GLOBAL X ETFs RESEARCH

Short- and Long-Duration Energy Storage Essential to the Clean Energy Transition

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The adoption of renewable energy is accelerating globally, particularly wind and solar power, as governments and corporations work towards meeting climate change-related emissions reduction targets and boosting energy security. The International Energy Agency (IEA) forecasts renewables capacity growth will be 50% higher from 2021–2026 than 2015–2020.[1] Despite this strong outlook, even faster renewable energy development will be required to reach global net-zero emissions by mid-century and keep global warming under 1.5˚C by 2100.[2] In our view, the widespread adoption of energy storage systems is key to reaching the high levels of renewable energy generation required to reduce emissions within the power sector.

In this report, we explore how the global proliferation of renewable energy can drive rapid growth in energy storage over the coming years, with both short- and long-duration energy storage systems essential to the green energy transition.

Key Takeaways

- Energy storage capacity and generation are set to grow rapidly over the coming years, driven by the global proliferation of renewable energy, grid supply challenges, government support, and lower technology prices.
- We expect the rapid adoption of short-duration battery energy storage systems to create investment opportunities across the renewables and battery value chains, including renewables developers, storage system manufacturers, and miners of critical minerals.
- Growing government support for long-duration energy storage systems could support power grids while accelerating wind, solar, and hydrogen power development significantly. To reach net-zero power sector targets, the growth of these systems could represent a $1.5–3.0 trillion investment opportunity.[3]

A Successful Clean Energy Transition Requires Energy Storage Solutions

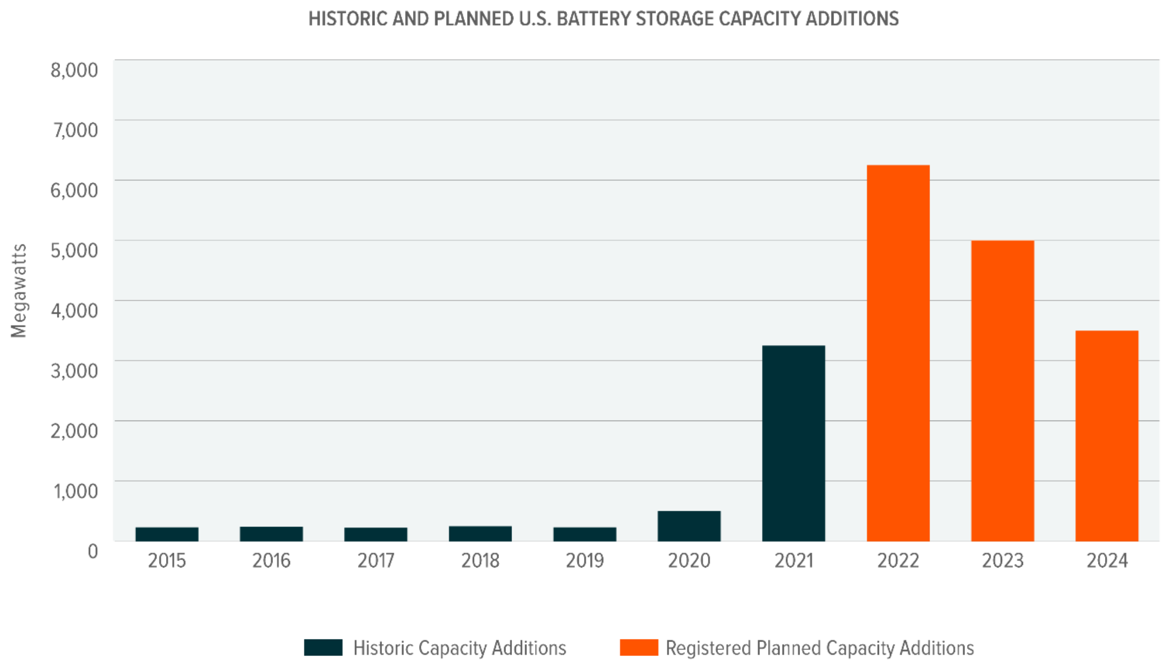
In 2021, renewable energy generation capacity grew by 9.1% to just under 3,065 gigawatts (GW).[4] Globally, renewables accounted for 81% of all new capacity additions last year, driven by the wind and solar power sectors.[5] We expect robust renewables' growth to continue, with forecasts for capacity to reach 4,800GW by 2026.[6] For context, 4,800GW is roughly equivalent to global fossil fuel and nuclear power capacity combined.[7] In total, renewables are forecasted to account for 95% of all power capacity growth between 2022 and 2026.[8]

