EPRI

Quick Insights

Accessing Flexibility of Customer-Sited Battery Energy Storage Systems

RESEARCH QUESTIONS

What role do customer-sited battery energy storage systems (BESS) have in enhancing grid reliability and resilience while facilitating decarbonization?

KEY POINTS

- Deployments of residential customer-sited BESS in the United States jumped in 2021 by 69% over 2020 installations, as energy users sought greater resilience in power supply.
- The power sector is increasingly supporting customer-sited BESS deployment in exchange for (partial) control of the devices during non-outage time periods.
- Electric utility companies and third-party aggregators are using aggregated customer-sited BESS to provide capacity, frequency regulation, demand response, and energy arbitrage, among other services. The result: potentially lower costs for utilities and savings for their overall customer base.
- Ongoing regulatory activity, particularly Federal Energy Regulatory Commission (FERC) Order 2222, is likely to accelerate the value of customer-sited BESS assets for reducing energy costs while enabling bulk power variable renewable electricity supply growth.

INTRODUCTION

Residential energy users in the United States have been battered by high-profile outages in recent years—from hurricanes, winter storms, and Western wildfires—leading to a boom in sales of both fuel-based backup generators and a growing array of battery energy storage system (BESS) products intended to improve customer resilience.

U.S. electric utilities are working towards improving distribution system reliability, managing system impacts from rising deployments of variable wind and solar power generation to meet growing decarbonization mandates and goals, and ensuring sufficient resource adequacy. Additionally, electrification of transportation (for example, electric vehicles), buildings (heat pumps), and industrial processes (industrial boilers) continues to grow, adding increased demand and complexity to the electric power system.

Utilities are addressing these trends in their future planning activities by, for example, including customer-sited BESS as a useful resource in their integrated resource planning documents. Some are even providing incentives to stimulate incremental customer-sited BESS deployment in exchange for partial utility control of the asset to use for the benefit of the distribution system.

CHALLENGES FACING ENERGY USERS AND UTILITIES – AND A POTENTIAL SOLUTION

Energy users and electric utilities face numerous challenges. For energy users, extreme weather events may cause a greater quantity of grid disruptions and power outages. In response, users are examining their options to improve their resilience to such outages. Large commercial and industrial energy users are demanding and signing contracts for power supplies that do not contribute to the growing atmospheric concentrations of greenhouse gases as well as pursuing means to reduce their exposure to utility demand charges.

Electric utilities are faced with the demands of improving grid reliability while managing, upgrading, and operating aging distribution and transmission infrastructure, along with growing penetration of variable distributed energy resources (DER), such as rooftop solar photovoltaics (PV). They also are concerned with governmental mandates requiring a greater share of power supply from variable renewable energy sources, while simultaneously managing early retirements of coal-fired and other fossil fuel power plants, along with potential resource adequacy challenges.

Customer-sited BESS may offer solutions to address primary energy user and utility concerns. For customers, BESS deployments may provide clean, quiet backup power supply that can moderate the impact of outages and improve resilience. Customer-sited BESS has the potential to help electric utilities manage grid impacts and support movement toward electric grid decarbonization. For example, customer-sited BESS may be able to reduce rooftop solar exports to the (potentially overloaded) grid at peak solar hours and in aggregate, provide capacity, distribution and transmission deferral, and ancillary services to support the evolution of the electric grid. Just as utilities have acquired demand response resources from their customers for decades, the allure of acquiring expanded services via customer-sited BESS is leading some utilities (a few of which are profiled below) to begin supporting their customers in adopting BESS in exchange for the utility's ability to utilize their customers' BESS assets.

BESS MARKET GROWTH

Energy users have already taken their desire for enhanced resilience into their own hands by purchasing fuel-based backup generators and, increasingly, BESS products. More than 1.5 GW of customer-sited BESS capacity had been installed in the United States through 2021, with the total forecast to grow to 12 GW by the end of 2026 (See Figure 1).[1] As of July 2022, nearly 174,000 customer-sited battery systems have been installed; residential BESS deployments, in particular, have grown rapidly, increasing by nearly 69% in the first quarter of 2022 from the first quarter of 2021.[2] Utility-scale installations grew even faster than customer-sited installations, with new

