Investing in storage

Assessment of the ‘bankability’ of storage in the NEM

Clean Energy Investor Group

December 2023

Baringa is a certified B Corp™ with high standards of social and environmental performance, transparency and accountability.

Table of contents

Baringa

Executive summary

Executive summary | Barriers to storage investment

Storage is an important enabler of the energy transition, providing reliability alongside variable renewables

- A suite of short-, medium- and long-duration storage will be required to maintain reliability and security of supply in the NEM as the generation mix transitions away from legacy coal capacity and as wind and solar PV penetration increases.
- The required volumes of storage depend on the rate of decarbonisation and the extent to which other firming technologies, such as gas generation, are assumed to play a role in the future NEM. The transition therefore relies on the right type of storage being built when and where it's needed in the NEM. For some technologies, such as pumped hydro storage, the 'when' requires significant lead time.
- Under Baringa's NEM Reference Case projections, significant volumes of storage capacity are required over the coming decades which are not built based on market economics alone. To see the market deliver this investment, additional revenue opportunities will need to be unlocked or cost reduction mechanisms implemented by government.
- In the NEM, revenue opportunities for storage can be categorised as energy market revenue, service market revenue, and contracted revenue. To incentivise investment in new storage assets, these revenue opportunities should be sufficiently strong and certain.
- The extent to which these revenue opportunities are able to support storage projects differs between short-duration storage (<4hr) and medium- to long-duration (4-12hrs, >12hrs).

Revenue opportunities and their potential for different storage durations

	Description	Short-duration storage	Medium- and Long-duration storage
Energy market	Revenue generated through the wholesale spot market (typically based on an energy arbitrage model, buying electricity (charging/pumping) at a low price and selling (discharging) at a higher price).	Energy market volatility and price range suitable for short-duration storage energy arbitrage revenue model.	Energy market volatility and price range insufficient to incentivise investment in longer storage durations.
Services market	Revenue generated through availability for, and provision of, market ancillary services (chiefly, frequency control). There are currently ten frequency control ancillary services in the NEM.	FCAS products align with short duration storage capabilities. Prices expected to reduce, but revenue potential remains.	FCAS products are based on rapid system recovery and do not incentivise investment in longer storage durations.
Contracted revenues	Contracted revenue streams outside of spot energy and FCAS markets. A range of contract types are available, either solely financial in nature or also involving physical delivery.	Contracts are largely tolling arrangements with gentailers (often <10yrs tenure). Coal closure uncertainty creates risk.	Suitable contracts to drive investment in long durations when and where needed are limited, and challenging for technologies with long lead times.

Executive summary | Addressing barriers to investment

Government support can help to overcome barriers to investment in storage by increasing the revenue opportunities for storage of different durations or reducing revenue requirements.

	Description	Examples
Energy market	Policymakers can restructure the energy market to better enable medium- and long-duration storage to secure sufficient energy revenue to drive investment.	Increases to the reliability price settings (one or more of the MPC and CPT) could allow storage to capture more revenue in the existing energy-only market. A capacity market could support medium- and long-duration storage in the NEM, particularly if designed to target technologies with 'missing money' in the energy-only market. A capacity mechanism (of a less targeted design) was considered by the ESB but ultimately not pursued.
Services market	Policymakers can restructure ancillary services value streams and potentially introduce new products which allow storage of different durations to better monetise the ancillary services they can offer.	**Short-duration storage:** introduction of 1 sec ('very fast') Contingency Raise/Lower FCAS product, consideration of system strength and/or inertia revenue streams (market-facilitated or bilateral contracting). **Long-duration storage**: prolonged ramping products (subject to ability to integrate with existing ancillary service markets and products)
Contracted revenues	Governments can develop and offer long-term contracts to de-risk storage investments, such as offtake agreements, floor price contracts or grid support contracts. Governments, with strong industry support, can also encourage contracting and facilitate the development of new contract structures.	**Short duration storage:** NSCAS revised to better enable contracting with storage, System Integrity Protection Schemes (SIPS), Retailer Reliability Obligation (RRO), virtual storage swaps and other contracts, Capacity Investment Scheme (CIS) **Medium- and long-duration storage**: RRO, NSW Government Long Duration Storage (LDS) schemes
Funding & finance	Rather than supporting revenue opportunities, governments can reduce upfront costs and therefore lower the returns required for the project to be commercial. This support could take the form of fully- or partially-funded projects (including Public Private Partnerships, PPPs), or providing favourable finance terms without entering a PPP.	**Short-duration storage examples:** ARENA grants, CEFC funding, Govt. concessional finance **Medium/Long-duration storage examples:** government ownership (Snowy, QLD Hydro, HydroTas), NSW Government pumped hydro recoverable grants, ARENA grants, CEFC funding/concessional finance, Grid Scale Storage Fund (South Australia)

Mechanisms to increase revenue/certainty

Mechanisms to reduce costs

Executive summary | Recommendations to support storage investment

We have identified six key recommendations which draw on our understanding of the barriers to investment, our commercial expertise, and lessons from international markets

Energy market

Services market

Contracted revenues

Funding & finance

Supporting investment in short-duration

1

Clarity and certainty around the coal closure schedule, and replacement capacity needs, will help to provide more confidence in expected FCAS and, in particular energy, revenues.

