THE ROLE OF ENERGY STORAGE IN AUSTRALIA'S FUTURE ENERGY SUPPLY MIX

SUMMARY PAPER

May 2021

This summary paper is complementary to the 2018 ACOLA Horizon Scanning report *The role of energy storage in Australia's future energy supply mix*
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- Energy storage is a technically and economically realistic approach to ensure energy security and reliability in 2030, particularly as our energy system becomes increasingly dominated by variable renewable energy. It can also contribute to reducing energy cost.
- As at 2018 when the ACOLA report was completed, energy storage was developing in a variety of forms, including batteries, thermal, hydrogen and pumped storage. The then most cost-effective storage options anticipated in 2030 were pumped hydro energy storage (PHES), lithium-ion batteries and zinc bromine batteries.
- Australia's abundance of raw materials for batteries and our high level of relevant R&D make energy storage a significant opportunity for industry growth and job creation.
- Policy leadership can foster growth in an energy storage industry. This includes support to increase skilled jobs at all points of the value chain, from raw materials mining through manufacturing to end-of-life battery waste management.
- Community endorsement is essential. It requires transparency and adherence to best practice. It is necessary to understand and address issues such as safety concerns, limited knowledge about energy storage and low trust in Commonwealth and state and territory governments by consumers.

What is energy storage?

Electricity is one of the most widely used forms of energy. Produced from a wide variety of energy sources, it is sent from a generating point to customers via complex transmission and distribution networks. To maintain this system, it is critical to balance the amount of generated power and the amount consumed because, traditionally, once electricity is generated it must be consumed almost immediately.

Energy storage enables time-flexible use of generated electricity by storing it to enable electricity on demand. Storing energy and outputting it at a moment's notice when required helps maintain a balance between supply and demand. There are a variety of energy storage technologies that are being actively developed, including lithium-ion batteries, hydrogen storage and pumped hydro energy storage (PHES).

Energy storage and renewable energy

As the global trend towards decarbonisation accelerates, the role of renewable energy is rapidly increasing. In Australia, each state and territory has set a goal of becoming carbon neutral by 2050 and each has high targets for introducing renewable energy.

Unlike traditional power generators, such as coal and gas, most renewable energy sources currently have limitations in their ability to adjust to fluctuations in demand. As renewable electricity use increases, energy storage provides a technically and economically viable approach to energy security. For example, the output of solar and wind power depends on appropriate weather conditions, making it sometimes difficult to adjust to demand. The storage system can help smooth the intermittency of renewable power and improve operational flexibility to balance supply and demand.

ROLE OF ENERGY STORAGE: SECURITY AND RELIABILITY

In 2017, ACOLA was commissioned by the Australian Chief Scientist to determine the range of energy storage requirements that may arise given possible energy generation pathways. This summary paper presents the key information and analysis from that horizon scanning study.

Security and reliability

The important capabilities required from energy storage are "security" and "reliability".

- **Security** is the capability to secure the necessary output quickly to restore the balance of supply and demand.
- **Reliability** is the capacity to maintain the balance between supply and demand for an extended period. In other words, to supply sufficient electricity, even when the supply of renewable energy is low.