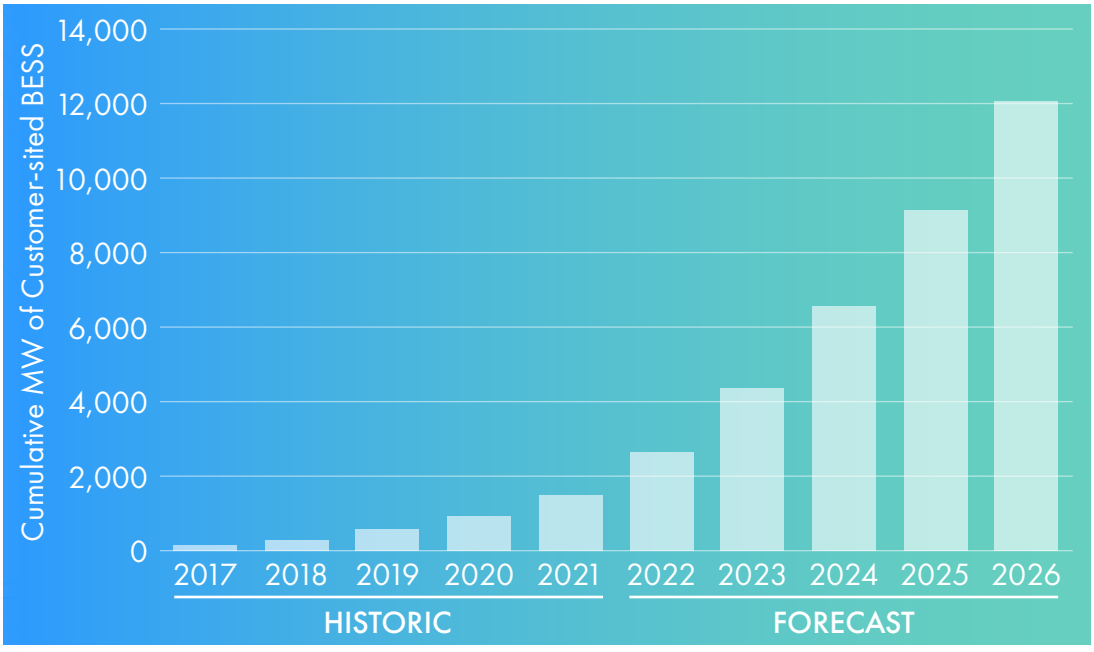

Figure 1. Cumulative Customer-Sited BESS MW Deployments in the U.S., 2015-2021, Forecast 2022-2026
Source: EPRI, based on Wood Mackenzie Power & Renewables, March 2022

1 Wood Mackenzie Power & Renewables and American Clean Power Association, *U.S. Energy Storage Monitor 2021 Year in Review Report*, March 2022. https://www.woodmac.com/industry/power-and-renewables/us-energy-storage-monitor/. The energy stored by these customer-sited BESS are forecast to rise from 3.6 GWh in 2021 to 32 GWh in 2026.

2 Wood Mackenzie Power & Renewables and American Clean Power Association, *U.S. Energy Storage Monitor Q2 2022 Full Report*, June 2022. https://www.

U.S. capacity additions up 169% in 2021 from 2020, predicted to redouble in 2022.[3] Indeed, most utilities have historically focused on utility-scale deployments while paying minimal interest in customer-sited equipment beyond developing interconnection standards. The rapid growth in customer-sited BESS capacity, though, could be used by utilities to support customer and utility needs.

UTILITIES AND THEIR GROWING BESS INITIATIVES

Electric utilities began to explore the use of customer-sited BESS in grid-interactive, commercial efforts in 2015 when Vermont-based Green Mountain Power (GMP) started deploying the newly released Tesla Powerwall. Fast forward to 2022, where more than two dozen utilities are supporting the customer adoption of BESS in exchange for utility grid system benefits.[4] Increasingly, utilities are capturing value from their customers' BESS, resulting in lower costs for their entire customer rate base (See Table 1). Among the services utilities are providing using aggregated customer-sited BESS include wholesale capacity and resource adequacy, distribution system support, and ancillary services such as fast frequency and regulation.