The robust growth outlook for renewable energy is due to several factors. Many governments are ramping up climate change mitigation efforts, including support for renewable energy adoption through tax credits, subsidies, and renewable project tenders and auctions. In the U.S., President Biden set a target for reaching a carbon pollution-free power sector by 2035.[9] Also, corporations are seeking their own renewable energy supply to meet sustainability targets. In 2021, corporations procured 31.1GW of renewable energy globally via power purchase agreements (PPAs).[10] The top three corporate clean energy buyers last year were Amazon, Microsoft, and Meta.[11]

In addition, technological advancements, including to wind turbines and solar modules, make wind and solar power increasingly cost-competitive with traditional power sources while boosting overall performance and efficiencies. Critically, energy storage system technologies are also improving and becoming more cost-competitive due to falling battery costs and increased government support in many countries, including the U.S. and China.[12] Global energy storage is forecast to explode from 17GW/34 gigawatt hour (GWh) in 2020 to 358GW/1,028GWh in 2030, according to BloombergNEF.[13] The U.S. and China appear set to be the largest energy storage markets, with India, Australia, Germany, Japan, and the U.K. also expected to see strong growth.[14]

U.S. BATTERY ENERGY STORAGE EXPECTS TO SEE RAPID GROWTH

Source: Global X ETFs with information derived from: U.S. Energy Information Administration. (2022, April 26). Preliminary monthly electric generator inventory (based on Form EIA-860M as a supplement to Form EIA-860).

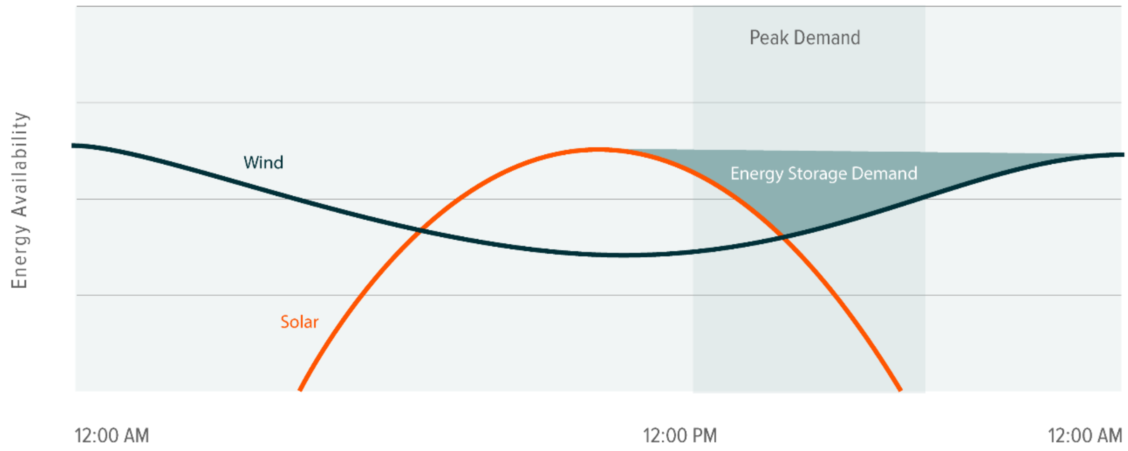


The energy storage landscape includes short- and long-duration energy storage solutions. Short-duration energy storage (SDES), also known as short-term energy storage, is defined as any storage system that is able to discharge energy for up to 10 hours at its rated power output. Long-duration energy storage (LDES) is any system that is able to discharge energy at its rated power output for 10 or more hours.[15] We expect both types of storage will be necessary to balance increasingly renewable power grids on hourly, daily, weekly, and even seasonal timescales.

In our view, the widespread adoption of energy storage systems is essential for renewable energy to comprise high shares of the global power system, and the growing deployment of energy storage has the potential to accelerate wind and solar power growth. As intermittent power sources, wind and solar energy production often does not align with peak energy demand.[16] The variability creates challenges for governments facing growing grid supply challenges, particularly amid increasing risks of extreme weather events that disrupt electricity production.[17] In the U.S., the power crisis in Texas due to extreme cold temperatures in February 2021 and the risk of blackouts in California due to the prevalence of wildfires are two examples that highlight the importance of adopting grid-stabilizing technologies. Renewable energy paired with energy storage systems offers a potential solution.[18]

WIND AND SOLAR GENERATION PATTERNS

Source: Global X ETFs with information derived from: Lawson, A. (2019, June 10). Maintaining electric reliability with wind and solar sources: Background and issues for Congress [Report R45764]. Congressional Research Service.



