Advancing energy storage with renewable integration

As the global transition toward renewable energy accelerates, energy storage has emerged as a cornerstone of sustainable power systems. With the scaling up of renewable energy adoption, the demand for energy storage solutions grows to balance supply and demand, enhance grid stability, bolster energy security and drive carbon emission reductions. However, the development of energy storage technologies continues to be influenced by key challenges, including high initial costs, energy density limitations, efficiency concerns, scalability constraints, lifespan limitations, degradation issues and recycling complexities.

Market landscape: a surge in demand

Industry reports indicate that the energy storage market is experiencing exponential growth, with global annual capacity additions projected to reach 228 GW/965 GWh in 2035, primarily driven by government mandates and targeted schemes. By the end of 2035, cumulative capacity is anticipated to reach 1,722 GW/6,214 GWh, with key markets including China, the United States, Germany, India, Italy and the United Kingdom.

Lithium-ion batteries continue to dominate capacity additions, while long duration energy storage (LDES) technologies, such as flow batteries and compressed air energy storage (CAES), are gaining traction as viable alternatives. In the power conversion system (PCS) segment, 2+ MW PCS units are expected to lead in the coming years, while the deployment of string PCS architectures is increasing. Research forecasts suggest PCS shipments will exceed 150 GW by 2030.

Key challenges: efficiency, costs and safety

Despite the rapid expansion, several critical challenges must be addressed to prevent bottlenecks in the sector. Efficiency and longevity remain major concerns, particularly for lithium-ion batteries, which degrade over time and require sustainable recycling solutions.

Meanwhile, cost reduction is crucial for improving the economic viability of large-scale storage deployments. The pursuit of higher energy density has driven innovations in ultra-high capacity products which require less enclosures and improve cost-effectiveness.

Technological advancements are also improving system efficiency and safety. The transition from air cooling to liquid cooling in energy storage systems represents a significant innovation, optimizing thermal management, extending system lifespan and reducing fire risks in large-scale installations. As technology evolves and regulatory support strengthens, energy storage solutions will become even more integral to the next phase of the clean energy revolution.

Power for higher: leading a new era of 12.5 MW

To overcome these barriers, Sineng Electric, leveraging its extensive expertise in power electronics, is developing next generation storage solutions aligned with prevailing industry trends. As utility scale energy storage plays a vital role in stabilizing the grid, mitigating power fluctuations and diversifying the energy mix, Sineng has introduced a high power solution. These solutions incorporate advanced power conversion systems and management technologies to ensure seamless integration with existing power infrastructure.

Sineng's energy storage solutions feature both string and central PCS technologies. The string PCS ranges from 125 kW to 12,500 kW, while the central PCS ranges from 1,250 kW to 12,500 kW. By leading the transition to 12.5 MW energy storage systems, Sineng offers solutions that deliver enhanced energy density, allowing for more energy throughput within a smaller physical footprint. These high power PCS units significantly reduce

conversion losses, resulting in improved round trip efficiency and optimized utilization of stored energy.

Moreover, the need for fewer PCS units to achieve the same total capacity reduces equipment, installation and maintenance costs. This simplification of system design not only ensures greater flexibility but also facilitates easier expansion.

Thermal management: liquid cooling technology

Liquid cooling technology has become a significant differentiator among leading energy storage manufacturers. Sineng Electric has embraced this innovative approach to enhance heat dissipation and enable higher power density. The new generation 430 kW string PCS, equipped with liquid cooling, offers flexible scalability, supporting configurations ranging from 3.2 MW to 12.5 MW.

Engineered for optimal thermal management, the liquid cooling technology effectively reduces temperature fluctuations, mitigates the heat island effect and extends the system's lifespan to over 25 years. The liquid cooling system maintains a consistent IGBT temperature differential of less than 3°C, ensuring stable power output and long-term operational reliability.

In comparison to traditional air-cooled systems, Sineng Electric's liquid-cooled PCS operates with minimal noise, eliminating the need for frequent filter replacements and significantly lowering maintenance costs. Additionally, the IP68-rated quick-plug terminal facilitates effortless plug-and-play installation, while the self-sealing plug ensures zero leakage even after 10,000 plug-ins. These advancements contribute to enhanced system uptime and improved operational efficiency.