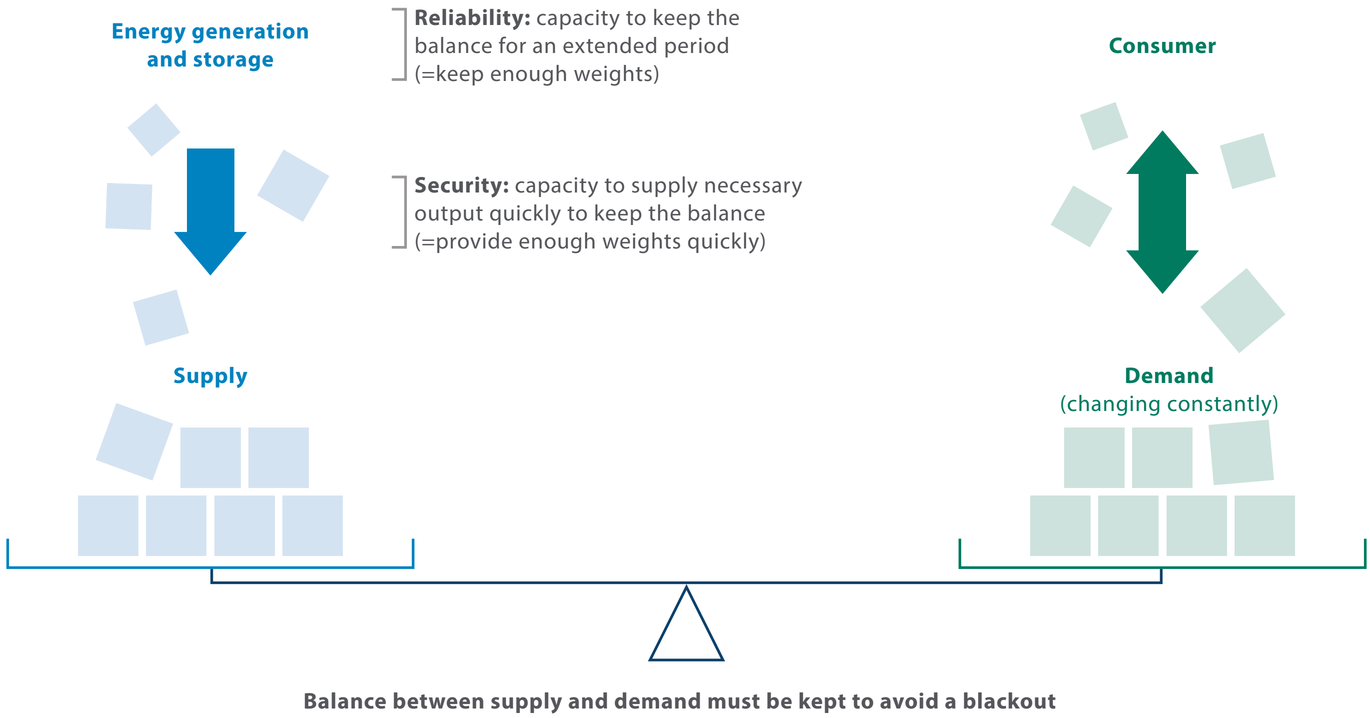
Can energy storage ensure security and reliability in the future?

ACOLA modelled the requirement for energy storage in 2030 and examined several scenarios based on the proportion of renewable energy in 2030: LOW renewable energy scenario (35 per cent), MID renewable energy scenario (50 per cent) and HIGH renewable energy scenario (75 per cent). These scenarios calculated the amount of electricity generated in each scenario, demand forecasts for each state and territory, interconnector capacities, and weather conditions that affect hourly supply.

The results showed that both security and reliability requirements can be satisfied with readily available technology in 2030. The report noted that it would be possible to maintain the energy supply and demand balance, without a significant increase in storage capacity, even if the proportion of renewable energy increased to 50 per cent. Until the penetration of renewable energy is well above 50 per cent, maintaining an acceptable level of energy security for customers will dominate energy reliability requirements. In the HIGH scenario, system security requirements fall well short of reliability requirements. However, the scale of fast response capacity required at this level may mean a small additional investment into energy storage for security would provide a significant contribution to meeting reliability.

The required costs were calculated at around $3.6 billion for the LOW scenario, $11 billion for the MID scenario and $22 billion for the HIGH scenario. By comparison, network capital spending in the NEM is currently $5–6 billion annually, and if this level of spending continues, the total would be around $70 billion in 2030. Some of the most cost-effective storage options available in 2030 included pumped hydro energy storage (PHES), and lithium-ion batteries.

