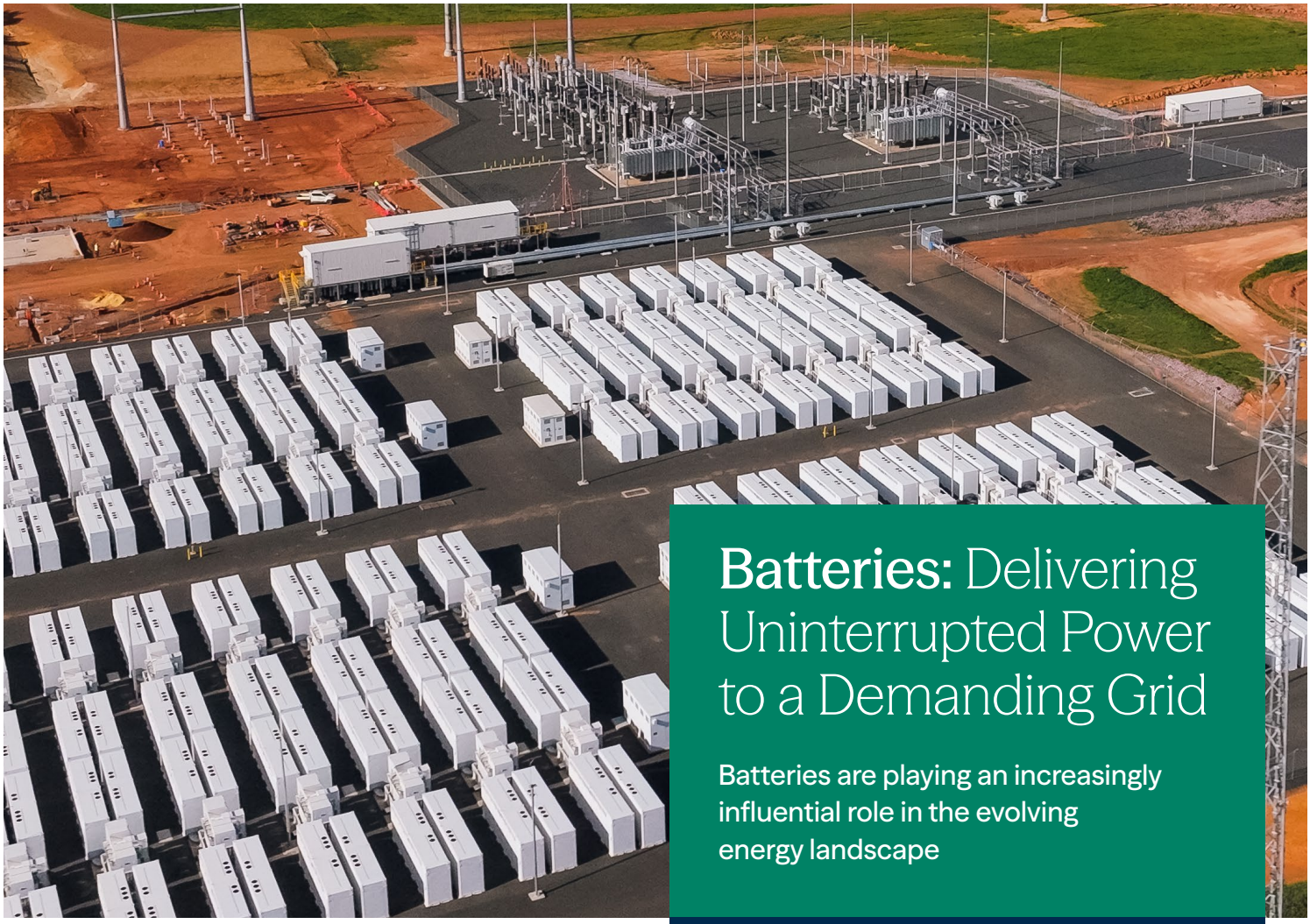


Batteries: Delivering Uninterrupted Power to a Demanding Grid

Batteries are playing an increasingly influential role in the evolving energy landscape

Australia Collie Battery

Key Takeaways

- Renewable developers are increasingly pairing utility-scale batteries with their solar and wind projects to ensure uninterrupted delivery of power, enhancing the value of these intermittent clean energy sources.
- Falling costs and improved technology have helped batteries reach a commercial tipping point, increasing their economic viability across many power markets around the world.
- Batteries offer developers and private market investors attractive opportunities to build and invest in global battery assets that can increase clean energy penetration, hedge risks, generate predictable revenue and potentially enhance risk-adjusted returns.