Grid-forming technology: enabling a smarter, more resilient grid

As power grids transition toward higher renewable energy penetration, grid-forming energy storage has become a fundamental technology for ensuring system stability and resilience. Unlike traditional synchronous generators, which inherently provide inertia, frequency regulation and voltage support, renewable sources such as solar and wind lack these stabilizing properties. Grid-forming storage bridges this gap by functioning as a virtual synchronous machine, autonomously regulating frequency and voltage to maintain a stable power supply.

Moreover, in the event of a blackout, grid-forming energy storage provides black start capabilities, enabling the grid to recover independently without the need for external power sources.

To address the challenges associated with integrating intermittent renewable energy, Sineng Electric has developed advanced control algorithms, including virtual excitation voltage, virtual impedance/power angle and inertia damping. These innovations overcome traditional grid-forming limitations, such as slow response and reduced robustness under large disturbances.

To date, Sineng's 1.25 MW central PCS, equipped with the latest virtual synchronous generator (VSG) technology, has been widely adopted. This EH series PCS supports grid-following, grid-forming and grid-off control, with the ability to seamlessly transition between these modes. This adaptability ensures optimal performance across complex environments and operating conditions worldwide.

Global deployment: demonstrating excellence

Sineng Electric has built a strong track record in grid-forming applications, successfully powering projects across regions including Asia-Pacific, North America, the Middle East, North Africa and Europe. The company has established a grid-forming energy storage demonstration base, where it conducts comprehensive testing and verification of critical functions such as fault ride-through, black start, inertia response, damping control, fast frequency regulation and power response.

Setting a benchmark in microgrid energy storage, the company has deployed its advanced grid-forming solutions to support a 200 MWh microgrid battery energy storage system (BESS) in Xinjiang, China, spanning nearly 1,000 square kilometers. At the core of this project are 20 units of Sineng's 2.5 MW central PCS MV turnkey stations equipped with VSG technology. This solution enables seamless switching across different operating modes and control algorithms. It caters to diverse application scenarios, including rural communities, islands, remote mines, oil and gas facilities, offshore areas, railway systems, industrial parks and more.

With a clear vision of a net zero world, Sineng Electric remains committed to developing transformative solutions that optimize energy efficiency, enhance grid reliability and support the global transition to a renewable-based power system.

Keep home powered: enhancing energy independence

As homeowners increasingly seek energy independence, cost savings and a zero carbon lifestyle, residential energy storage solutions are becoming more sought after. Sineng Electric offers a comprehensive range of home energy storage systems designed to optimize self consumption, reduce electricity bills and provide backup power during outages.

To meet critical demands for safety, flexibility and ease of use, it has developed an advanced household battery pack. Featuring automotive grade, high capacity batteries, the solution eliminates the barrel effect, enabling the mixed use of new and old battery cells. Its modular design supports scalable configurations ranging from 6.4 kWh to 25.7 kWh, accommodating diverse household energy needs. Compatible with both single-phase and three-phase hybrid inverters, the home battery also adopts a plug-and-play design for streamlined installation.

Built for exceptional durability, the battery boasts an IP65 protection rating, a wide operating temperature range and a service life exceeding 10 years. A multilayered safety system ensures maximum protection, incorporating millisecond-level intelligent fire response, real-time temperature monitoring and advanced composite insulation materials for superior thermal safety.

Sineng's home battery, combined with inverters ranging from 5.0 kW to 15 kW, forms a residential all-in-one solution. Paired with the smart energy management platform EnjoySolar, homeowners can gain full visibility into their home energy system, from generation to consumption, making energy management more intuitive and efficient.

Through continuous technological innovation and a user centric approach, the company is redefining the future of home energy storage, empowering homeowners with greater control, sustainability and resilience.

Shaping the future of energy storage

With a clear vision of a net zero world, Sineng Electric remains committed to developing transformative solutions that optimize energy efficiency, enhance grid reliability and support the global transition to a renewable-based power system. From pioneering high-power PCS and liquid cooling technologies to advancing grid-forming capabilities and residential storage solutions, it continues to set new benchmarks in modern energy storage.

https://en.si-neng.com/