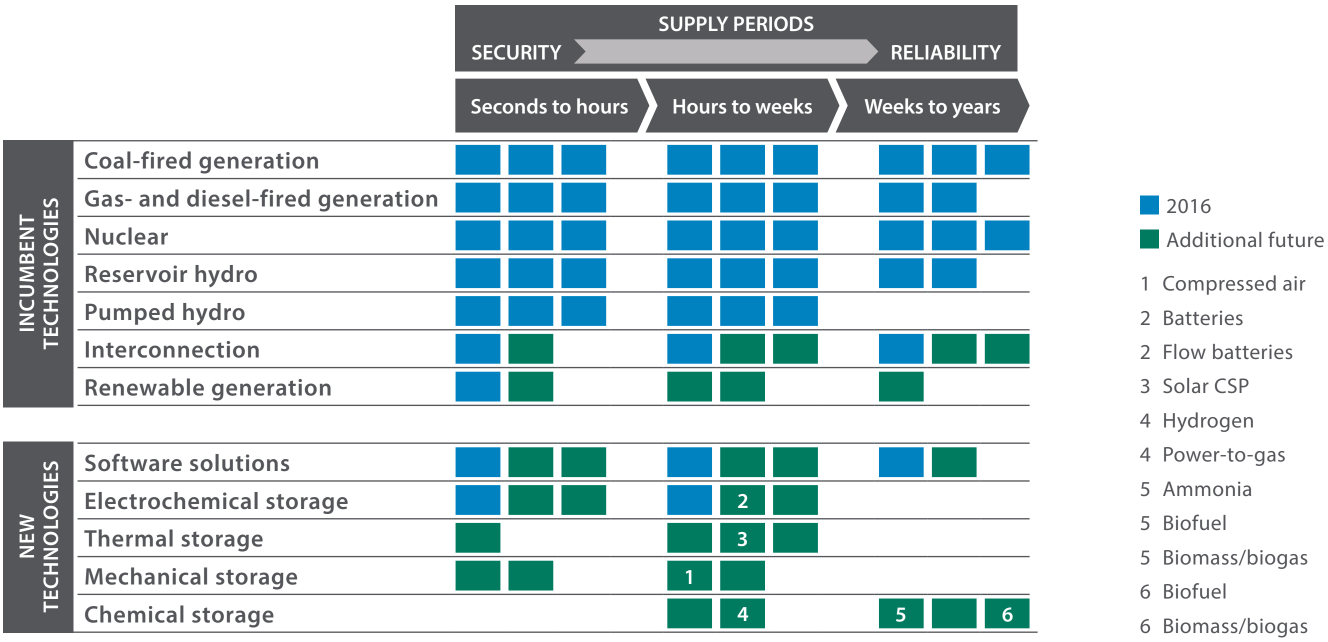
For further details, refer to Chapter 1 of the full report.



ENERGY STORAGE TECHNOLOGIES

There are a growing range of available and emerging technologies to deliver energy storage. Energy storage is seen by many as the next big change required in Australia's electricity systems. Storage can solve challenges that range from smoothing the intermittency of renewable generation to providing power quality support, and managing peak demand for consumers.

For further details, refer to Appendix 1 of the full report.



Batteries

Batteries store energy by using chemical reactions to convert stored chemical energy into electricity and vice versa. Lithium-ion batteries, which are widely used in mobile phones and notebook computers, have considerable potential for future applications. Other batteries have been developed using a variety of chemistries, including lead-acid and sodium-ion.

Hydrogen energy storage

Hydrogen storage uses the process of electrolysis of water to produce and store hydrogen. Once produced, hydrogen is used to power generators and fuel cells when energy is demanded. Hydrogen can be transported as a pressurised gas or liquid or converted into ammonia. Hydrogen can easily store large amounts of energy and be further developed for fuel cell vehicles, ancillary services, and bulk energy storage.

Pumped hydro energy storage (PHES)

PHES converts electrical energy into potential energy and stores it. A large amount of water is pumped from the lower to the upper reservoir during low electricity demand. The water then flows from the upper to the lower when demand arises to drive a turbine and generate electricity. It is a well-established energy storage technology and also the cheapest. However, given land and water resource use, there are environmental impacts and social license issues that need to be addressed.

Concentrated solar power with thermal energy storage (CSP TES)

This technology uses reflectors to concentrate sunlight and convert it into heat energy, stored in a medium such as molten salt. When power is necessary, the heat is extracted from the storage tank to generate steam to drive a turbine and supply electricity. Molten salt is used as the heat carrier. It is a more reliable source of electricity than solar panels to meet electricity demand, and there are several examples in operation in Australia.

Compressed air energy storage (CAES)

CAES stores energy by compressing ambient air and storing it at high pressure in suitable underground geological structures. When energy is needed, the compressed air is released and reheated to drive turbines to generate electricity. While Australia is geologically well placed for CAES, it has chosen not to pursue this technology.

POTENTIAL FOR ECONOMY AND EMPLOYMENT

In addition to our geographic advantages in establishing and leveraging renewables, Australia's research and development strengths and abundant resources provide potential for Australia to pursue energy storage opportunities to enhance our economy and create employment opportunities.

Abundant resources

Australia has an abundance of raw mineral resources for batteries and is the largest lithium supplier globally.

Australia also has abundant resources and supply chains for producing renewable hydrogen and ammonia, which are promising new energy storage technologies and provide potential export opportunities to markets such as Japan and South Korea.

