



Australian Government



Clean energy and large-scale battery storage

Large-scale battery storage is supporting the transformation of Australia’s electricity grid, harnessing increasing levels of low cost, low emissions renewable energy to deliver a cleaner, more reliable electricity system.

NEOEN



Hornsdale Power Reserve

1st

large-scale lithium ion battery in Australia

150 MW

installed capacity

194 MWh

energy generation

Grid challenge creates game changer

Australia’s electricity system is undergoing unprecedented rapid change, as it takes advantage of our world leading renewable energy resources to integrate increasing amounts of clean energy into the grid.

Increasingly, the CEFC is investing in complementary projects and technologies – such as South Australia’s landmark “big battery” the Neoen Hornsdale Power Reserve - to improve the capacity of the grid to integrate this new energy. We are also encouraging private sector finance into emerging opportunities in energy transmission, interconnectors, renewable energy zones, pumped hydro and green hydrogen.

The Clean Energy Council’s *Clean Energy Australia Report 2021* estimated that more than 27 per cent of Australia’s electricity

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Energy storage supports cost effective, reliable, clean electricity and is a key component of Australia’s transition to a low emissions economy. Utility scale batteries can help electricity networks support a higher penetration of renewable energy, delivering support to the grid at demand periods.”

Ian Learmonth
CEO, CEFC

came from clean energy sources in 2020, compared with just 17 per cent four years earlier. Additional renewable energy capacity is critical to accelerating the decarbonisation of the energy grid, requiring significant additional investment in the grid and energy storage. Large-scale batteries, with their ability to support increased amounts of renewable energy while maintaining grid stability, are a important element in the next wave of clean energy investment.

The investment

Leading French independent renewable energy producer Neoen owns and operates the 150 MW/194 MWh Hornsdale Power Reserve (HPR) in South Australia.

HPR – the first large-scale lithium ion battery in Australia – began operating at 100 MW capacity in November 2017. It rapidly became an integral part of the South Australia Energy Plan, demonstrating it could respond faster than other energy storage or generation technologies to maintain grid stability.

An additional 50 MW capacity, installed at HPR in September 2020, further enhanced the ability of the battery to stabilise the grid, avoid price volatility and reduce the risk of blackouts.

The CEFC committed \$50 million in senior debt to the battery expansion, which has also enabled greater renewable energy penetration and reduced strain on the Heywood interconnector transmission line between Victoria and South Australia.

In a world first, The Tesla Virtual Machine Mode was added as part of the HPR expansion, enabling advanced power inverters to provide a service to support the inertia needs of South Australia.

The Australian Renewable Energy Agency (ARENA) provided \$8 million in grant funding to the expansion, which was the first project under the South Australian State Government Grid Scale Storage Fund.

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HPR is a game changer for the energy sector and has demonstrated some of the new capabilities we need in the electricity network to successfully integrate greater proportions of renewables as our generation fleet continues to decarbonise over time.”

Paul Gleeson,
Energy Leader, Aurecon

Economic and energy game changer

Some 60 per cent of South Australia's electricity comes from renewable energy sources, according to the *Clean Energy Australia Report 2021*. The South Australian Government has ambitions to further increase this to net 100 per cent renewable energy by 2030.

The Hornsdale Power Reserve is well positioned to play an important role in helping South Australia realise its clean energy plans.

As the first non-synchronous regulation Frequency Control Ancillary Services (FCAS) provider in Australia, HPR has demonstrated it can respond significantly faster and more precisely than conventional generators, with response times of milliseconds.

HPR has helped prevent blackouts by reacting quickly and accurately to disturbances and fluctuations in the frequency of the grid. The battery has provided FCAS to help maintain the

