Energy Explainer: Big Batteries

As the Australian energy system undergoes rapid transformation, there's growing interest in the crucial role battery energy storage systems (BESS) – often termed 'big batteries' – can play in the future electricity grid.

In today's National Electricity Market (NEM), coal-fired generation meets around 60 per cent of annual electricity demand. Coal, gas and hydro plants also provide important services the grid needs to maintain its stability including frequency control and inertia.

AEMO's 2020 Integrated System Plan forecasts that 63 per cent of coal-fired generation is set to retire by 2040, replaced by wind and solar farms that are complemented by up to 19 gigawatts of firming generation, such as pumped hydro, battery storage and gas.

Distributed energy generation capacity is forecast to double or even triple in the next 20 years, with rooftop solar expected to provide up to 22 per cent of total electricity. This rapid growth creates new technical challenges for AEMO as the market operator, for regulators and for governments seeking to find the right policy settings to make sure the grid remains viable and stable.

The problem is that while renewable energy sources are growing fast, they cannot provide all the electricity we need, all the time. We still need "dispatchable" power plants - power that can be dispatched on demand or at the request of power grid operators, according to system needs.

Over recent years, battery technology has emerged as a key enabler of the uptake of renewables by overcoming the problem of intermittent supply when it is not sunny or windy. BESS store excess power created when conditions for renewable energy are most favourable and release it during demand peaks, such as heatwaves.

But how many grid-scale batteries, also known as Battery Energy Storage Systems (BESS), are connected in the NEM and what services can they provide?

Grid-scale batteries in Australia

Australia's first big battery, the Hornsdale Power Reserve, was built in South Australia in 2017. Built by Neoen using Tesla batteries with a capacity of 100 megawatts (MW), it has since been expanded to 150 MW.

Today, there are five grid-scale batteries with a capacity of 260 MW operating in South Australia and Victoria. However, there are more than 40 big batteries with a total capacity of more than 7,400 MW in the planning pipeline (click here for more detail).

Grid-scale batteries (commissioned) in the NEM

Region	Site Name	Capacity (MW)	Storage (hours)
SA	Hornsdale Power Reserve Unit 1	150	1.25
SA	Dalrymple BESS	30	0.27
VIC	Ballarat Energy Storage System	30	1.0
VIC	Gannawarra Energy Storage System	25	1.97
SA	Lake Bonney BESS1	25	2.08

Source: AEMO Feb.2021

If all the batteries currently in the pipeline were operating at full capacity, they could power around 10 million households, for one hour (see diagram below).

Diagrammatic comparison of the approximate number of houses which could be powered by batteries currently operating with those in the pipeline (Victoria and South Australia).

Planning is currently underway for the world's biggest grid-scale battery in the Hunter Valley, New South Wales. According to developer CEP Energy, the $2.4bn battery at Kurri Kurri, north-west of Newcastle, would have a power capacity of up to 1,200 MW – about eight times greater than the battery at Hornsdale.

In Victoria, construction has begun on the Victorian Big Battery (VBB). At 300 MW/450 MWh it will improve grid security by providing extra capacity during the peak summer months. Under the System Integrity Protection Scheme (SIPS) contract owner Neoen has signed with AEMO, the VBB will unlock up to an additional 250 MW of peak capacity on the existing Victoria to New South Wales Interconnector.

What role can grid-scale batteries play?

Batteries are not new, but interest from investors has grown as production costs have rapidly decreased and are predicted to continue to fall as the market grows around the world.

Further, the versatility of big batteries is driving their uptake. A grid-scale battery consists of rows of domestic or vehicle lithium-ion batteries installed together - which can be easily expanded simply by adding additional units. Advances in technology and materials have greatly increased the reliability, output, and density of modern battery systems.

New innovations in technology are overcoming limitations and enhancing their value, such as electrochemical capacitors that can quickly charge or discharge energy for later use and provide an almost unlimited operational lifespan. As technical innovation expands storage capability, batteries will be able to deliver power for longer time periods.

Batteries can be built in conjunction with solar or wind farms or simply store power from the grid for use when it's needed most. They can supply household power as well as grid-stabilisation services.

Batteries can ramp up quickly, have near zero start-up time and provide a strong frequency response. Placed at strategic locations around the grid – for example, incorporated into planning for new Renewable Energy Zones (REZs) – batteries can inject bursts of power to fill gaps in dispatchable supply, meaning that renewable generation can be used more efficiently and serve greater demand.

Ideally located close to the source of power generation and the market served, batteries can reduce the need for investment in new transmission infrastructure.

One example is the 300MW battery to be completed in Geelong later this year that will have the theoretical capacity to service the average energy needs of 400,000 households for an hour, but which will also stand ready to pump power into the grid in the event of a shortfall, making sharing between NSW and Victoria more efficient.

Could batteries deliver power system security in the future?

Research underway in Australia and elsewhere is exploring the potential for batteries to play a bigger role in the power grid.

AEMO is currently participating in a University of NSW research project investigating how small-scale energy devices, like battery storage systems, can help in maintaining reliable supplies of power when the grid is impacted by sudden and unexpected equipment failures.

System strength and system restart are two key services provided by coal/synchronous generators that are not currently widely provided by batteries. However, as technology improves, and with sufficient batteries installed they may be able to take on this role, with the potential to operate as a virtual synchronous machine.

This would allow batteries to play an even greater role in the electricity system, including delivering more of the power system security services that coal plants currently provide

The next decade will be a fascinating time for batteries and battery storage, with the rapid growth of innovative grid scale batteries set to change the energy landscape.

Further information can be found in AEMOs 2020 Integrated System Plan (ISP) (summary document, Infographic), or listen to our Energy 101 Podcast – battery basics.