Clean Energy Limitations May Boost Battery Opportunities

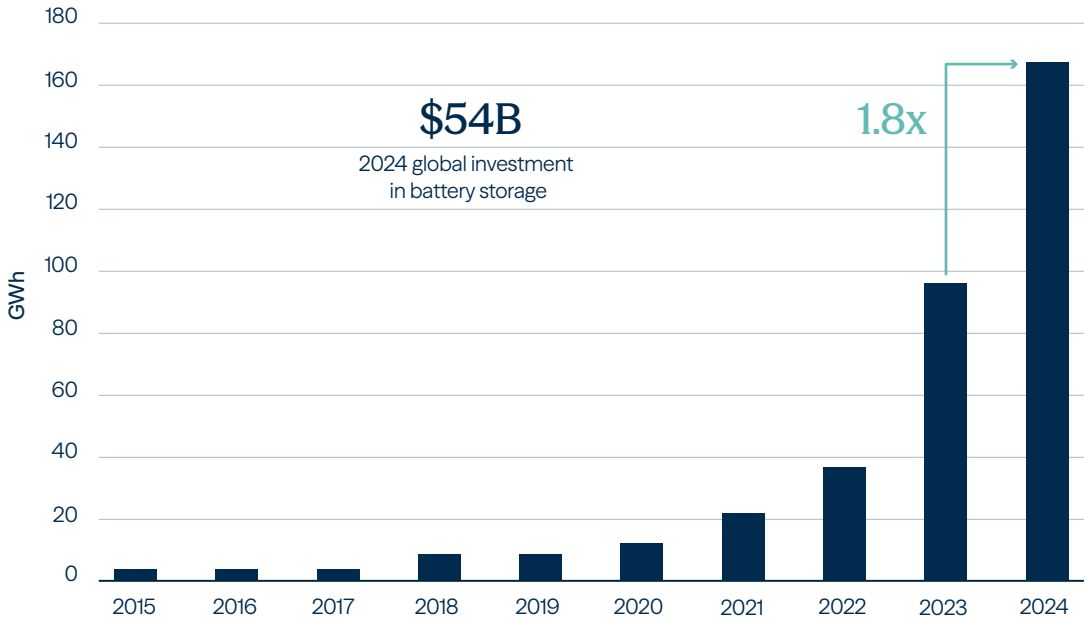
Renewable energy has emerged as the critical component to meet the enormous increase in demand for electricity and achieve global net-zero emissions goals. Yet the world's cheapest sources of new bulk power—solar and wind—come with a significant limitation: They're intermittent.

To address this challenge, batteries—specifically large-scale lithium-ion storage batteries—are charging ahead to play a vital role in the "any-and-all" approach to provide uninterrupted access to power. With global energy storage capacity nearly doubling in 2024, batteries have become an essential infrastructure asset class, as much for their ability to increase renewable power penetration and help stabilize overburdened electricity grids as for the long-term revenue generated by the services they provide.

The concept is simple: During windless periods or after sunset—or on peak power usage days—batteries can quickly discharge their stored electricity to help cover shortfalls and keep the grid running smoothly. Plummeting costs and rapid technology advancements have lifted batteries to a commercial tipping point, with an estimated $54 billion invested in global battery storage in 2024 alone (**Figure 1**).