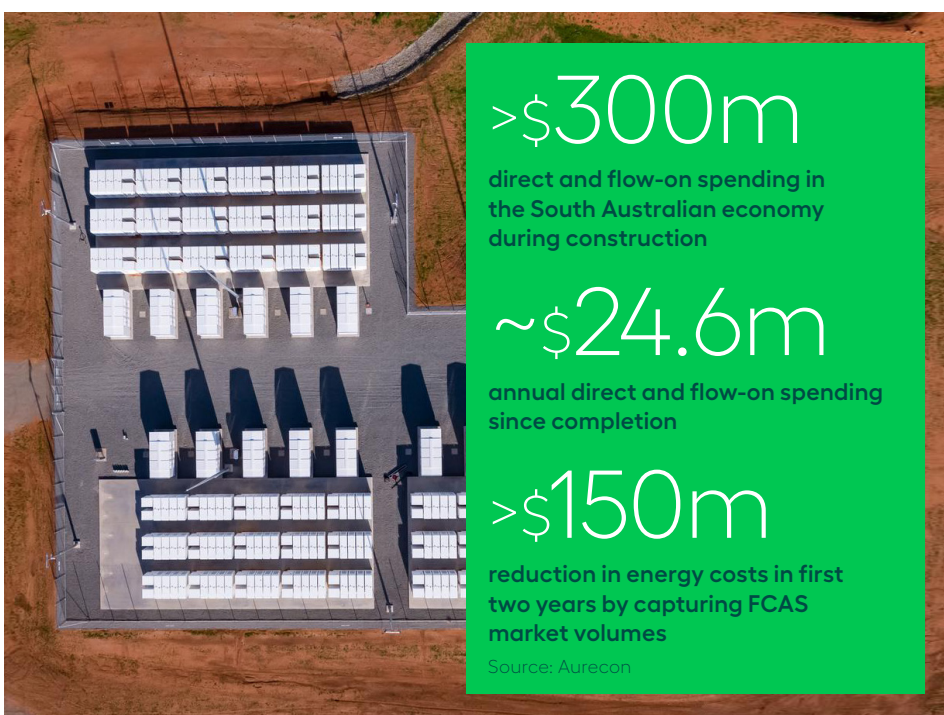
power system within a normal operating frequency band.

Under certain circumstances, the Australian Energy Market Operator (AEMO) can call for FCAS to be sourced from within South Australia. Typically this has led to higher electricity prices due to the limited number of FCAS providers in the State. HPR has contributed to the removal of the need for 35 MW of local FCAS constraint, helping keep prices lower for consumers.

The South Australian Government has officially reserved some 70 MW of HPR capacity from which it can draw in emergency situations. This output can provide a burst of power to prevent load-shedding blackouts and to provide system security services to the energy grid.

The remaining capacity is available to Neoen for market participation.

Neoen reports that HPR has placed downward pressure on power prices for consumers by storing renewable energy when demand is low and dispatching it when demand is high.



World first collaboration on inertia services

Neoen and Tesla, in co-operation with ARENA, AEMO and ElectraNet, have been testing the capacity of Hornsdale Power Reserve to provide inertia services for the network. The delivery of inertia services by a battery at this scale is a world first.

The inertia in power systems refers to the energy contained in generators and motors at power stations and synchronous condensers as they rotate at the same frequency as the electricity grid. If demand for power spikes, frequency of the grid tends to decrease, but the rotating mass acts as a “shock absorber” and slows the rate of change. This shock absorber effect can help maintain the stability of the power system when there is an unexpected power plant failure, by giving other generators in the grid time to respond.¹

Renewable energy is connected to the grid without this rotating mass which means increasing the amount of renewable energy in an electricity system can result in inertia shortfalls. Batteries such as HPR can provide “virtual inertia” by quickly injecting power into or withdrawing power from the grid in response to system imbalances, to mimic what synchronous machines would be doing in the same circumstances.

There is no market revenue stream for this type of inertia or fast frequency response service. The Australian Energy Market Commission (AEMC) is considering rule change requests to recognise the value of such services alongside the Energy Security Board post-2025 market framework program.²

Award winning finance paves way for future projects

The Hornsdale Power Reserve expansion required an innovative financing model to accommodate the unique financial risks of a battery storage investment:

1

The CEFC delivered the first project financing of a stand-alone NEM-connected battery in the Australian market to demonstrate the investment potential of grid technologies

2

Neoen developed a special purpose vehicle for the existing battery, with some \$71 million allocated towards the installation of additional capacity and an upgrade to virtual machine mode

3

The SA Government committed to pay \$3 million a year for five years to secure the delivery of inertia benefits

4

The \$50 million in senior secured CEFC debt finance has a repayment structure designed to accommodate highly variable revenue streams from FCAS and energy arbitrage markets. The majority of the finance has a traditional amortisation schedule based on contracted cashflows. The remainder will be repaid through a percentage of merchant revenue.

