Energy storage technologies pakistan

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The rise in demand for electric vehicles (EVs) worldwide, driven by governments" rebates to curb carbon emissions, has spurred advancements in battery technology. Significant research funding has gone into the EV battery to achieve the objectives of a high number of charge cycles, distance, and low weight and volume, with Chinese companies, CATL and BYD are leading the way.

These developments and the economies of scale have resulted in a constant decline in the cost of storage batteries. Lately, falling international prices of raw materials have pushed the small battery manufacturers out, leaving a few major players, mainly from China. Once dominant, Nickel Manganese Cadmium batteries are being replaced by Lithium Iron Phosphate technology, which now holds nearly half the market share.

Benefiting from the rapid improvements in storage technology, battery-based energy storage systems (BESS) are gaining acceptance at the grid-scale level to address the intermittent nature of variable renewable energy (VRE) sources like wind and solar. With the large-scale induction of VRE in the grid, concerns about their irregular output are rising.

Initially, with fewer installed gigawatts (GWs), backup energy storage systems were not a priority. Still, the supply-demand mismatch and other system stability concerns are becoming more pronounced with the large-scale induction of VRE in the grids. Pakistan"s installed solar capacity has reached 14GW, although only 3GW is connected to the grid. As more grid-connected solar power comes online, the need to integrate storage batteries into the grid will gain importance.

As the world doubles down on sustainability research, interest in battery-based energy storage systems rises

Battery storage offers numerous benefits, including short-term energy shifting, ancillary services, grid congestion alleviation, and expanded electricity access. An important factor to consider before installing large-scale grid-based storage batteries is the added complexity due to the large number of components housed in the battery module.

EVs typically require 50-100kWh battery capacity, while grid storage systems range from tens to hundreds of MWh. A 1GW BESS can have up to 1.5 million parts, posing operability, maintenance, and continuous operation challenges.

Critical BESS components depend on complex supply chains that are vulnerable to disruptions from raw material shortages and regulatory changes. Integrating storage technologies with the existing grid requires careful planning, as cost and benefit projections can be difficult to quantify. Unlike EVs, where lithium iron

phosphate technology is widely accepted, the best technology for stationary applications like grid storage is still being debated.

The international demand for BESS projects, after rising slowly in recent years, is projected to grow exponentially in the coming years. EV batteries and grid-based battery energy storage systems have distinctly different requirements. EV batteries should have a high energy density and lightweight and fast charging capabilities, making lithium-ion batteries ideal due to their performance across these parameters and cost balance.

On the other hand, BESS batteries prioritise scalability, long cycle life, and cost-effectiveness, with vanadium redox flow and sodium-sulfur batteries being popular choices for their large energy capacity and long-term storage capabilities. At this time, lithium-ion batteries, due to their technical prowess, are the most commercially successful technology and have become virtually the norm in both EV and BESS applications.

Pakistan"s electricity sector has several technical options as it proceeds with the deployment of BESS projects: in the transmission network, in the distribution network near load centres, or co-located with VRE generators. VRE resources which are located far from load centres require transmission investments to deliver power efficiently.