Table 1. Selected Utility Initiatives Using Customer-Sited Battery Energy Storage Systems

Utility (State)	Program/pilot Name	Customers	Installed Capacity (MW)	Sources of Utility Value	Additional Details
Eversource/ National Grid (MA)	ConnectedSolutions	798	12.1	ISO-NE long-term capacity; demand management	Third-party aggregators use customer- and third-party-owned BESS
Green Mountain Power (VT)	Home Energy Storage	~2,500	17ww	Demand response, energy arbitrage, and ISO-NE's Regulation Market	$4.7 million in savings (per 2021 IRP); Majority utility-owned, with some customer-owned through Bring Your Own Device Program
Hawaiian Electric (HI)	Battery Bonus	~900	4.65	Fast frequency response, peak demand reduction, capacity and (future) operating reserves and ramp smoothing	50-MW program tied to Sept. 2022 closure of 180-MW coal unit; ~140 MW of customer-sited BESS installed in Hawaii (as of 12/31/21)
Portland General Electric (OR)	Smart Battery Pilot	71[A]	0.6	Distribution system support for three specific substations	4-MW, 525 residential customer-owned BESS goal

[A] *Portland General Electric reports an additional 52 customers with 460 kW of storage capacity are in the process of signing up for the Smart Battery Pilot as of April 1, 2022.*
Source: EPRI

In May 2017, GMP launched its Grid Transformation Pilot that allowed homeowners to pay a monthly fee to lease a utility-owned and managed Tesla Powerwall battery. GMP's goal was to provide its customers with enhanced resilience against power outages while allowing the utility to dispatch the units to reduce transmission and capacity costs for all customers.[5] Four years later, GMP gained state regulatory approval to convert its effort to a two-part Home Energy Storage program as part of a new tariff. GMP customers could (a) enter a 10-year lease for two Powerwalls for $55/month (and starting in March 2022, two Enphase home batteries for $65/month) or (b) purchase their own system from five pre-certified vendors and receive a rebate of up to $850/kW (plus $100/month if located in a solar-constrained area) for sharing energy with GMP to lower costs and carbon for all customers.

GMP has approximately 17 MW of customer-sited battery capacity enrolled, generating $1.9 million in savings via demand response and energy arbitrage in ISO-NE's frequency regulation market in 2021,[6] and more than $4.7 million since the 2017 pilot was launched.[7]

woodmac.com/industry/power-and-renewables/us-energy-storage-monitor/.

3 Wood Mackenzie Power & Renewables and American Clean Power Association, *op. cit. 1.*.

4 EPRI, *Customer-Sited Energy Storage Programs: Utility and 3rd Party Programs Across the USA*, January 6, 2022.

5 Green Mountain Power, "GMP Launches New Comprehensive Energy Home Solution from Tesla to Lower Costs for Customers," press release, May 12, 2017. https://greenmountainpower.com/news/gmp-launches-new-comprehensive-energy-home-solution-tesla-lower-costs-customers/.

6 Jason Plautz, "Green Mountain Power's Bid to Extend Home Storage Programs Meets Tax Credit Snafu," Utility Dive, January 31, 2022. https://www.utilitydive.com/news/green-mountain-powers-bid-to-extend-home-storage-programs-meets-tax-credit/617985/.

7 Green Mountain Power, 2021 Integrated Resource Plan, December 2021, p. 32. https://greenmountainpower.com/wp-content/uploads/2021/12/2021-

As part of the tariff, the current program is capped at 5 MW, 500 new customers/year, and is currently under review to be extended beyond its scheduled end in September 2022.

Eversource and National Grid teamed up in 2019 to offer their ConnectedSolutions programs to Massachusetts customers who own BESS. The utilities are using the program to procure capacity to meet long-term capacity requirements in the ISO-NE marketplace, though Eversource plans to explore the use of storage for targeted dispatch at the substation level to relieve local congestion. Rather than control their customers' BESS directly, the two utilities work through third-party aggregators to control and dispatch the battery systems. The two utilities had enrolled more than 11 MW from 687 residential customers and 11 non-residential customers as of June 2021.[8] Residential customers receive $225/kW from Eversource ($275/kW from National Grid) for the utilities to use their batteries during as many as 60 three-hour high-demand periods during the summer. Over the course of the year, a typical Eversource residential user could accrue up to $1,125 in earnings.[9]

Figure 2. Typical Residential Customer-Sited BESS and Solar Installation in Pacifica, California
Source: EPRI

Oregon-based Portland General Electric (PGE) launched its Smart Battery Pilot in August 2020. The pilot aims to demonstrate the use of customer-sited batteries as a distributed flexibility resource. PGE's intent is to avoid the need for some 200 MW of conventional generation by 2025 as it increases its use of bulk variable renewable energy supplies.[10] The five-year Smart Battery pilot aims to deploy 525 residential battery installations, totaling up to 4 MW/8 MWh, to provide aggregated services within three substations in greater Portland. PGE is providing instant rebates of between $1,000 and $3,000 for new BESS installations from five different vendors, with an additional bill credit of up to $40/month for their customers' participation in the pilot. In the event of a power outage, the participating customer retains full usage of their battery for use as a power backup. As of April 1, 2022, 71 customers representing 571 kW were participating in the Smart Battery pilot, with an additional 52 customers (460 kW) in the process of becoming participants.[11]