Figure 1: Battery Storage Capacity Needs Are Rising Rapidly

Global energy storage capacity additions



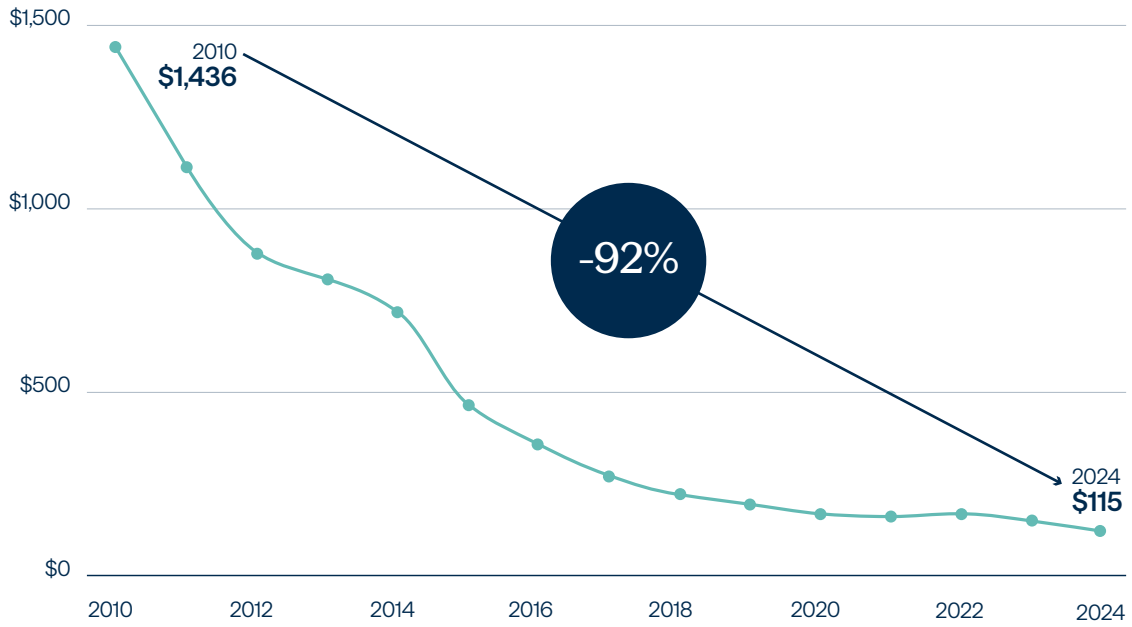
Source: BNEF.

Batteries are playing an increasingly influential role in the evolving renewable energy landscape, boosting the value of solar and wind projects and providing developers with risk mitigation and new revenue streams. While battery developers could face headwinds, including tariffs and low barriers to market entry, we believe these challenges are we believe these challenges are manageable given the expected long-term growth in electricity demand. This environment may present opportunities for developers and private market investors.

Battery Technology: Falling Costs and Improved Technology

Several types of battery technologies are used to store energy and many more are in development, but only one dominates the industry: lithium-ion. These storage batteries use essentially the same lithium-ion technology found in smartphones, laptops and especially electric vehicles (EVs), although they are much larger. Battery storage developers are benefiting from EV industry growth and falling costs, including a 92% decline since 2010 to make lithium-ion batteries (**Figure 2**), and a 50% drop in just the past two years.[1] Battery prices are expected to drop an additional 50% by 2026, according to internal Brookfield data.

Figure 2: Lithium-Ion Battery Prices Have Plummeted Since 2010
Average lithium-ion battery pack price ($ per KWh)



Source: BloombergNEF, 2024.

Improved technology is a major contributor to this decline. Batteries with higher density can store more electricity without increasing their size or weight. Between 2014 and 2024, the density of lithium-ion battery cells doubled, which lowered costs by reducing the amount of raw material, labor and production time required for manufacturing.

While costs are falling fast due to technological improvements, these batteries' ability to provide essential support for intermittent renewables and mounting electricity grid constraints is also contributing to the demand. Typically, thousands of storage batteries are housed together in containers known as battery blocks. Battery developers often locate blocks next to solar energy or wind farms, where they work in tandem and store hundreds of megawatt-hours of electricity.

Growing Grid Constraints

The ability to deliver power continuously is becoming increasingly vital as demand surges, driven by large technology companies' need to power their expanding fleet of data centers around the clock and the broader electrification of industries. Renewable energy is capturing most of this growth because it's the cheapest form of new electricity supply in most regions of the world, and pairing it with batteries only enhances the value.