2

Securing long-term contracts is critical to bankability. Announced government support schemes will support further investment in short duration storage and could employ innovative contract designs to ensure they support storage which best meets market needs.

Supporting investment in medium/long-duration

4

To support investment in longer duration firming capacity, significant increases in the CPT are likely, beyond those proposed by the AEMC in its Draft Rule – proposed to increase from 7.5 hours at the MPC to 8.5 hours – to 12-18 hours. However, a significant increase may be unpalatable for decision makers.

3

New longer-ramping ancillary service product(s) targeted at long-duration firming sources (long duration storage or other fast-ramping firm technologies) could be considered, like the EirGrid products (see slide 26). This would increase the revenue 'stack' for medium-duration storage and, combined with other supportive changes for medium- and long-duration storage, could support bankability and investment.

5

Long-term contracts, struck at appropriately high prices will be critical for medium- and long-term storage, given its missing-money issues. There are a number of forms these contracts could take, including renewable firming products catering for *Dunkelflaute* conditions.

Targeted capacity/availability contracts could support the entry of new projects, as an alternative to a broader capacity market.

6

Noting some of the above are likely to be difficult to design and/or implement (e.g.., energy and ancillary service market changes), Government funding remains critical for ensuring the necessary long-duration assets are developed as needed.

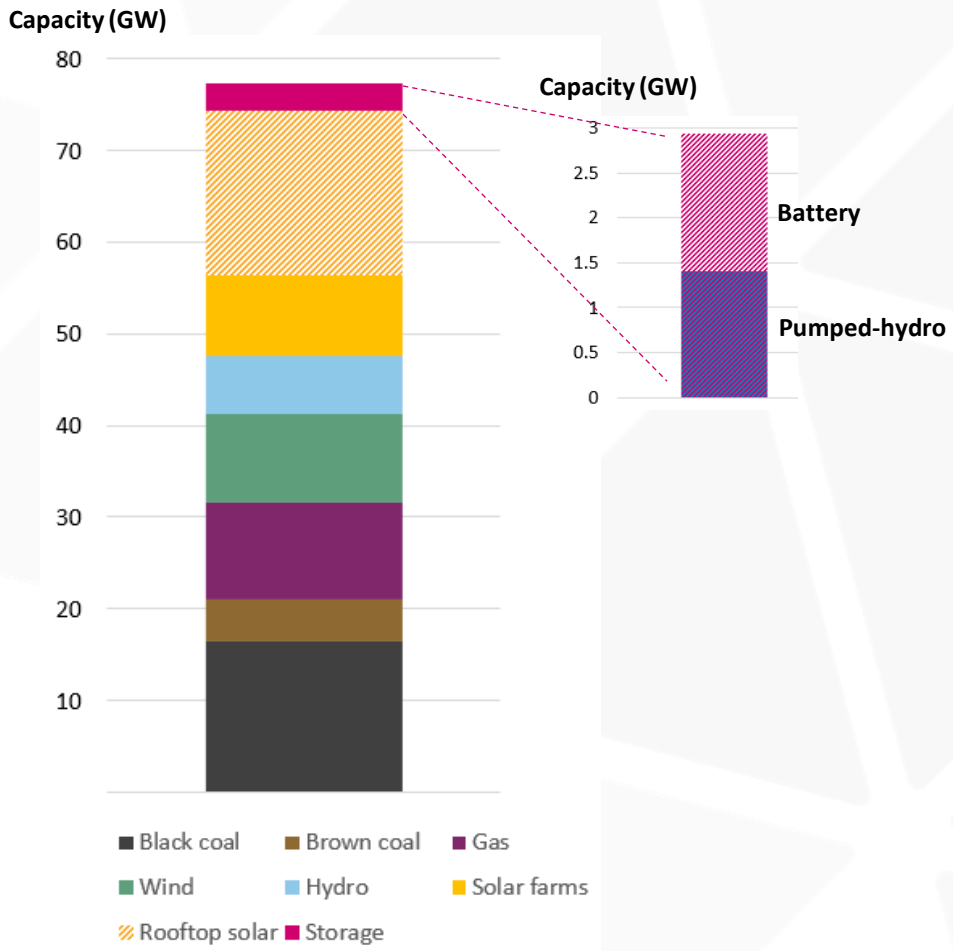
State of storage in the NEM

Storage in the NEM | Existing and proposed projects

Short-duration batteries and large pumped hydro assets dominate the storage landscape in the NEM, with the purpose of storage development broadening to include network and system security functions