Growth in Battery Energy Storage Encompasses the Renewables and Battery Supply Chains

Battery energy storage systems (BESS) projects typically have short storage duration of 4–6 hours.[19] BESS designs can use a variety of battery chemistries, including lithium-ion, nickel-based, sodium-based, and lead acid.[20] However, lithium-ion systems dominate the space. Over 90% of installed energy storage capacity in the U.S. came from lithium-ion systems as of year-end 2019, similar to the rest of the world.[21,22]

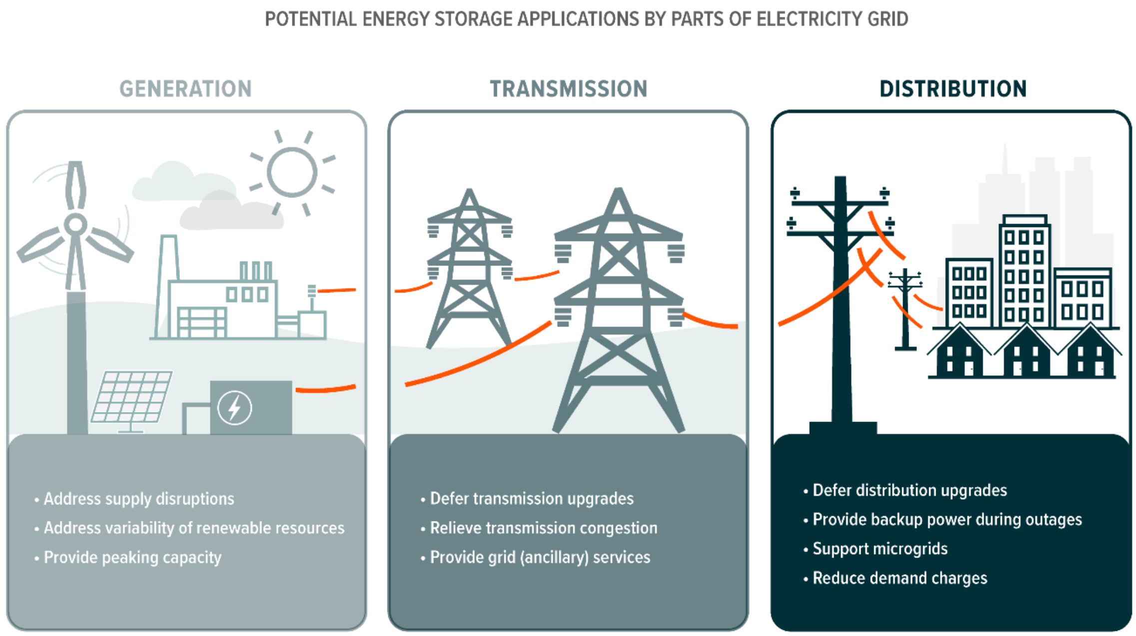
Lithium-ion BESS are expected to continue to dominate the energy storage market globally over the coming decade due to their increasing cost-competitiveness and established supply chain.[23] Given the strong growth outlook, the global battery energy storage market could grow from $10.9 billion in 2022 to $31.2 billion by 2029. For the full decade, the battery energy storage market could grow at 16.3% compound annual growth rate (CAGR).[24]

The growing BESS market creates opportunities for renewables project developers. Leading renewables developers such as NextEra Energy Resources, Enel Green Power, AES Corp, and Vistra Corp. are rapidly expanding their battery energy storage project pipelines.[25] Notable operational projects include the 409MW/900 megawatt hour (MWh) Manatee Energy Storage Center from Florida Power & Light, a regulated utility of NextEra, and the 400MW/1,600MWh Moss Landing Energy Storage Facility by Vistra in California. The two projects are among the largest BESS in the world.[26] Vistra plans to expand Moss Landing with an additional 350MW/1,400MWh battery system.[27]

Renewables developers could find additional wind and solar development opportunities as energy storage scales, with energy storage being a potential solution for insufficient and congested transmission and distribution infrastructure.[28] Notably, energy storage systems offer several potential benefits including enhancing grid reliability, deferring transmission upgrades, and relieving transmission congestion.[29,30] A lack of transmission or congested lines are a primary barrier to widespread renewables development in many countries, including the U.S. and Chile.[31,32]

ENERGY STORAGE PROVIDES SEVERAL POTENTIAL BENEFITS THROUGHOUT ELECTRICITY GRID

Source: Global X ETFs with information derived from: Smith, F.M (2018, January 23). Intro to Energy Storage. Clear Path.