The HPR expansion financing won the Asia Pacific Energy Storage Deal of the Year in the 2019 IJGlobal Awards.

1 National Renewable Energy Laboratory, Inertia and the Power Grid: A Guide Without the Spin, May 2020

2 AEMC media release, Consultation begins on new ways to deliver system services as the power system evolves, July 2020



How large-scale batteries support grid integrity

AEMO manages the National Electricity Market (NEM) power system, which supplies electricity across New South Wales, Queensland, Victoria, Tasmania, South Australia and the Australian Capital Territory.

AEMO works to ensure that electricity production and consumption are matched, with some generating capacity kept in reserve. Electricity sales are traded through the NEM and prices fluctuate in response to supply and demand. AEMO also monitors electricity voltage and frequency and monitors the impact of planned power outages to ensure the system can accommodate the changes in generation or transmission capacity.¹

Unplanned events such as high demand, extreme weather, natural disasters, generator outages and transmission outages can impact energy resources. Batteries can help manage the impact of such events and support the integrity of the grid by providing:

- **Rapid response** to sudden and excessive flows of electricity on interconnectors
- **Frequency Control Ancillary Services** to help maintain a large power system with a set frequency range
- **Virtual inertia** services, to stabilise power system frequency.

Understanding FCAS

Frequency Control Ancillary Services (FCAS) are a vital component of any large power system and help maintain the power system at 50 Hertz (Hz). If the frequency deviates too far from a 49.0 to 51.0 Hz range, automated “load shedding” can occur where power is automatically disconnected from the system to try to restore the supply and demand balance, causing significant inconvenience to power users.

If frequency correction does not occur quickly, the power system can collapse. Participants in the FCAS markets, such as battery storage projects, can bid to offer services at particular times, which creates a revenue stream for these projects, even if the charge or discharge services are not required.

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By working closely with the CEFC who have a sound understanding the market, the HPR expansion has demonstrated that it is possible to adequately quantify and address the risks that exist. Neoen anticipates many more batteries will be financed in Australia into the future as a result of this project.”

Tony Ng,
Head of Project Finance,
Neoen Australia

¹ AEMO National Electricity Market fact sheet
July 2020

Boosting the role of renewables in energy supply

Large-scale lithium ion battery storage is suitable for storing and releasing energy over short periods of time to balance the electricity network. The flexibility to respond to grid events by charging from, or discharging power to, the grid in fractions of a second helps maintain grid stability.

The characteristics of renewable energy produce some challenges to existing transmission networks, which were not designed to accommodate intermittent energy production. Additionally, the retirement of fossil fuel generators is resulting in the reduction of grid stability services such as inertia and frequency management.

According to the AEMO 2020 Integrated System Plan, distributed energy could provide as much as 22 per cent of the nation's underlying annual energy consumption by 2040, with more than 26 gigawatts of additional renewable energy required to replace coal-fired generation. This will require up to an additional 19 gigawatts of new dispatchable resources, including utility scale battery storage.¹

Large-scale batteries are well placed to deliver both comparable grid stability services and energy storage capacity to balance energy production.

According to ARENA, the use of batteries to support renewable energy generation is expected to increase over the coming years due to falling equipment and installation costs as the technology class moves towards full-scale bankability.²

Large-scale batteries are already cheaper than other grid balancing technologies such as emergency gas-fired and diesel generators.³

Meanwhile, national science agency CSIRO confirmed in June 2021 that renewables, even with integration costs, were the cheapest sources of new electricity generation capacity in Australia. CSIRO also reported that battery storage costs were lower than previously thought because batteries were achieving longer lives than expected. What's more, the falling battery storage costs underpinned the long term competitiveness of variable renewables.⁴

CEFC Investment Insights

Batteries are booming

Uptake of battery technology has accelerated rapidly since HPR became the first large-scale battery of its kind in Australia. The Clean Energy Council reported in May 2021 that investment in large-scale batteries leapt from 150 MW in the final quarter of 2020 to 600 MW in the first quarter of 2021.

