities are also seeing the direct benefits of deploying local energy storage. In Nevada, a single energy storage facility built on the site of a retiring power plant will contribute to utility bill reductions of up to 20%. In regions with the greatest reliability challenges, energy storage has demonstrated its unique ability to enhance grid resilience while also making electricity more affordable.

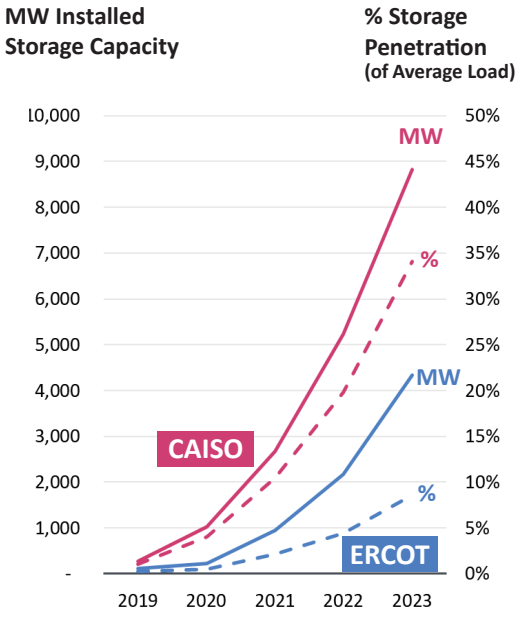


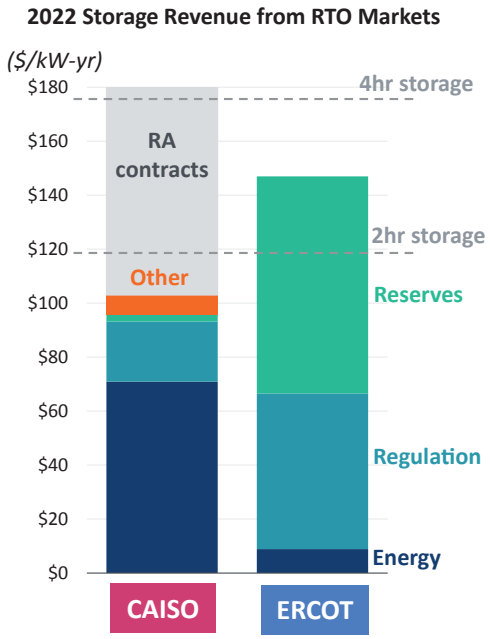
Note: Data from ACP & Wood Mackenzie
* Estimated with current available data

Performance in Texas & California Demonstrates Unique Flexibility of Storage Resources

In 2024, energy storage was the second most deployed electricity supply technology after solar. While thermal and renewable generation assets are largely confined to specific market roles, energy storage excels by serving a variety of needs, charging and discharging in response to price signals and system demands. This flexibility has made storage an increasingly dominant market resource in ERCOT and CAISO, and positions it to support other regions as reliability challenges evolve. **Since 2019, energy storage deployment has grown 25x with almost 29 GWs now connected to the grid, representing enough capacity to cumulatively power 22 million homes.**

Energy storage is designed to enhance grid reliability, reduce congestion, improve the integration of diverse generation assets, and maximize the use of all resources. California and Texas have demonstrated that with that with modern market design, energy storage delivers substantial value, meeting the unique needs of each market, while increasing reliability and lowering costs for consumers. Whether in competitive markets or regulated resource planning, energy storage complements both thermal and renewable generation, improving overall grid operations.