Batteries are also beginning to play a key role as a backup power source for data centers, with many operators replacing their diesel generators with battery storage systems. While diesel generators are highly polluting, take several minutes to power up and require frequent maintenance, batteries are emissions free and can discharge electricity instantly.[2]

On peak power usage days, the high demand often strains the grid and sometimes leads to power supply shortages. The buildout of data centers to support artificial intelligence growth will only exacerbate this challenge. Batteries can provide the large volumes of power needed for these peak demand periods.

For example, on May 14, 2025, springtime temperatures in Texas climbed to the highest level in the past century. With many natural gas plants offline preparing for summertime service, batteries in the state discharged their stored electricity during peak demand hours that day to keep the power flowing—at one point covering 8% of the demand.[3]

X-ELIO's Bollingstedt Battery Is a Grid-Connected Energy Storage System in Germany

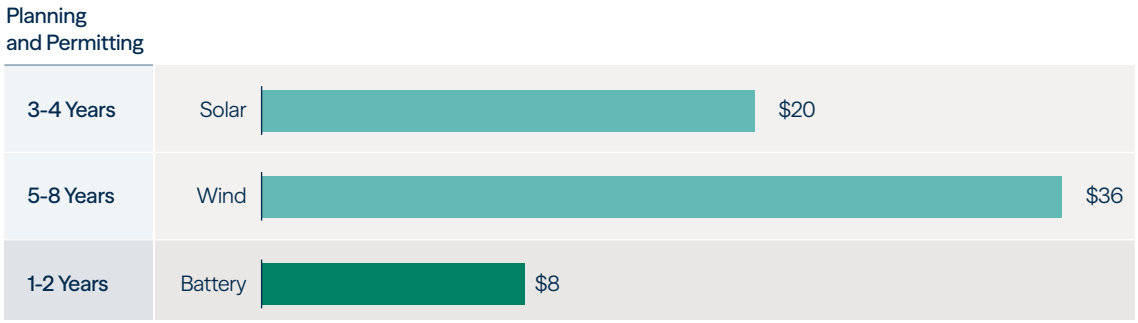
Bollingstedt Battery is Germany's largest battery storage facility and is co-owned by X-ELIO, a leading global renewable energy provider and a Brookfield portfolio company. It's capable of supplying electricity to 170,000 multi-person households for two hours.

Opportunities for Growth

While batteries are playing an increasingly important role in enhancing renewable energy penetration and alleviating grid constraints, they are also attracting attention from both developers and investors for their potential to help reduce renewable project investment risks and generate more predictable long-term revenue. Below we highlight several growth opportunities and key benefits of batteries.

- **Supply/Demand Capture:** As solar penetration increases rapidly in a given market, supply occasionally outstrips demand on sunny days, lowering power prices. Batteries paired with these solar projects, or located in the same or a similar market, can fully charge at low prices, store that energy and then dispatch it when needed at higher prices.
- **Energy Arbitrage:** Batteries also can help developers generate predictable revenue. Energy arbitrage is essentially a trading strategy that calls for buying power at low prices, storing it in battery systems and then selling it when prices are high.
- **Ancillary Services:** These services are essential to ensure grid stability because they help provide uninterrupted power to homes and businesses. They typically include fast-response services such as voltage control or frequency regulation, which delivers small bursts of power quickly to maintain a certain frequency level on the grid. In California, batteries already cover 20% of the evening peak, contributing to reductions in natural gas use and emissions with precise timing.
- **Long-term Contracts:** Battery revenue increasingly can be solidified through long-term contracts at fixed prices. As grid operators and regulators have recognized the need for battery storage, they have developed contractual structures and regulated revenue streams that support the long-term economics of batteries, giving this asset class infrastructure-like characteristics. Battery system owners can receive fixed, recurring payments, regardless of whether their power is needed on any given day.
- **Speed to Build:** Batteries can also be built more quickly than any other power generation technology. It takes up to two years at a relatively low cost to plan and obtain permits for a battery project. In contrast, solar projects can take twice as long at more than twice the cost, and wind projects can take four times as long at more than quadruple the cost (**Figure 3**).
- **Convenience:** Battery projects benefit from a smaller footprint, meaning developers don't need to acquire as much land as solar and wind projects to generate the same amount of electricity. Battery systems are also easier to "plug and play." When containers arrive on site, each holding thousands of connected batteries, virtually no assembly is needed.

