Unlocking Storage: A Roadmap for Regional Market Integration

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Storage is the "Swiss Army Knife" of the Grid

AMERICAN CLEAN POWER

Market	Role of Energy Storage	Grid Benefits
Energy	Arbitrage (charge low / discharge high), stabilize prices, integrate renewables	Enhances market efficiency, lowers peak costs, improves affordability
Capacity	Bids as firm capacity, available during peak demand, dispatchable when paired with renewables	Boosts reliability & lowers costs, provides hybrid clean & firm power
Ancillary Services	Fast-response backup, frequency regulation, voltage support, black start capability	Improves grid stability & flexibility, enables renewables, reduces outages

SOURCES OF GRID RELIABILITY SERVICES

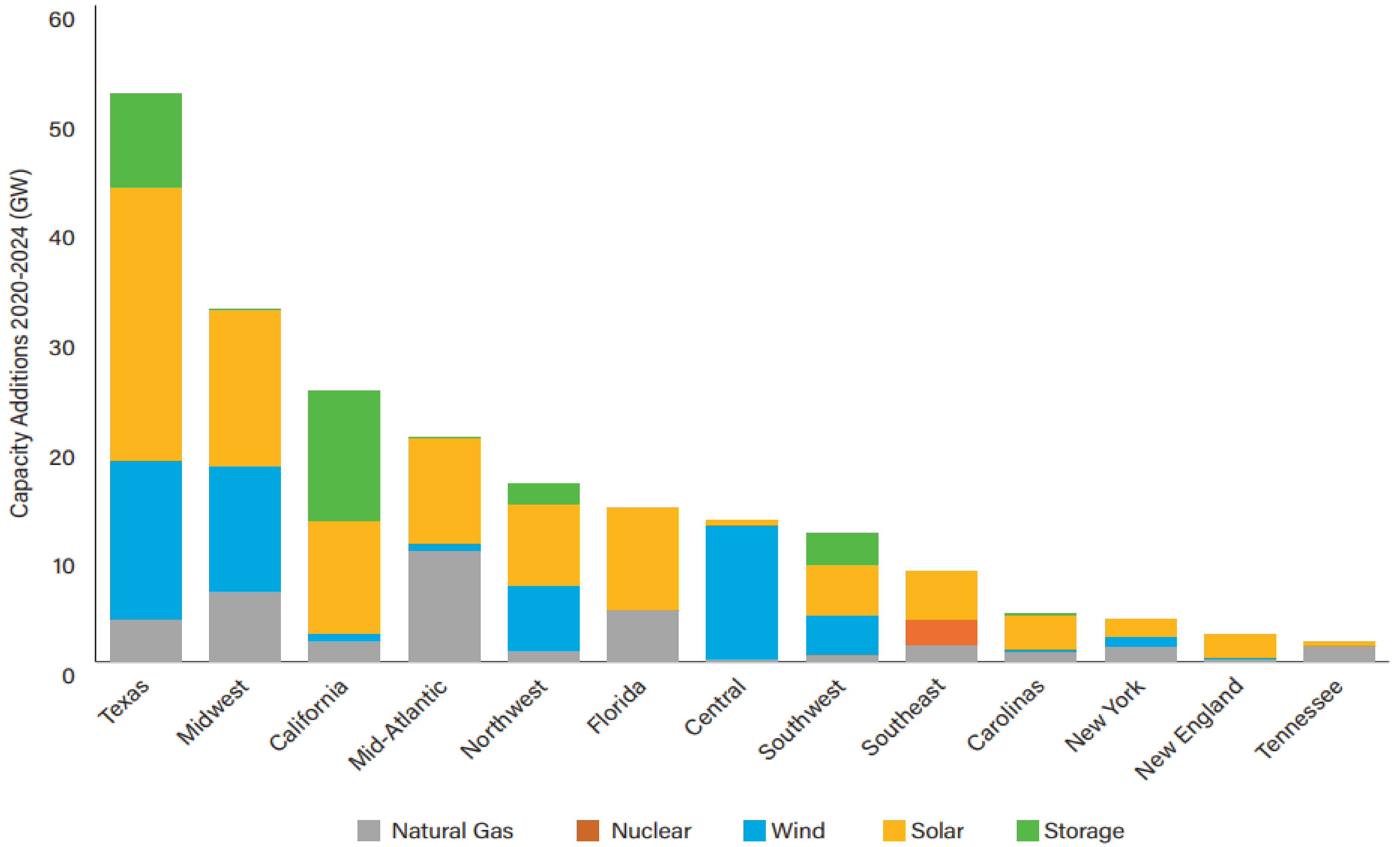
	Inverter-Based			Synchronous				Demand Response
	Wind	Solar PV	Storage/ Battery	Hydro	Natural Gas	Coal	Nuclear	Demand Response
Disturbance ride-through	Excellent	Very Good	Very Good	Excellent	Good	Good	Good	Good
Reactive and Voltage Support	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Limited
Slow and arrest frequency decline (arresting period)	Very Good	Very Good	Very Good	Very Good	Good	Good	Limited	Good
Stabilize frequency (rebound period)	Very Good	Very Good	Very Good	Very Good	Excellent	Limited	Limited	Good
Restore frequency (recovery period)	Good	Good	Good	Excellent	Excellent	Limited	Incapable	Good
Frequency Regulation (AGC)	Very Good	Very Good	Excellent	Excellent	Excellent	Limited	Incapable	Excellent
Dispatchability/Flexibility	Good	Good	Excellent	Excellent	Very Good	Limited	Incapable	Good