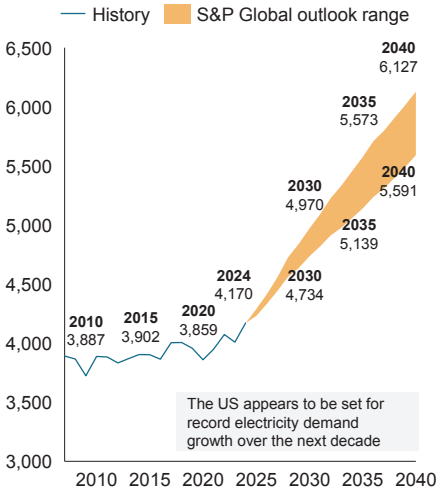


Brattle Group Analysis, including sources & notes: Figure reformatted from results in CAISO 2022 Special Report on Battery Storage Resources and from Modo Energy. In 2022, batteries in CAISO received nearly $30.5 million of bid cost recovery (BCR) mostly from RT market (~10% of all BCR settled despite being 5% of ICAP). Energy category includes revenues from Imbalance schedules. CA RA contract revenue ranging from $60 - $96 /kW-year is from Figure 16 ("RA only") CPUC 2023 Energy Storage Procurement Study.

Energy Storage is Key to Meeting Historic Demand for Electricity

Electricity demand in the United States is projected to surge by an unprecedented amount over the coming decade. Data indicate that electricity demand could expand 35-50% by 2040. This is primarily due to AI data centers and new manufacturing activity in the short-term whereas electric vehicles (EV), space-heating electrification, and broad economic growth underlie the long-term dynamics. This demand is growing faster than the supply of new energy solutions that could power it — data centers and manufacturing facilities, for example, take about three years to build versus development and construction times of typically five or more years for new power generation to come online, creating an urgent need for faster policy action to unlock resources like energy storage, which are ready to be deployed and proven to stabilize and strengthen electric grids facing increasing peak electricity use.

US Lower 48 net on-grid electricity demand



Source: US National Power Demand Study

Energy Storage is Not Just Another Power Source — It's the Swiss Army Knife of the Electric Grid

Energy storage is designed to enhance generation assets and optimize the efficiency and reliability of the power grid. For example, energy storage enables solar facilities to function like firm capacity, increasing their reliability contributions to the grid. It also supports natural gas and coal plants by improving effieciency and cost-effectiveness, reducing consumer costs, and balancing electricity supply and demand more effectively. Energy storage stands out for its unique ability to **"stack" multiple market services**, simultaneously providing value across energy, capacity, and ancillary services markets. This flexibility enables energy storage to optimize energy arbitrage, deliver frequency regulation, and serve as emergency backup power — all within a single resource. By responding in real-time to system needs, energy storage enhances grid reliability, efficiency, and resilience, making it a critical tool for a more flexible and adaptive power system

MARKET	ROLE OF ENERGY STORAGE	GRID BENEFITS
ENERGY	Energy storage plays an active role in energy markets through energy arbitrage, charging during low-price periods and discharging when prices peak to optimize revenue and support market efficiency. Storage participates in Day-Ahead and Real-Time markets and helps stabilize prices by strategically charging or discharging to mitigate volatility. Storage also facilitates renewable integration by capturing excess generation and discharging it during periods of high demand. In markets with demand response programs, customer-side storage helps reduce grid demand during high-stress events by shifting load or providing energy on request.	Storage enhances market efficiency by reducing peak-period costs and stabilizing energy prices. Its ability to shift load and absorb excess renewable energy reduces system stress and supports greater integration of clean energy.Its fast dispatch capability improves market flexibility and reduces reliance on expensive peaking resources. Finally, congestion relief improves transmission efficiency and lowers congestion costs, ehancing overall grid affordability.
CAPACITY	Energy storage is counted as a firm capacity resource in electricitymarkets, contributing to Resource Adequacy. By bidding into capacity auctions, storage commits to being available during future peak-demand periods. When paired with renewable energy creates a hybrid resource that offers firm and dispatchable power.	Energy storage enhances grid reliability by providing firm capacity during periods of peak demand, improving reliability, and lowering system costs. Its hybrid role with renewables ensures dispatchable clean energy, improving both grid reliability and affordability.
ANCILLARY SERVICES	Energy storage plays a critical role in ancillary services markets by being available to respond to rapidly evolving grid needs and ensuring immediate or near-instant backup power during generation imbalances. Storage corrects grid frequency deviations in real-time, provides spinning and non-spinning reserves to back-up the loss of large conventional generators, and ramps to meet rapid changes in net demand. With black start services, storage helps restart the grid after outages by supplying power without external support. Additionally, storage enhances voltage stability by managing reactive power to maintain transmission reliability. Some markets offer fast frequency response programs that leverage storage's ultra-fastreaction to frequency deviations. While formal ramp rate services are limited, storage helps smooth load and generation fluctuations in real-time. Although congestion relief is not always a formal market product, storage can alleviate transmission bottlenecks by discharging at strategic times.	Storage's role in the ancillary services markets enhances grid stability, flexibility, and reliability. Its fast-response capabilities help prevent frequency instability and blackouts, while voltage support ensures smooth power delivery. Black start capability strengthens grid resilience by enabling faster restoration after outages. Additionally, storage facillitates renewable integration by smoothing fluctuations and reducing reliance on fossil-fuel reserves.