Figure 3: Batteries Are Cheaper and Easier to Develop Than Solar and Wind Systems
Total development expense until ready to build ($ per KW)

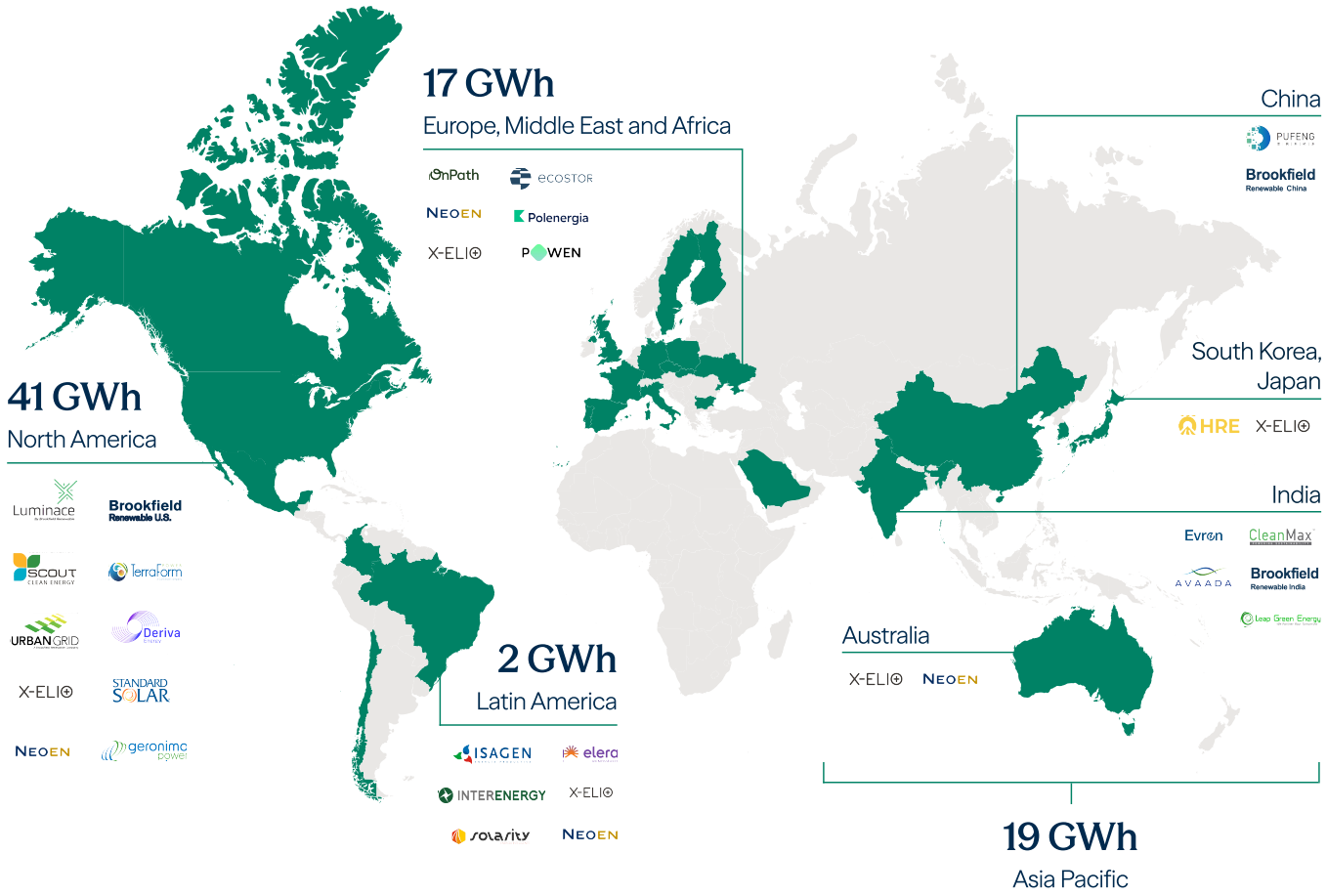


Source: Brookfield internal research

Brookfield's Broad Battery Playbook

Brookfield Renewables is one of the world's largest battery storage developers, with portfolio companies spread across five continents (**Figure 4**). Our robust 80 GWh portfolio includes projects that are either operating or in development. Within two years, we expect to have commissioned another 20 GWh of battery projects as batteries continue to enhance our global transition strategy.