Research and development strength

Australia is undertaking world-leading research in several energy storage areas, including next-generation batteries, hydrogen and advanced thermal storage systems.

Australia also has strengths in polymer chemistry, a technology that could contribute to the development of next-generation solid-state batteries.

Job creation at all levels of the supply chain

Because of the above strengths, pursuing an Australian energy storage industry provides business opportunities, including skilled employment opportunities, at all stages of raw material extraction, manufacture, deployment and end of life use. For example, it is estimated that PHES projects will create between 2.75 and 5.5 full-time jobs per MW for the length of the project. There are also opportunities in the end-of-use phase of energy storage; for example, battery recycling can create new industries and jobs.

CONSIDERATIONS FOR REALISING THE POTENTIAL OF ENERGY STORAGE

R&D and commercialisation

Australia can lead the world in developing and commercialising an integrated supply chain from mining to waste management of energy storage technologies. In order to achieve this, leadership by governments will be required to support innovation, investment and the growth of high-tech industries to drive translation and commercialisation of research. This includes, for example, supporting increased collaboration between researchers and industry, research funding, risk capital funding (to test projects at scale) and tackling systemic issues associated with research-industry collaboration.

For further details, refer to Chapter 2 of the full report.

Waste management

Batteries in all uses, including vehicles, will present a significant waste management challenge or recovery opportunity in the coming decades. Currently, lead-acid batteries, such as those used in conventional/combustion engine vehicles, are the only battery technology to have a high level of recycling in Australia (90 per cent). As there is no economic or policy driver in place, encouraging investment in end-of-life management infrastructure is a priority.

Australia has an opportunity to play a stewardship role to ensure the sustainable repurposing and recycling of all batteries. Focused development of recycling infrastructure and technology will be crucial and provides opportunities for industry development and job growth.

For further details, refer to Chapter 3 of the full report.

Public attitudes towards energy storage

According to ACOLA's survey of more than 1,000 energy consumers, approximately 60 per cent of respondees wanted to see higher levels of renewable energy. Of the 60 per cent, nearly three-quarters preferred that energy storage, rather than coal and gas, bolster grid reliability.

However, there are concerns with regards to energy storage technologies, primarily cost and safety. The development of safety standards for energy storage technologies will be essential to ensure early accidents, which can hinder the widespread use, are minimised.

Additionally, the survey indicated that there is a low level of trust in governments and electricity sector organisations. This is likely to stem from the frequent and substantial changes to electricity policy over the past decade.

Policy certainty, communication and engagement can help regain this trust, which will be important for successful deployment of energy storage technologies. This includes explaining what energy storage is, how it works, the benefits (especially for cost and energy security), and investment required for technology adoption.

For further details, refer to Chapter 4 of the full report.

REPORT'S KEY FINDINGS

1. There is a near-term requirement to strengthen energy security in NEM jurisdictions. Maintaining acceptable energy security levels for customers will dominate energy reliability requirements until well in excess of 50 per cent renewable energy penetration.

2. At an aggregated national level, Australia can reach penetrations of 50 per cent renewable energy without a significant requirement for storage to support energy reliability.

3. Australia is well placed to participate in global energy storage supply chains. Business opportunities will arise, given appropriate policy decisions at State and Commonwealth levels, and incentives.

4. Australia's research and development performance in energy storage technologies is world class, but would benefit from strategic focus and enhanced collaboration.

5. The availability of private sector risk capital and profitable revenue streams for Australian energy storage start-ups and projects is a challenge for new ventures, as is policy uncertainty.

6. A high uptake of battery storage has a potential for significant safety, environmental and social impacts that would undermine net benefits.

7. Unless planned for and managed appropriately, batteries present a future waste management challenge.

8. Australians are deeply concerned by the sharp rise in electricity prices and affordability. They hold governments and energy providers directly responsible for the perceived lack of affordability.

9. Energy storage is not a well-known concept in the community and there are concerns that a lack of suitable standards at the household level will affect safety.

10. Australians favour a higher renewable mix by 2030, particularly PV and wind, with significant energy storage deployed to manage grid security.

Further details of the findings can be found on pages 10 to 13 of the full report.