Hawaiian Electric Company (HECO) is incentivizing the installation of an additional 50 MW of customer-sited BESS on Oahu to partly counter the regulatory requirement to close a 180-MW coal-fired powerplant. HECO launched its Battery Bonus program in July 2021,

Integrated-Resource-Plan.pdf.

8 Michael Matz, "The Age of Customer-Sited Energy Storage is Approaching," *EPRI Journal*, June 8, 2021, https://eprijournal.com/the-age-of-customer-sited-energy-storage-is-approaching/.

9 Eversource, "Demand Response for Home Battery Storage," https://www.eversource.com/content/nh/residential/save-money-energy/energy-efficiency-programs/demand-response/battery-storage-demand-response, viewed May 23, 2022.

10 Portland General Electric, *Integrated Resource Plan 2019 Update*, January 29, 2021, p. 12. https://assets.ctfassets.net/416ywc1laqmd/7JkfpRUwMrqCwfKsxAPG3g/9703398aa3212f8532ffb5ced616af87/2019-irp-update-04-20-2021.pdf.

11 Francisco Rosales, Enterprise Project Coordinator, Portland General Electric, email communication, April 1, 2022.

and is providing rebates of between $500-$850/kW for BESS added to new or existing rooftop solar installations.[12] In addition, program participants receive a monthly $5/kW peak capacity bill credit for the 10-year duration of the program. As of March 28, 2022, 4.65 MW of new customer-sited BESS had signed up for Battery Bonus. (Separately, HECO has an agreement with Swell Energy to secure the services of another 6,000 residential customer BESS, or roughly 50 MW.) As of the end of 2021, Hawaii already was home to some 140 MW of customer-sited BESS, some of which HECO uses to provide grid services including fast frequency response, peak demand reduction, and capacity. In the future, HECO intends to add operating reserves and ramp smoothing. The company also is considering expanding its battery bonus program concept to Maui to meet system capacity limitations.[13]

Figure 3. Commercial Customer-Sited BESS Installation in San Jose, California
Source: EPRI

OUTLOOK

There are a number of factors that are likely to influence how fast utilities promote and utilize customer-sited BESS. These include:

- ***Resilience: Customer interest in BESS back-up for power outages***. Energy users in certain regions of the United States—for example, hurricane-prone coastal areas or regions where controlled outages to prevent powerline-linked fires—are likely to be more receptive to adopting BESS for resilience than those in regions where outages are less frequent.
- ***Markets and Economics***. Determining whether to incentivize, and by how much, customer-sited BESS will vary depending on a utility's situation regarding the economics of using BESS for grid services, the ability to participate in wholesale energy markets, and/or capture other value streams.
- ***Utility Rates***. A utility's rate structure can impact whether its customers, particularly those considering purchase of a rooftop solar system, acquire BESS. The move away from traditional net energy metering (NEM) tariffs and adoption of alternative tariffs based on the value of DERs could encourage energy users to install BESS when installing customer-sited solar.
- ***Advanced Distribution Utility Management***. Whether a utility company has the requisite systems to aggregate and dispatch customer-sited equipment to provide utility benefits will impact its ability to take advantage of the services customer-sited BESS can provide. Having an operational DER Management System (DERMS), for example, will provide a utility with greater capabilities to analyze market and reliability impacts, as well as the control, of dispatching BESS.
- ***Renewables Integration: The penetration of variable solar and wind power, including distributed solar, in a utility's service***

12 Hawaiian Electric, "New 'Battery Bonus' Program to Offer Oahu Customers Cash Incentive to Add Energy Storage to Rooftop Solar System," press release, July 19, 2021. https://www.hawaiianelectric.com/new-battery-bonus-program-to-offer-oahu-customers-cash-incentive-to-add-energy-storage-to-rooftop-solar-system.

13 Kavya Balaraman, "Hawaiian Electric to Revisit Maui Capacity Planning Amid Supply Chain Concern," Utility Dive, March 24, 2022. https://www.utilitydive.com/news/hawaiian-electric-to-revisit-maui-capacity-planning-amid-supply-chain-conce/621017/.

area. A utility's need for services from customer-sited BESS will partly be determined by how large a share variable renewables accounts for the company's power supply, as well as the level of distributed solar impacting its distribution system.