Regional Electricity Markets Need Reform to Fully Enable Energy Storage Benefits

Many existing market structures and rules were designed around the abilities and needs of traditional generation assets, limiting the full potential of energy storage technologies to benefit the grid. By evolving market designs or creating market products that recognize the multi-faceted role of energy storage technology, regional electric grids can unlock its full capabilities. These reforms would not only improve the reliability and efficiency of the grid, but also lower costs for businesses and consumers.

	PROPOSED MARKET REFORM	HOW DOES THE REFORM IMPROVE RELIABILITY?
1	**Ramp & Uncertainty Product:** managing fast, short-term changes in net load	This market mechanism manages fast, short-term fluctuations in net demand. Unlike other resources that take many minutes or hours to ramp, energy storage reacts instantly (within milliseconds). By smoothing fluctuations, storage avoids unnecessary renewable curtailment and supports base generation by preventing the need for inefficient ramping.
2	**Day-Ahead Uncertainty Product:** ensuring resources are positioned for expected hourly changes in load	This market tool ensures sufficient resources are available on the next day to meet net demand forecasts, including a margin for uncertainty. Storage is always on and therefore meets availability needs at low cost, reducing the burden on traditional steam generators that must incur substantial start-up costs and providing greater flexibility to the grid to accommodate low-cost renewable generation. By optimizing energy use across hours, storage enhances the efficiency of the generation fleet.
3	**Accurate Capacity Accreditation:** for energy storage & all resources ensures capacity ratings match real capability	This reform underscores the need for accurate capacity accreditation methodologies. Properly valuing storage's peak capacity contributions ensures that the grid can quickly deploy all resources to meet growing reliability challenges of load growth, maintain the most cost-effective mix of resources, reduce the risk of outages and enhance system resilience. Energy storage has demonstrated its effectiveness and efficiency in other markets, and capacity modeling should reflect its real-world capability.
4	**Contracting for Local Reliability Needs after Retirements:** an alternative to costly Resource-Must-Run Contracts and transmission upgrades	A competitive alternative to costly Reliability-Must-Run (RMR) contracts (which keep uneconomic plants online) and transmission upgrades (which take many years), can lower costs for ratepayers and enhance system reliability. Storage can be strategically sited in congested areas and rapidly deployed to provide local reliability support, reducing reliance on aging uneconomic facilities and, after retirement, avoiding difficult and costly transmission upgrades. Long-duration energy storage technologies may be able to address unique resource gaps.
5	**Opportunity Cost Bidding:** ensuring storage can provide optimal reliability and efficiency benefits through pricing and real-time market participation	A market mechanism that enables storage to strategically charge when electricity is cheapest and discharge during the highest-value periods of peak demand, maximizing reliability benefits and market efficiency. By improving price signals and reducing inefficient cycling of traditional generation, this reform promotes stable electricity pricing, lowers overall system costs, and enhances grid reliability, easing the strain on base power facilities.

ACP will Advance Reforms to Integrate Energy Storage and Boost Grid Reliability

The American Clean Power Association is committed to collaborating with regional grid operators, state policymakers, and stakeholders to advance reforms that enhance grid reliability and lower costs for Americans. In many organized electricity markets, the participation of energy storage resources is limited by outdated market designs. ACP believes that these reforms are crucial steps toward improving grid reliability while ensuring Americans benefit from affordable, domestic clean energy.