Grid-scale battery storage - a reality or not?

By Menno Sulsters

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Grid-scale battery storage could change the power situation in South Africa in many positive ways. A battery energy storage system (BESS) that charges or collects energy from the grid or a power plant and then discharges it later to provide electricity or other grid services when needed could be just what South Africa needs.

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Grid-scale battery storage can also contribute to cleaner energy. The world has realised that we need to change our attitude to and practice of carbon-intensive processes. This awareness has contributed to the growth in demand for cleaner approaches to mitigate global climate change. This has led to a rapid cost reduction in renewable energy power generation, such as wind, solar, hydro, and biogas

Grid-scale battery storage and dispatch can also be used for any power produced, regardless of the source.

But can we do it?

Currently, we can choose one of several battery chemistries available or under investigation for grid-scale applications. These include lithium-ion, lead-acid, redox flow and molten salt, including sodium-based chemistries. Each have diverse technical characteristics and therefore each has unique advantages and disadvantages.

The US and global market are dominated by lithium-ion chemistries. Due to technological innovations and improved manufacturing capacity, lithium-ion chemistries have declined sharply between 2010 and 2016 (by more than 70%) and prices are projected to decline further.

BESS could therefore start fulfilling an increasing role in the power system with the rapid decreases in the costs of battery technology. Policymakers, regulators and utilities are all developing policies to jump-start BESS deployment as prices continue to decline and the need for system flexibility increases with wind and solar deployment.

Battery storage is one of several technology options that can enhance power system flexibility and enable high levels of renewable energy integration. Various studies and real-world experience have indicated that interconnected power systems can safely and reliably integrate high levels of renewable energy from variable renewable energy (VRE) sources without new energy storage resources.

Grid-scale battery storage has various benefits, such as addressing the intermittency of solar and wind power. They can also respond rapidly to large fluctuations in demand, making the grid more responsive and reducing the need to build backup power plants.

They can also contribute to meeting electricity demand during peak times, such as on hot days when people use more air conditioners to cool down. Energy storage also allows greater grid flexibility as distributors can buy electricity during off-peak times when energy is cheap and sell it to the grid when it is in greater demand.

It also helps to provide resilience as it can serve as a backup energy supply when power plant generation is interrupted, as with load shedding in South Africa.

However, like any other form of technology, grid-scale battery storage also has its own challenges.

Regulatory barriers include a lack of rules and regulations to clarify the role of BESS. There are also restrictions or lack of clarity around if and how storage can be used across generation, transmission and distribution roles.

Market barriers, on the other hand, include a lack of markets for system services as well as a lack of discernment in quality and quantity of services. Data and analysis capabilities are also challenges because battery storage systems are an emerging technology with more risk for investors than conventional generator investments.

Key characteristics

We must also remember that all battery storage systems have key characteristics that should be considered when potentially planning for grid-scale battery storage:

- The rated power capacity (the total possible instantaneous discharge capability (in kilowatts (kW) or megawatts (MW)) of the BESS, or the maximum rate of discharge that the BESS can achieve, starting from a fully charged state.
- The energy capacity (maximum amount of stored energy (in kilowatt-hours (kWh) or megawatt-hours (MWh)).
- Storage duration (the amount of time storage can discharge at its power capacity before depleting its energy capacity).
- The cycle life or lifetime before failure or significant degradation.
- Self-discharge, expressed as a percentage of charge lost over a certain period, reduces the amount of energy available for discharge and is an important parameter to consider in batteries' intended for longer-duration applications.
- State of charge, expressed as a percentage, represents the battery's present level of charge and ranges from completely discharged to fully charged. The state of charge influences a battery's ability to provide energy or ancillary services to the grid at any given time.
- Round-trip efficiency, measured as a percentage, is a ratio of the energy charged to the battery to the energy discharged from the battery.

Storage batteries also offer various services, such as arbitrage. This is when a battery is charged when energy prices are low and discharged during more expensive peak hours. Or firm or peaking capacity where system operators must ensure they have an adequate supply of generation capacity to reliably meet demand during the highest-demand periods in a given year.

Operating reserves and ancillary services maintain reliable power system operations where generation must exactly match electricity demand at all times.

Transmission and distribution upgrade deferrals can help defer or circumvent the need for new grid investments. They do this by meeting peak demand with energy stored from lower-demand periods, reducing congestion and improving overall transmission and distribution asset utilisation.

Unlike traditional transmission or distribution investments, mobile BESS installations can be relocated to new areas when no longer needed in the original location, increasing their overall value to the grid. Black Start is another service, where an on-site diesel generator is used to start the on-site source of electricity.

Utility-scale BESS can be deployed in several locations, including inside the transmission network, in the distribution network near load centres or co-located with VRE generators. Where the BESS is installed has important implications for the services the system can provide. The most appropriate location for the BESS will depend on its intended use.

It is important to analyse the costs and benefits of multiple locations to determine the optimal siting to meet system needs.

The increasing association between storage and mobility is important. Electric vehicles, for example, creates a new space for expanding technology markets and reducing carbon emissions. The demand for qualified installers is growing as well as for the production of batteries.

However, we need better materials for grid-scale battery storage to improve performance, which are in development. Artificial intelligence, (AI) also plays an important role. Artificial neural networks using artificial intelligence is increasingly used for energy management and analysis. They are also used for predicting more accurately what to anticipate in terms of weather patterns by using historical data.

Developmental impact

The developmental impact of grid-scale battery storage in SA can be significant across the entire value chain and benefit commodities abundant in South Africa, such as vanadium, platinum and iron. South Africa could support a local battery manufacturer or fabricate major system components for flow batteries with its sophisticated manufacturing base.

While there is no rule of thumb for how much battery storage is needed for the integration of high levels of renewable energy, the appropriate amount of grid-scale battery storage depends on system-specific characteristics. This includes the current and planned mix of generation technologies, flexibility in existing generation sources, interconnections with neighbouring power systems, the hourly, daily and seasonal profile of electricity demand and the hourly, daily, and seasonal profile of current and planned VRE.

According to the Energy Storage Updater: September 2020 issued by Norton Rose Fulbright, battery storage installed on the distribution grid is ready to play a critical role in meeting local resiliency needs.

The report states that distribution grid infrastructure is struggling to keep up with the pace of electrification in many parts of the world. This is due to increasing decentralised power generation, the rise of electric vehicles and electrified heating.

“Distribution-level battery storage offers an ideal solution in many cases. When installed in transmission-congested areas, it is reported to improve grid reliability and prove more affordable than traditional grid upgrades.”

Considering the benefits, challenges and demand for battery storage solutions, it is clear that grid-scale battery storage is not pie in the sky. It is reality and it is here.

ABOUT THE AUTHOR

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