- ***Energy Policy and Regulations: State Policy Measures***. The industry will need to work through unique requirements throughout the United States in the level of state support for electric grid decarbonization efforts, as well as BESS deployment goals or mandates.
- ***Federal Policy Measures***. At the national level, FERC Order 2222 implementation could have a significant role in how customer-sited BESS (and other DER) participate alongside traditional generation sources in wholesale power markets.[14] Utilities or third-party companies can aggregate these resources into fleets and receive compensation in energy markets for grid services. Separately, future modifications of the U.S. Business Energy Investment Tax Credit (ITC) could influence the outlook for customer-sited BESS.
- ***Flexible Interconnection Standards***. Flexible interconnection refers to an interconnection agreement that includes operational restrictions. For example, in exchange for grid connection, customers may agree to have the utility curtail the generation of their DER systems at something less than maximum capacity when the local grid is constrained. Developing and implementing flexible interconnection arrangements may facilitate connecting customer-sited energy storage and other DER to the distribution grid more rapidly and at a lower cost. It also may allow utilities to utilize BESS more readily as a grid resource while ensuring grid reliability and safety.

Separately, there remain concerns over the safety of customer-sited BESS, particularly the potential for fires related to defects in core lithium-ion battery cells. For the near-term, it may benefit electric utilities to focus on outdoor installations and to ensure sufficient redundant supply options should a specific product failure necessitate widespread shutdowns. Likewise, ongoing supply chain and environmental constraints on lithium-ion battery materials have created a near-term disruption to the BESS-supply sector. One upshot is the ongoing shift from lithium nickel manganese cobalt (NMC) chemistries to lithium iron phosphate (LFP) ones.

Overall, there is growing recognition of the utility opportunity to leverage highly flexible, customer-owned BESS assets that have often already been paid for. By leveraging customer BESS, utilities may only need to pay for the services they perform. As is already being demonstrated, customer-sited BESS can be a resource for electric utilities that economically supplements front-of-the meter BESS to meet the goals of improved reliability (and also support customer resilience), and decarbonization of the electric power sector.

ONGOING EPRI RESEARCH

EPRI's research agenda includes a number of projects related to customer-sited BESS and how it potentially can play an important role in the future of the power system. Research includes:

- Economic Tools & Value Analysis: Creating tools to assess BESS economics and value generation from multiple markets (the "value stack") that exist.[15]
- Product & Program Evaluation: Tracking and assessing customer energy storage and energy company efforts and deployments to promote and utilize such resources for system benefits.[16]
- Deployments: Deploying innovative BESS technology demonstration projects.[17]
- Interconnection: Developing and promoting improved BESS interconnection standards that may facilitate faster, lower-cost interconnection of new BESS to the utility distribution grid.[18]

CONTACT INFORMATION

14 For an overview of FERC Order 2222, see Federal Energy Regulatory Commission, "FERC Order No. 2222: A New Day for Distributed Energy Resources," September 17, 2020, https://www.ferc.gov/media/ferc-order-no-2222-fact-sheet.

15 EPRI Program 94, Energy Storage and Distribution Generation. Available Online at https://www.epri.com/portfolio/programs/053125; see, for example, EPRI, *Energy Storage Valuation 2021: Functions, Methods, Tools, Lessons Learned, and Examples*, January 21, 2022.

16 EPRI Program 94, Energy Storage and Distribution Generation. Available Online at https://www.epri.com/portfolio/programs/053125; see, for example, EPRI, *Customer-Sited Energy Storage Programs: Utility and 3rd Party Programs Across the USA*, January 6, 2022, EPRI, Energy Storage Database, January 1, 2022, and EPRI, *Customer-Sited Energy Storage: Field Testing Supplemental*, December 31, 2021.

17 EPRI Program 94, Energy Storage and Distribution Generation. Available Online at https://www.epri.com/portfolio/programs/053125; see, for example, EPRI, *Energy Storage for Customer Resilience*, April 2, 2021. CEC EPC-19-054

18 EPRI Program 174, DER Integration. Available Online at https://www.epri.com/portfolio/programs/067418; see, for example, EPRI, *Navigating DER Interconnection Standards and Practices*, November 3, 2017, and BATRIES, *Solutions to Improve Energy Storage Interconnection*.

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