In addition, AEMO has reported that five grid-scale batteries with a capacity of 260 MW were operating by April 2021. AEMO estimated more than 85 big batteries with a total capacity of 18,660 MW were in the planning pipeline.

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HPR's expansion is a landmark innovation project within Neoen's growing portfolio of wind, solar and battery storage assets. The focus on trialling inertia underscores the powerful role that innovation in battery storage can play in ensuring grid stability and enabling high penetration of renewables.”

Louis de Sambucy,
Managing Director, Neoen Australia



1 AEMO 2020 Integrated System Plan for the National Electricity Market July 2020

2 ARENA Large-scale battery storage knowledge sharing report November 2019

3 Department of Environment, Land, Water, and Planning (DELWP) The Victorian big battery Q and A November 2020

4 CSIRO GenCost 2020-21 Final report June 2021

Accelerating Australia's clean energy capacity



About the CEFC

The CEFC has a unique mission to accelerate investment in Australia's transition to net zero emissions. We invest to lead the market, operating with commercial rigour to address some of Australia's toughest emissions challenges. We're working with our co-investors across renewable energy generation and energy storage, as well as agriculture, infrastructure, property, transport and waste. Through the Advancing Hydrogen Fund, we're supporting the growth of a clean, innovative, safe and competitive hydrogen industry. And as Australia's largest dedicated cleantech investor, we continue to back cleantech entrepreneurs through the Clean Energy Innovation Fund. With \$10 billion to invest on behalf of the Australian Government, we work to deliver a positive return for taxpayers across our portfolio.

CEFC finance in action

Essential grid infrastructure for decarbonisation

\$295m CEFC commitment

The EnergyConnect infrastructure project will connect the South Australian and New South Wales power grids, with an added extension to Victoria. The TransGrid project, which spans more than 900 kilometres, is a significant first step in the delivery of the AEMO 2020 Integrated System Plan. The project is expected to deliver cheaper, more reliable power and up to 1800 MW more clean energy.

Victorian Big Battery to deliver extra peak capacity

\$160m CEFC commitment

Neoen is also developing the 300 MW Victorian Big Battery. Neoen has signed a contract with AEMO to deliver an additional 250 MW of peak capacity on the existing Victoria to New South Wales interconnector. The extra power flowing between the States during the peak summer season is expected to deliver support to the grid at periods of high demand.

Solar and pumped hydro combine

\$54m CEFC commitment

The Kidston Renewable Energy Hub, north-west of Townsville in Queensland, is repurposing an old gold mine as a proposed pumped hydro storage facility that is supported by a solar farm. The CEFC committed up to \$54 million to the solar farm component.

Virtual power plant drives down energy bills

\$30m CEFC commitment

Australia's largest virtual power plant project is installing rooftop solar and Tesla Powerwall systems across more than 3,000 residential buildings in South Australia to drive down the energy bills of social housing tenants while delivering enhanced stability for the electricity grid.

Vital transmission link for grid reliability

\$125m CEFC commitment

Lumea (part of TransGrid) is developing grid infrastructure to support Australia's largest renewable energy project, the expansion of the Snowy Mountains Hydro Electric scheme, Snowy 2.0. When complete, Snowy 2.0 will provide enough additional dispatchable energy to power the equivalent of 500,000 homes for more than a week during peak demand.

Synchronous condenser supporting stability

\$62m CEFC equity commitment

Total Eren has included a 190 MVar synchronous condenser as part of the 200 MW Kiamal Solar Farm generating system, facilitating a timely connection to the Victorian Transmission System, as well as strengthening the grid in north-western Victoria for the longer term.

1 million smart meters boost energy efficiency

\$75m CEFC commitment

IntelliHub is accelerating the rollout of smart meters to give homes and businesses better information to help them choose the right solar and battery storage solutions to meet their individual consumption needs. IntelliHub has deployed one million smart meters across Australia and New Zealand.

Battery offers remote control over energy use

\$15m CEFC commitment

Sandfire Resources is using solar and battery storage to reduce its reliance on diesel at its DeGrussa Copper-Gold Mine in Western Australia. A 10 MW solar plant and 6 MW of battery storage provides the majority of daytime electricity requirements at the mine, offsetting about 5 million litres of diesel fuel a year and abating more than 12,000 tCO₂-e annually.