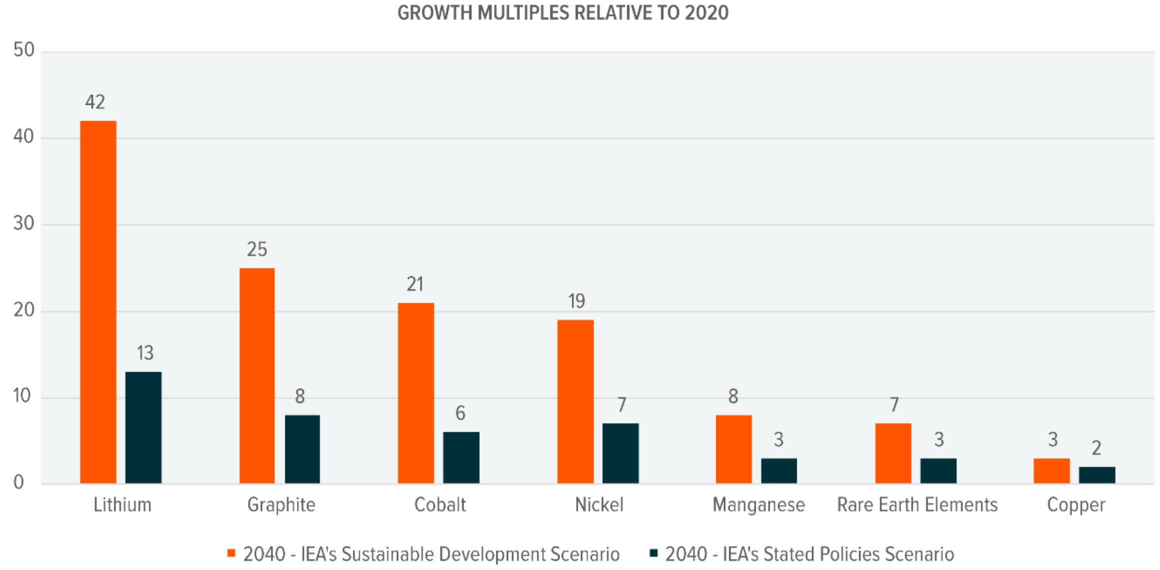


As a result, renewable energy developers are increasingly pairing wind and solar projects with BESS projects to create hybrid power systems. Of the 14.5GW of battery storage capacity registered as of year-end 2020 to come online in the U.S. through 2024, 63% are set to be co-located with solar power projects and an additional 9% with wind power projects.[33] Hybrid renewables plus storage projects have the potential to reduce upfront transmission upgrade and interconnection costs, reduce how much electricity production is curtailed in times of oversupply, and expand the time window in which a project can send electricity to the grid.[34]

The rapid uptake of BESS can also create opportunities across the battery energy storage supply chain. Leading battery energy storage system manufacturers, including Tesla and Fluence Energy, a joint venture between Siemens and AES Company, reported strong demand through Q1 2022.[35,36] Fluence Energy added 600MW in energy storage project orders, a 525% increase compared to Q1 2021.[37] Energy storage growth could also increase demand for miners of lithium and other critical minerals, including copper, cobalt, nickel, and rare earth elements. Depending on rate of growth in clean energy technologies such as electric vehicles and energy storage, lithium demand could be 13–43 times higher in 2040 than 2020. Cobalt and nickel demand could be around 6–20 times higher.[38]

ESTIMATED DISRUPTIVE MATERIALS GROWTH BY 2040

Source: Global X ETFs with information derived from: International Energy Agency. (2022, March). *The role of critical minerals in clean energy transitions*. IEA Publications.



Note: The IEA's Stated Policies Scenario (STEPS) takes a conservative approach to the implementation and achievement of existing climate change goals. It does not consider any significant measures beyond what policy makers have in place now. In this scenario, the IEA estimates overall demand for disruptive materials doubles by 2040 from 2020 levels. The IEA's Sustainable Development Scenario (SDS) assumes all current net zero pledges are achieved in full. The SDS assumes developed economies reach net zero emissions by 2050, China around 2060, and every other country by 2070. In this scenario, total demand for disruptive materials rises by 300% over the next two decades.

