Battery Energy Storage System (BESS) Factsheet

Western Downs, Qld. Image supplied by Neoen Australia.

What is BESS? Basically a big battery (or rather a series of smaller ones)!

Battery Energy Storage Systems (BESS) are installations that store and release electricity to support grid reliability. They consist of batteries that are able convert electrical energy into chemical energy so that it can be stored. BESS import electricity when the network is generating more than is being used to charge, store it, and then release it when demand is high. This process is managed by a BESS monitoring system which uses real-time data from the National Electricity Market (NEM) to 'bid' into the energy market to charge or discharge electricity according to supply and demand. The electricity market is operated by the Australian Energy Market Operator (AEMO), who is responsible for balancing network supply and demand through the centralised bidding process.

Grid-scale battery facilities are operated by site owners and/or contracting partners who are ultimately responsible for making sure the facility works safely and efficiently, monitoring its performance, handling maintenance, and working to deliver power when needed.

BESS facilities in Queensland (in operation, under construction, and proposed for development) have the ability to deliver between 10 – 500 megawatts (MW) of power and play a crucial role in stabilising the energy network.

Role of BESS in the Queensland electricity network

BESS are typically charged during periods where energy supply in the network is much higher than demand, drawing from the grid (which is a mix of both traditional and renewable energy sources), or from a co-located renewable energy source such as solar or wind. In Queensland, this typically happens during the day when solar energy generation is at its peak, particularly from rooftop solar, complemented by wind energy, which provides a consistent long-term supply while accounting for daily and seasonal variations in wind strength.

Stored electricity is then released by the BESS back into the grid when demand is high. This typically occurs in the afternoon and evening when Queenslanders are returning home – turning their lights on, using electrical appliances, and using air conditioning or heating.

By storing excess energy generated during peak production times, BESS reduce waste, prevent curtailment or shedding of renewable energy and provides energy for use during periods of low production. BESS can also deliver backup power during network disruptions, enhancing grid stability. By balancing supply and demand, especially when electricity generation from renewable sources fluctuates, BESS play a necessary role in improving Queensland's energy resilience, keeping our homes, business and industry running.

Bouldercombe, Qld. Image supplied by Genex

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BESS Technology

BESS technology is continuously evolving, with advancements in battery chemistry and system integration. Supplier research and development is focused on improving energy density, product lifespan, noise emissions, safety, and repurposing and recycling.

Lithium-ion batteries

Grid-scale lithium-ion batteries are made up of lithium iron phosphate or other lithium-based chemistries, capable of storing large amounts of energy in solid state electrodes. Industrial-scale lithium-ion BESS are designed as modular units, often resembling shipping containers, and contain thousands of smaller interconnected battery cells. These smaller cells operate much like a typical battery, where chemical reactions across an anode and cathode create an electric flow. Lithium-ion batteries offer high energy density, making them ideal for sites with limited space that require high-power, quick response solutions.

Most BESS facilities in Queensland are lithium-ion batteries and can release electricity into the grid for up to two-to-four hours, at several hundred megawatts. Historically, the typical life span of lithium-ion batteries has required replacement every 10 to 12 years due to capacity degradation. However, the technology being installed today can be expected to last twice that with global manufacturers warranting performance for at least 20 years. Grid scale lithium-ion batteries deployed in Queensland are typically made by respected global manufacturers with an operational warranty.

Flow batteries

Flow batteries are currently being trialled in a handful of locations across Queensland and grid storage applications may become operational by the end of 2026. Different to lithium-ion batteries, flow batteries store energy in liquid electrolytes held in external tanks, such as those based on vanadium, iron, or zinc-bromine chemistries. Flow battery components include two separate positive and negative tanks containing liquid electrolytes, and a fuel cell containing electrodes and a membrane. The two electrolyte solutions are pumped through separate chambers in the fuel cell, where their oxidation state changes when they're in contract with the electrodes. Electrons and ions then pass through the membrane, resulting in the flow of electricity.

Due to their nature, flow batteries take up more space that lithium-ion batteries for the same storage capacity, but the design allows energy storage capacity to be scaled up by increasing electrolyte tank size. Flow batteries storage capacity at present ranges up to 100 MW but can release electricity into the grid from anywhere between four and 24 hours (so called long duration energy storage (LDES)).

One of the benefits of flow batteries is that there is no consumption or degradation of the solution, and as a result the storage capacity does not reduce with time in the way lithium-ion batteries do.

Chinchilla, Qld. Image supplied by CS Energy

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Bouldercombe, Qld. Image supplied by Genex

BESS Management - Safety

Batteries in Queensland are assembled and installed under Australian Standard (AS/NZS 5139:2029), which is a comprehensive standard focusing on the safety and installation of BESS used with power conversion equipment. BESS facilities must also operate in compliance with local or state-imposed project approval conditions, and relevant guidelines and standards.