RECENT PROGRESS

Since the release of the report three years ago, there has been a range of energy storage projects progressed in Australia. For example, in 2017, a large-scale energy storage facility in South Australia was constructed using Tesla's lithium-ion battery system, with excellent results. The battery reduced the need to use the existing expensive regulating system called Frequency Control Ancillary Services (FCAS), which is a service to balance energy supply and demand by providing or reducing energy quickly by coal or gas plants when the balance is likely to be disturbed. The battery achieved a 90 per cent reduction in the local FCAS market in just four months[1]. Although $96 million was spent on the construction, the battery contributed to saving $40 million within just one year and recouped its initial cost in two years[2]. The storage system was expanded from 100 MW to 150 MW in 2020 and is expected to contribute to South Australia's target of being net 100 per cent renewable by 2030[3].

A major PHES project is also in progress. Snowy Hydro's project, "Snowy 2.0", involves tunnelling through two existing dams to build a new underground power station by 2025. The plant, which will use surplus electricity to pump water, could supply enough electricity to 3 million homes for a week and improve the electricity system security and reliability. Snowy Hydro started preliminary mining work in 2019 and obtained approval from the Australian Government for the main construction work in 2020[4]. The project has already created more than 500 jobs, with over 100 local companies working on the project[5], which is also expected to contribute to Australia's climate change policy and lower electricity prices in the future.

Progress has also been made on hydrogen. In January 2021, Australian company LAVO announced that it had developed the world's first home hydrogen battery. About the size of a refrigerator, it stores hydrogen by electrolysing water in the cell by connecting it to solar panels, and then generates electricity from the stored hydrogen. The batteries can store enough energy to operate an average family home for 2 days. LAVO hopes to reduce the battery's price from $34,000 for the first 2,500 units to $30,000 for the next 5,000 units in 2022[6].

The Future Battery Industry Cooperative Research Centre (FBICRC), officially launched in 2020, is important progress in building and targeting all segments of Australia's battery value-chain and delivering commercial outcomes to accelerate and grow industry expansion. With about $130 million in cash and in-kind contributions, the FBICRC focuses on three interdependent key areas: (1) evidence-based advice to inform government policies and regulations and secure public trust for new energy technologies; (2) innovative pathways to mine, extract, refine and recycle battery minerals, metals and materials; and (3) develop battery fabrication capabilities, enhance battery testing facilities, and develop new battery energy storage systems.

Many of these investments respond to the challenges and considerations identified by ACOLA. Importantly, projects must make constant efforts not only to improve technologies but also to secure social license and improve public understanding, because this endorsement will be crucial for the success of energy storage.

HORIZON SCANNING SERIES

We live in a time of rapid change; change that is driven by developments in science and technology and challenged by our capacity to adapt in the present and prepare for the future. ACOLA's Horizon Scanning reports present independent and timely analyses to guide decision makers through the decade ahead.

ACOLA's full report on The role of energy storage in Australia's future energy supply mix was commissioned by Australia's Chief Scientist, Dr Alan Finkel AO, on behalf of the National Science and Technology Council with funding support and partnership between ACOLA and the Australian Government Office of the Chief Scientist.

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Summary Paper
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1 RenewEconomy (2017) The stunning numbers behind success of Tesla big battery Available at https://reneweconomy.com.au/the-stunning-numbers-behind-success-of-tesla-big-battery-63917/

2 RenewEconomy (2020) Tesla big battery recoups cost of construction in little over two years Available at https://reneweconomy.com.au/tesla-big-battery-recoups-cost-of-construction-in-little-over-two-years-25265/

3 Neoen (2021) Hornsdale Power Reserve Available at https://hornsdalepowerreserve.com.au/

4 NSW Department of Planning, Industry and Environment (2020) Snowy 2.0 Main Works Available at https://www.planning.nsw.gov.au/Assess-and-Regulate/State-Significant-Projects/Snowy-2-0/Main-Works

5 Energymagazine (2020) Snowy 2.0 gets construction go-ahead Available at https://www.energymagazine.com.au/snowy-2-0-gets-construction-go-ahead/

6 PV magazine (2021) Australian world-first domestic hydrogen battery signs an iconic investor Available at https://www.pv-magazine-australia.com/2021/01/25/australian-world-first-domestic-hydrogen-battery-signs-an-iconic-investor/

"This report clearly shows the two sides of the coin – that energy storage is an enormous opportunity for Australia but there is work to be done to build consumer confidence – the best way to change attitudes is to increase understanding about energy storage."

Dr Bruce Godfrey FTSE
Chair, Expert Working Group

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