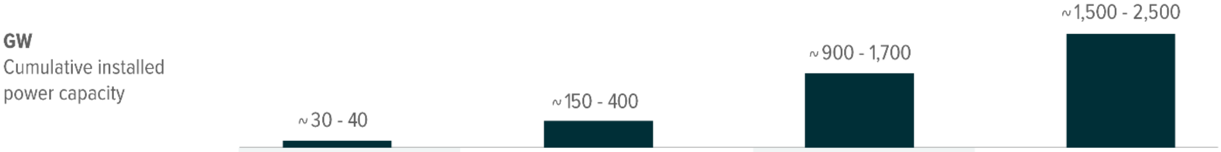
Development of LDES Systems Has Newfound Momentum

Long-duration energy storage systems offer stable energy output ranging from 10 hours to days, weeks, and even seasons, providing enhanced grid reliability compared to short-duration energy storage systems.[39] LDES systems have been around for decades, most notably in the form of pumped storage hydropower systems. However, cost, permitting, and technological barriers, in addition to a lack of regulatory support, prevented LDES systems from widescale adoption.[40,41]

We expect that to change, though, as significant growth opportunities for LDES technologies emerge. To reach a global net-zero power sector targets, LDES must be scaled up by an estimated 400 times from present-day levels to 85–140TWh by 2040.[42] This scale-up equates to a $1.5–3.0 trillion investment opportunity.[43] Government interest in LDES systems is growing, including in the U.S. In July 2021, the U.S. Department of Energy announced an initiative called the Long Duration Storage Shot, which seeks to reduce costs for LDES by 90% by 2030.[44]

LDES TOTAL ADDRESSABLE MARKET & CUMULATIVE CAPEX INVESTMENT BY YEAR

Source: Global X ETFs with information derived from: LDES Council, & McKinsey & Company. (2021, November). Net-zero power: Long duration energy storage for a renewable grid. LDES Council.



	2025	2030	2035	2040
TWh Cumulative installed power capacity	**~1**	**~5 - 10**	**~35 - 70**	**~85 - 140**
Cumulative capex investment. USD bn	**~50**	**~200 - 500**	**~1,100 - 1,800**	**~1,500 - 3,000**

Note: Forecasted ranges based on scenarios with varying rates of LDES adoption.

We expect that growth in LDES systems can also create investment opportunities in renewable energy. Similar to BESS, LDES systems could help unlock the potential of wind and solar power in power generation, particularly as renewables begin to reach 60–70% market share.[45] Further grid stabilization could make renewables a more suitable option that compares to traditional stable baseload power sources such as natural gas, coal, and nuclear.

In addition, the need for LDES systems presents a sizeable use case for hydrogen, particularly green hydrogen. As the table below shows, hydrogen-based energy storage has the potential to store power for weeks to months, so these projects could be used to account for seasonal differences in electricity production.[46] Power-to-hydrogen-to-power industrial scale projects are still in the very early stages of development. That said, pilot projects are expected to come online over the next few years, including the 12MW HYFLEXPOWER project in France.[47]

Similar to hydrogen-based storage, most other LDES technologies are also in the early stages of adoption. The types of LDES systems that we expect to take off at a commercial scale include compressed air energy storage, liquid air energy storage, non-lithium-ion batteries, and hydrogen-based energy storage systems. The adoption of these technologies is expected to vary due to location suitability and cost constraints.