These services also contribute to frequency restoration, but are also considered essential reliability services on their own.

Excellent / Very Good / Good / Limited / Incapable

The electrical power system is in the midst of a digital revolution. Modern inverter-based generation and storage are electronically coupled to the power system, and using their digital controls, they can provide a wide range of grid services. This table provides a conceptual comparison of the ability of key resources to provide essential reliability services to the grid, and is derived from recent and ongoing efforts by the North American Electric Reliability Corporation (NERC), which sets the reliability rules for the power system.

Regional Electricity Generating Capacity Additions, 2020-2024



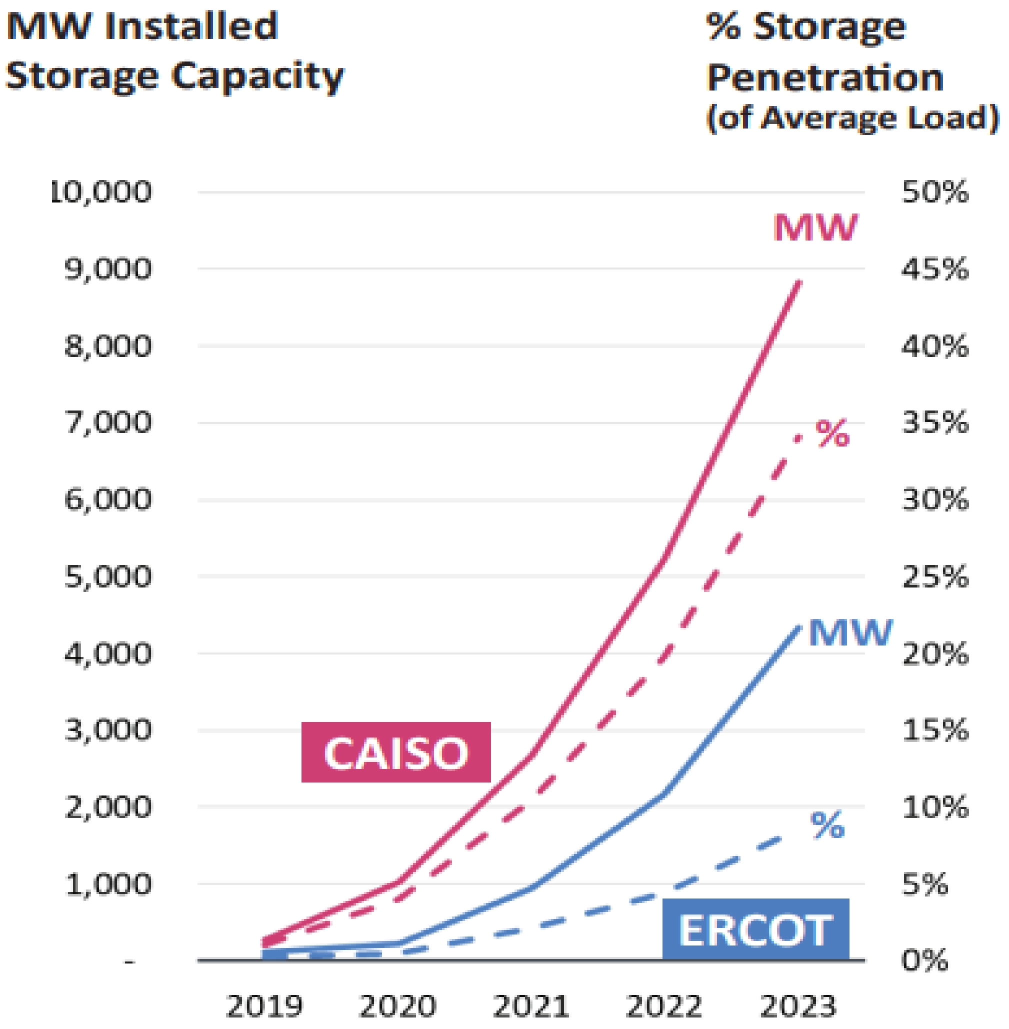
Source: ACP, EIA

Performance in Texas & California Demonstrates Unique Flexibility of Storage Resources

Since 2019, **U.S. *energy storage deployment has grown 25x with almost 29 GWs*** now connected to the grid, representing enough capacity to cumulatively power 22 million homes. Almost half of that in California and Texas.

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.



	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.

Note: From Brattle Study Recommendations for PJM and MISO

NYISO Ramping Product	Role of Energy Storage	Grid Benefits	Recommended Enhancements to Current Design
Day Ahead Uncertainty Product: A market tool to ensure sufficient availability to meet forecasted net demand	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. Storage also provides 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.	By providing needed availability at lower cost, storage enhances the overall efficiency of the generation fleet, reduces excessive cycling of baseload fossil generators, reduces unneeded renewables curtailment, and ensures grid stability during periods of high demand.	**Increase Operating Reserve Demand Curve Maximum Value Above the Current $750/MWh Threshold** to reflect system value in scarcity conditions and ensure price signals incentivize resource availability. **Comprehensively address the need for availability to meet day-ahead forecasts for net demand,** by addressing the "physical energy gap" between cleared day-ahead physical supply and forecasted demand (due to insufficient purchases and/or virtual supply) either through procurement of additional 30-minute reserves, or via the **NYISO-proposed 60-minute capability and 4-hr duration** reserve product to more cost effectively meet system needs.