Figure 4: Brookfield's Global Portfolio of Battery Assets



Source: Brookfield

Neoen: Among Leading Global Renewable Developers[4]

Neoen is a Brookfield portfolio company (100% Brookfield equity ownership) and one of the world's leading developers of renewable and battery projects. Along with its solar power plants and wind farms, this Paris-based company develops, builds and operates large-scale battery facilities in Australia, Finland, France, Italy and Sweden. Batteries now make up approximately a third of Neoen's portfolio.

Investment Details

Type	**Equity**
Sector	**Renewable Power & Transition**
Region	**Australia, France, Italy, Nordics**
Brookfield Ownership	**100%**

Neoen Battery Facility in Sweden

Neoen plans to advance its development pipeline to execute 2+ GW of new capacity per year by 2026. In order to achieve this goal, Neoen will harness the power of Brookfield's operating platform, which provides the company with access to attractive financing and capital structures, as well as in-house operating teams with deep relationships across the development space to build corporate contracts and procure equipment. We believe additional tailwinds from energy storage demand, decarbonization and grid modernization should continue to drive the company's success in battery energy storage systems over the long term.

One of Neoen's earliest and most significant battery projects emerged from a crisis. In September 2016, storms in South Australia knocked out power state-wide, sparking government interest in grid-stability solutions. The following July, the Hornsdale Power Reserve Consortium, led by Neoen with batteries supplied by Tesla, won a contract to build a 100 MW battery storage project before the upcoming summer arrived. On December 1, 2017, Hornsdale Battery was completed and connected to the grid ahead of the deadline. Just two weeks later, Hornsdale responded to a coal generator shutdown in less than one second to maintain grid stability.

Neoen currently operates the 300 MW Victorian Big Battery in Australia, one of the world's largest batteries. The Victorian Big Battery has a 250 MW System Integrity Protection Scheme (SIPS) contract with the Australian Energy Market Operator (AEMO). Under the contract, the battery provides an automatic instant response in the event of an unexpected network outage, providing AEMO with an additional means of ensuring grid stability. The battery also supports increased penetration of renewables in Victoria through network services such as fast frequency control, by rapidly injecting or absorbing power to stabilize the electrical grid's frequency within seconds of a disturbance. By ensuring grid stability, the battery is instrumental in helping Victoria reach its target of 50% renewable energy generation by 2030. It has twice the capacity of Hornsdale Power Reserve in South Australia, also owned and operated by Neoen.

Listen now to learn more about our acquisition of Neoen.

Watts Next?

The ability of utility-scale batteries to efficiently store and quickly discharge electricity has positioned them not only as a foundational component in the renewable energy landscape but, in our view, has elevated them to an essential infrastructure asset class. While falling costs and improved technology continue to enhance batteries' economic viability, their risk-hedging, revenue-generating and quick deployment benefits are redefining what it means to invest in energy infrastructure.

We see this environment as an opportune time for experienced developers to build and invest in global battery assets capable of enabling renewable energy penetration, stabilizing power grids, and potentially enhancing risk-adjusted returns for investors and private capital providers for decades to come.

AusNet

ENDNOTES

1. BNEF, Contemporary Amperex Technology Co., Limited.
2. "Replacing Diesel Generators With Battery Energy Storage Systems," Arcadis, August 2, 2024.
3. "How Big Batteries Could Prevent Summer Power Blackouts," Bloomberg, June 17, 2025.
4. Provided for illustrative purposes only. **Past performance is not a reliable indicator or guarantee of future results.** The case study discussions are provided for informational purposes only and are intended to illustrate the investment process. Forward-looking statements are subject to risks and uncertainties; actual results may differ materially.

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