DEFINING THE LANDSCAPE OF LONG-DURATION ENERGY STORAGE

Technology	Technology Description	Average Energy Discharge Duration	Average Lifecycle (Years)	Deployment Status	Notable attributes, developers and/or projects
Compressed Air Enegy Storage (CAES)	Electricity is used to compress air. When needed, air can then be heated to expand and drive a turbine that generates power.	4–24+ hours	30 to 50	Several projects have been deployed.	The technology requires suitable geologic conditions for underground storage. CAES systems have been available for decades, but are not yet widely adopted. Advanced CAES technologies are gaining momentum, with a sizeable project pipeline under development. Hydrostor is a leading developer in terms of capacity in the planning stages.
Gravity-Based LDES Technologies	Power is used to raise weights, which are lowered to generate power when needed.	5–24 hours	30 to 50	Not commercially deployed, although pilot projects are under development.	Gravity-based systems do not have a cycle limit or degradation, and they have the potential for high efficiency between 80% and 90%. Energy Vault and Gravitricity are two companies leading the development of pilot projects.
Liquid Air	Electricity is used to turn air to liquid form by cooling it down. Liquid is then reheated and expands to drive a power-generating turbine.	8–24 hours	50	Deployed at a commercial scale.	The technology does not have geographic constraints, and there is no degradation over time. Highview Power is a leading developer of LAES systems, with projects in the planning stages in Spain, the U.S., UK, and Chile.
Flywheel	Electric energy is converted into and stored as kinetic energy through the use of a motor that spins a rotor.	10–24 hours	35	Deployed at a commercial scale.	The technology is commercially deployed, but it has not been widely adopted. Next-generation flywheel technologies could reduce system energy loss and boost efficiency.
Concentrated Solar Power (CSP) with Thermal Storage	Solar rays are concentrated and reflected from panels towards a receiver. This heat can then be stored and converted into electricity when needed.	10–24 hours	75	Deployed in several countries.	CSP projects are most suitable for areas with very high solar irradiation levels, such as deserts. The technology offers high conversion efficiencies. CSP projects are commercially deployed in many countries, including Chile, the U.S., Morocco, China, and Spain.
Flow Battery	Electricity is stored and released via electrolyte flows through electrochemical cells in one or more tanks.	10–24 hours	25	Deployed in market, primarily small-scale systems.	Scalable to meet project requirements, flow batteries can be used in small-scale to utility-scale energy storage applications.
Pumped Storage Hydropower	Electricity is generated as water moves between two reservoirs at different elevations, which powers a turbine generator to create electricity.	8–36 hours	100	Deployed in several countries.	The most well-established of the LDES technologies, pumped storage hydropower has been around for over 100 years. Systems are constrained to areas with adequate water resources.
Iron-Air and Iron Flow Batteries	These batteries store and discharge energy through cycles of converting iron metal to rust and then back to iron.	4–100 hours	N/A	Not commercially deployed, although pilot projects are under development.	This modular and scalable technology has few geographic limitations. It offers potential for significantly longer energy storage duration than most other LDES technologies. Form Energy and ESS Inc. are leading companies that have pilot projects under development throughout the U.S.
Thermal Battery	Systems store electricity or heat in thermal energy mediums, such as molten salts and aluminium alloy. The systems can then discharge electricity or heat when needed.	6–200 hours	30	Not commercially deployed, although the technology is market ready.	The technology does not have geographic constraints, and there is no degradation over time.
Hydrogen-Based Energy Storage	Hydrogen is stored as a gas or liquid, which can then be used in generators and power plants to produce electricity.	Hours to Months	30	Several pilot and large-scale projects are in development stages.	Hydrogen-based storage is limited to areas with large underground salt caverns. A mix of pilot and large-scale projects are under development, including in Europe and the U.S.

Sources: Global X ETFs with information derived from: Balaraman, K. (2020, October 14). To batteries and beyond: Compressed air, liquid air and the holy grail of long-duration storage. Utility Dive.; Gravitricity. (n.d.) Fast, long-life energy storage. Accessed on May 16, 2022.; Hydrostor. (2022). Our projects.; International Flow Battery Forum. (n.d.) What is a flow battery? Accessed on May 16, 2022.; LDES Council, & McKinsey & Company. (2021, November). Net-zero power: Long duration energy storage for a renewable grid. LDES Council.; Long Duration Energy Storage Association of California. (n.d.) Who we are. Accessed on May 16, 2022.; O'Donoghue, A. J. (2022, May 10). How this big project will turn the high desert in central Utah 'green'. Deseret News.; Office of Energy Efficiency & Renewable Energy. (n.d.) What is pumped storage hydropower? U.S. Department of Energy. Accessed on May 16, 2022.; Solar Energy Industries Association. (2022). Concentrating solar power.; Solar Paces. (2021, September). CSP projects around the world. IEA Energy Technology Network.

Conclusion: Energy Storage Plus Renewables Creates Opportunities

Renewable energy sources, primarily wind and solar power, are set to account for the majority of growth within the power sector over the coming years. But to take full advantage of this potential growth requires reliable energy storage systems that can bolster energy grids already under pressure from increasing variability and climate change. We expect investment opportunities to materialize across the renewables and battery energy storage value chains, including miners of critical minerals, manufacturers of BESS technologies, and renewables developers. Longer-term, we expect the potential that long-duration energy storage systems hold to finally gain traction, accelerating opportunities in the renewables, energy storage, and hydrogen spaces.

Footnotes

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