Ramp & Uncertainty Product: A market mechanism designed to manage fast, short-term fluctuations in net 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. Storage also provides 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.	By quickly responding to short-term load changes, storage reduces reliance on slower, less flexible resources, ensuring the grid remains stable. This prevents inefficient cycling and ultimately reduces excessive renewable curtailment, improving efficiency	**Include expected ramp in market procurement.** While these reliability needs are already met through NYISO's multi-interval dispatch, they are not necessarily appropriately priced and can lead to the need for out-of-market payments and insufficient incentive for flexibility. **Increase Demand Curve Maximum Value Above the Current $40/MWh Threshold** demand curve to reflect high system value of incremental reserves during times of high up-ramps (which will deplete available reserves in subsequent intervals)

Note: From Brattle Study Recommendations for NY

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Sources of Grid Reliability Services (terms):

- **Disturbance Ride Through**
  What it means: Ability of a resource to stay online during a grid disturbance (e.g., voltage or frequency dip) rather than tripping offline.
  Why it matters: Prevents cascading failures and maintains grid stability.
- **Reactive and Voltage Support**
  What it means: Providing reactive power to maintain voltage levels needed for electricity to flow efficiently.
  Why it matters: Keeps the "pressure" in the grid stable — like air pressure in tires.
- **Slow and Arrest Frequency Decline (Arresting Period)**
  What it means: Quickly injecting power after a sudden drop in frequency to slow the decline.
  Why it matters: First line of defense to avoid blackouts when generation drops suddenly.
- **Stabilize Frequency (Rebound Period)**
  What it means: Following the arrest, supplying or absorbing energy to hold frequency steady.
  Why it matters: Prevents over-correction and keeps the system from oscillating.
- **Restore Frequency (Recovery Period)**
  What it means: Bringing the frequency back to normal (typically 60 Hz in the U.S.) over several minutes.
  Why it matters: Re-establishes full system equilibrium and reliability.
- **Frequency Regulation (AGC – Automatic Generation Control)**
  What it means: Fine-tuning power output second-by-second to match small load changes.
  Why it matters: Keeps grid "heartbeat" stable in real time.
- **Dispatchability / Flexibility**
  What it means: Ability to quickly ramp up or down in response to grid needs or price signals.
  Why it matters: Ensures supply meets demand moment-to-moment, especially during volatility.