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Battery Storage: Expanding Investments and Market Challenges

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In this article, the authors examine the market for battery energy storage systems and explore the challenges facing the industry.

The capacity of battery energy storage systems (BESS) nearly doubled in the United States in 2023, reaching a total capacity of almost 12 gigawatts (GW).[1] The exponential growth of battery storage was driven by:

(i) New tax credits in the Inflation Reduction Act;

(ii) 19.6 GW of utility-scale solar installations;

(iii) The value storage delivers during peak demand and times of grid stress; and

(iv) A decline in prices for key battery materials.

COMMERCIAL SERVICES

From a commercial perspective, BESS projects deliver various services to the market, including energy arbitrage, firm capacity and operational reserves. The more services the unit can deliver, the higher the value of the unit to the electricity grid – the multitude of services is sometimes referred to as "value stacking." An example of arbitrage is that a BESS owner or user can charge the BESS when electricity pricing is low, and discharge for windows of time when load demand and pricing rises. Firm capacity service entails providing a fixed amount electricity storage over a duration of time, typically when there is peak demand and transmission would be otherwise overloaded. BESS projects can be utilized to maintain grid frequency during outages or other sources ramping down.

While a BESS can be charged with energy that is sourced from any type of generation, a BESS can be interconnected with solar and wind generation facilities at the same or adjacent site locations (such projects being termed "co-located BESS projects").

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[1] https://cleanpower.org/news/market-report-2023/.

GROWTH TRAJECTORY

Prior to 2010, the installed capacity of battery storage was negligible.[2] Lithium-ion batteries, the dominant storage technology today, debuted in 2011 in the United States and more than tripled the installed capacity that year. Cumulatively, domestic installed battery capacity surpassed 50 megawatts in 2011, 200 megawatts in 2016, and 5,000 megawatts in 2021, and is expected to exceed 30,000 megawatts by the end of 2024 according to U.S. government data.[3]

Growth is not expected to slow. Regulators in California, the state with the most battery storage, expect that storage must be five times greater than it currently is by mid-century to meet clean energy goals.[4] Texas, second to California in storage, is currently home to four of the five largest battery storage plants scheduled to come online in 2024 and 2025, with an average capacity of 540 megawatts. Arizona, Florida, and Massachusetts round out the top five in battery storage under construction, illustrating the industry's geographic diversity. Many new battery facilities will open with new solar plants or be added to existing solar plants. If data collected in the federal government's Preliminary Monthly Electric Generator Inventory proves accurate, solar and battery storage will account for 81% of new U.S. electric-generating capacity in 2024.[5]

SOURCES OF EXPANSION

Sites with BESS installations often have the same low carbon benefits of the renewable energy projects they support and have received similar backing for that reason. Besides many state-level programs, there is a good deal of federal support for battery storage. According to the White House, "[t]he Bipartisan Infrastructure Law, CHIPS & Science Act, and Inflation Reduction Act combined will invest more than $135 billion" in technologies crucial to battery storage, including rare minerals, domestic manufacturing, and research into longer-lived and denser batteries.[6] The Department of Energy also offers a set

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[2] https://www.nrel.gov/docs/fy19osti/74426.pdf.

[3] https://www.nrel.gov/docs/fy19osti/74426.pdf; https://www.eia.gov/todayinenergy/detail.php?id=61202.

[4] https://www.nytimes.com/interactive/2024/05/07/climate/battery-electricity-solar-california-texas.html.

[5] https://www.eia.gov/todayinenergy/detail.php?id=61424.

[6] https://www.whitehouse.gov/briefing-room/statements-releases/2022/10/19/fact-sheet-biden-harris-administration-driving-u-s-battery-manufacturing-and-good-paying-jobs/.

of programs to assist the battery industry, including through its Loan Programs Office.[7]

Unique to batteries for storage has been a steep, ongoing fall in cost and their modular, movable nature. Since 1994, battery costs have declined by 99% while the density for top-tier cells rose fivefold.[8] Over that same period and projected to continue, every time battery deployment doubled, battery costs decreased by nearly a fifth. The reduction in BESS costs, coupled with the ever-increasing demand for energy reserves across the United States, bolstered profits in the industry. In April 2024, Tesla, which began its battery storage business in 2015 and is one of the largest suppliers, announced that "[e]nergy generation and storage remains [its] highest margin business."[9]

While a growing number of firms are making batteries designed for storage, modularity is a feature in the industry. At a BESS site, batteries are typically housed in containers with fans on top for cooling. Containerization means very little on-site modification is needed to increase storage capacity and augmenting a battery storage site with more batteries is a common practice. The possibility of moving solar-charged storage batteries to boost supply in areas with energy scarcity is also gaining momentum, though we note that such a structure would face regulatory, permitting, and contract-structuring challenges that would need to be worked through.[10]

The combination of robust governmental support, falling costs, and modular equipment give BESS projects a compressed timeline compared to other power delivery facilities in the energy sector. One recent sizable storage project in Michigan envisions two years to bring power to the grid starting from a request for proposals from battery suppliers in May 2024.[11]

CHALLENGES TO DEPLOYMENT

In 2022, China overtook the United States for the lead in BESS installations and production.[12] By the end of the 2020s, China will likely account for approximately 35% of the world's battery storage sites while the United States

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[7] https://www.energy.gov/oe/energy-storage.

[8] https://rmi.org/the-rise-of-batteries-in-six-charts-and-not-too-many-numbers/.

[9] https://www.batterytechonline.com/automotive-mobility/tesla-accelerates-plans-for-entry-level-evs-robotaxis-ia-powered-robots.

[10] https://www.economist.com/interactive/essay/2024/06/20/solar-power-is-going-to-be-huge.

[11] https://www.utilitydive.com/news/dte-energy-battery-energy-storage-trenton-coal-plant/718593/.

[12] https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/metals/091223-infographic-china-battery-energy-storage-systems-capacity-us.

will be second at between 15% and 20%. The European Union, no slouch in other areas of renewable energy, will be close behind. A consortium of eleven developing countries committed to installing 5,000 megawatts of battery storage in their countries, attracted to the low cost and low carbon potential of BESS projects.[13] The Chinese lead in batteries means Chinese companies are often involved in setting up battery storage worldwide, including in the United States. To help U.S. companies catch up, the Biden administration announced 100% tariffs on Chinese solar cells and batteries in May 2024. However, recognizing U.S. dependence on Chinese imports for battery storage, those tariffs won't kick in until 2026.[14]

Being a relatively new pillar in America's energy markets, BESS projects still have many issues to resolve. More regulatory guidance is needed to clarify rules on open and equal access participation.[15] One of the most significant bottlenecks could be grid connection and other licensing and regulatory delays. The differences in battery quality or intensity of previous use makes projecting future BESS generation difficult. Dependent on temperature and discharge rates, BESS suppliers generally believe their batteries can last up to 20 years with appropriate maintenance. A lifespan of about two decades is not unusual in the renewable space. The industry standard today for solar panels' lifespan is 25 to 30 years. Newer technologies, such as water cooling, may continue to improve renewable longevity and make batteries even more cost effective. Coupled with supply chain, regulatory, and dependability questions, the market preference for shorter term contracts and variation of services stacking complicates project financing.

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[13] https://www.rockefellerfoundation.org/news/10-countries-join-first-of-its-kind-consortium-to-deploy-5-gw-of-battery-energy-storage-systems/.

[14] https://www.ft.com/content/92576467-d0f2-420e-aa29-a51935a60512.

[15] https://www.renewableenergyworld.com/storage/good-better-bess-how-to-build-your-battery-energy-storage-system/#gref.