Energy storage solutions

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In September 2017, Southern Australia suffered a state-wide blackout, sparking energy security debates around the intermittency of renewable energy. The solution came via a tweet from Elon Musk: "100 days from contract signature or it"s free". Musk was referring to a 100MW battery storage system that would be installed quickly and help alleviate the pressure on a grid with high generation but low transmission and distribution connections. Tesla went on to successfully deliver the battery storage system, with a further 350MW procured since then, bringing the total to 450MW. However, in July 2021 a fire incident during storage system commissioning highlighted the importance of testing, monitoring and strict safety controls of these systems.

Much like Australia, many other nations experience such power outages, including the US and Indonesia, with dire consequences for business activities and compromising key infrastructure, such as transportation and telecommunications. Battery Energy Storage Systems (BESS) can play a critical role in preventing the human and financial cost of large-scale power outages by plugging the intermittent renewable energy supply and alleviating transmission and distribution (T& D) congestion, a major cause of blackouts. This allows for grid independence from renewables and flexible storage, reducing peak demand and increasing grid stability.

Renewable energy storage also reduces reliance on fossil fuels by facilitating system-wide energy orchestration through peak-shaving, integrating distributed energy resources and reducing carbon emissions supporting countries on the "race to zero". Lithium-ion batteries are currently the preferred choice of technology for these systems due to lower cost, broader understanding of technology and greater energy density.

With the cost of electric batteries dropping by 89% over the past decade, driven by the spill over of electric vehicle (EV) battery technology advancements, the market is set to boom in the coming years. It is forecasted to represent 40% of total battery demand by 2030. Furthermore, as regulation progresses, the expansion of ancillary services and flexibility markets will enable the monetisation of storage assets via "value stacking", reducing payback periods by four to six years.

However, quantifying the value of a BESS can be challenging due to future market changes and lack of long term historical data, making it difficult to evaluate the potential revenue streams and costs. This is exacerbated by the complexity of deploying long-term BESS with optimized market participation. Software, a critical component in BESS, can address these challenges by modelling short and long term battery performance (including ageing) and automating optimized market participation to maximize revenues and minimize damage to cells and modules.

A further concern is that the supply of raw materials for batteries (nickel, cobalt, lithium, and graphite) may not be able to meet increased demand, but longer battery lifetimes, new chemistries (e.g. Cobalt free) and improved battery recycling can mitigate this challenge.

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Technology plays a critical role in overcoming the challenges associated with implementing and operating BESS. Key solutions include:

BESS are essential in enabling grid resilience and integrating renewable assets to reduce CO_2 emissions and support global efforts to achieve net-zero pledges. Digital twins to support bankability, optimization through AIoT, and battery monitoring and analytics can prevent accidents, enhance the economic viability of adopting BESS, and act as a catalyst to ensure governments and corporations meet net-zero targets. Much like Elon"s project in Australia, similar BESS projects are nearly doubling in total installed capacity every two years. The hardware and financial incentives are in place, now AIoT technology can help expedite deployment, ensure safety and boost ROI of such projects supporting a faster race to zero.

Efficient energy storage is a vital part of efforts to break our long-held dependence on fossil fuels and embrace a cleaner future.

As part of the global energy transition, a number of battery technologies are being pioneered that can store surplus renewable power and boost efforts to decarbonize sectors ranging from data centres to road transport.

The race to decarbonize is putting severe strains on the supply of rare metals and minerals needed for battery storage and other energy transition technologies.

A group of MIT chemists aims to circumvent the electric vehicle (EV) industry"s metals shortage by developing a lithium-ion battery that uses a cathode based on organic materials, in place of using elements like cobalt or nickel.

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