As of 2024, only one thermal event has occurred in Queensland at a grid-scale lithium-ion BESS facility, and this was due to faults in the power electronics interface, not the result of battery pack manufacturing. The incident was isolated to a single BESS module, and the issue was identified during the project's testing and commissioning phase before the facility was connected to the grid.

Lithium-ion batteries

The chemical reaction in lithium-ion batteries produces heat, and, if not controlled, can result in thermal runaway, leading to the destruction of the battery or, in severe cases, fire. While these events do happen, they are rare, and batteries are equipped with Battery Management Systems (BMS) to monitor charge, cooling systems, temperature in real-time, and fire suppression systems to reduce fire risks. Components of lithium batteries are only flammable if internal system temperatures reach 150°C – 280°C, depending on battery chemistry.

To mitigate the risk of runaway thermal events, non-combustible fire barriers are installed within the BESS containers and there are minimum separation distance requirements between each container. As BESS units are self-contained, this provides for staged protection, first, through internal containment of any event by the BMS and, second, by minimising the risk that an event could spread to other units. Appropriate clearances to surrounding vegetation are maintained by the introduction of an Asset Protection Zone, where vegetation and potential fuel for combustion is kept to a minimum by the operator.

BESS facilities are safeguarded with Emergency Management Plans which are typically developed in collaboration with relevant emergency response authorities, including risk-proportionate onsite fire management measures for the surrounding habitat, neighbouring properties and businesses (including related infrastructure).

Leading-practice BESS operators have implemented fire response safety training for local Queensland stakeholders, including Rural Fire Services. This proactive approach ensures rapid and informed responses to any incidents, including education on not using water to 'extinguish' a battery experiencing a thermal event (this is the same as if you had a domestic battery event at home), as the unit likely still retains a state of charge and may pose an electrical hazard if the internal system is exposed to water.

Protection of the surrounding environment including nearby water sources, native vegetation, wildlife, or any nearby agricultural activities, is achieved by constructing the BESS foundations using suitable drainage and incorporating appropriate emergency planning that is risk-proportionate to the project.

Flow batteries

The chemical reaction in flow batteries does not result in the generation of heat and, due to the nature of their design (i.e., tanks, pipes, and pumps), there is no risk of fire as a result of the unit over-heating.

Whilst the first commercial facility is yet to be developed in Queensland, flow batteries are designed with robust containment measures to handle electrolyte disposal and mitigate environmental impact.

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BESS Decommissioning

Decommissioning grid-scale batteries at the end of their operational life requires careful planning and adherence to leading practices to minimise environmental impacts and ensure safety. Operators develop Decommissioning Management Plans which must be approved by the regulator before decommissioning a BESS facility. The Decommissioning Management Plan outlines processes for dismantling infrastructure, removing materials, and rehabilitating the site in line with project approvals.

Many battery manufacturers offer take-back programs, enabling the recovery or recycling of components, while non-recyclable materials are disposed of in accordance with regulations. There are recycling technologies for the valuable metal components of a lithium battery. Ancillary BESS facility infrastructure and plant material such as concrete and steel are also typically recycled.

Due to safety risks like fires or chemical leaks, end-of-life batteries require specialised handling, transportation, and disposal through certified operators. Local government waste facilities are unsuitable for these materials, as industrial-scale batteries must be processed at facilities equipped to neutralise hazardous components. This involves strict protocols for storage, transportation, and the disposal of non-recyclable elements, ensuring compliance with environmental and safety regulations. and disposal through certified operators. Local government waste facilities are unsuitable for these materials, as industrial-scale batteries must be processed at facilities equipped to neutralise hazardous components. This involves strict protocols for storage, transportation, and the disposal of non-recyclable elements, ensuring compliance with environmental and safety regulations.

RELATED RESOURCES:

Battery Storage Facilities – Guidance for Local Government

Best Practice Guide: Battery Storage Equipment

Queensland Battery Industry Strategy 2024 – 2029

Battery energy storage systems | Electrical Safety Office

Battery energy storage systems (BESS) | WorkSafe.qld.gov.au

Industrial Lithium-Ion Battery Emergency Response Guide

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Image supplied by Stanwell

QREC collaborates with industry, communities and all levels of government to drive the growth of Queensland's renewable energy sector.

As Queensland's only renewable peak industry body, we represent stakeholders across solar, wind, pumped hydro, electricity transmission, battery storage, and renewable fuels.

Our leadership in policy development promotes leading practices and fosters positive community relationships. Through this focus, we aim to power regional growth, support Queensland's economic future, and provide access to clean, relaiable and affordable energy for all.

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