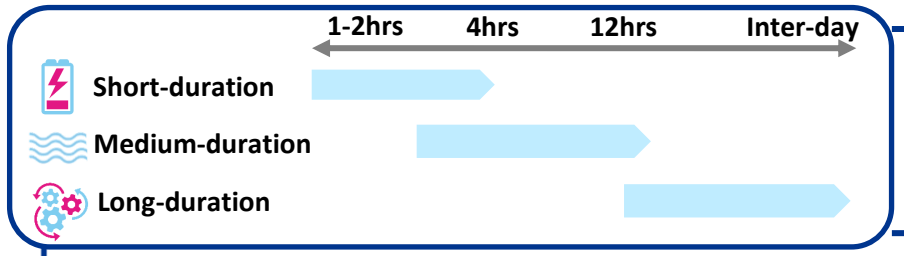
Storage is being developed across the NEM

- The capacity mix in the NEM has been transformed over the past decade or so; coal's dominance is gradually shrinking with a more diversified capacity mix today. The share of wind and solar has grown rapidly, accounting for 47% of total installed capacity in June 2023. This share is expected to increase as more capacity is built to replace coal generators as they retire.
- To complement the variability of wind and solar, and also its asynchronicity, there is a growing need for flexible capacity and new providers of system security services. Storage has been an important contributor in meeting the demand for new flexible capacity, particularly battery storage which has seen rapid technology improvements and cost reductions, and also benefits from faster installation times relative to other fast-start technologies (such as gas-powered generators and pumped hydro).
- Storage currently makes up 3.8% of installed capacity in the NEM. The battery fleet is primarily 2hr duration batteries, however there is a trend towards longer 4hr duration batteries being installed as technology costs reduce.
- Traditionally, storage was largely developed by state and federal governments as large state-owned pumped hydro infrastructure.
- As batteries have emerged, there has been a shift in the scale of storage, the drivers of storage investment, as well as the nature of support. Batteries are typically smaller in power (MW) and duration (MWh). A number of batteries have been installed to achieve system service functions first and foremost, with their energy provision as a secondary priority. For example, frequency control (through the FCAS markets) and performing network services (including provision of redundancy, as per the Victorian Big Battery and Waratah Super Battery).
- Government ownership continues to play a role in delivering medium- and long-duration storage in the NEM, with government programs supporting market-led projects and governments committing to develop large new government-owned projects (e.g.. Snowy 2.0, Pioneer-Burdekin, and Borumba).



Storage in the NEM | Nature of storage

Investment in storage of different durations will respond to different drivers of growth.



Short-duration storage

Duration: 30min-4hrs

Market function: meeting FCAS requirements and some intraday load-shifting. This duration of storage is also co-located with renewable energy generators (especially solar) for hybrid assets. Consists of both utility-scale and small-scale/behind the meter (BtM). 2hr duration is most common for BtM investments (e.g.., residential batteries).

Mature technology types: Lithium-ion battery, Lithium-iron-phosphate battery

Emerging technology types: Vanadium redox flow battery, Nickel-hydrogen battery

Current barriers to investment:

- Bankability dependent on securing long-term contracts with investment-grade counterparties. Available contracts are typically limited to tolling arrangements. Uncertainty of coal closures creates risk.
- Some services that batteries with grid-forming inverter capabilities can provide are not currently monetised.

Medium-duration storage

Duration: >4-12hrs

Market function: intra-day load shifting

Mature technology types: Pumped hydro

Emerging technology types: Compressed air, hydrogen-based-storage (various), gravity-based storage, concentrated solar thermal.

Current barriers to investment:

- Available revenue streams (energy market, FCAS market, available contracts) are currently insufficient to incentivise investment in longer durations.
- Emerging technology types require further investment and support.

Long-duration storage

Duration: above 12hrs

Market function: inter-day supply, including for ‘renewables drought’ conditions. Typically cycle infrequently and operate low CFs.

Mature technology types: Pumped hydro

Emerging technology types: Compressed air, hydrogen-based-storage (various), gravity-based storage, concentrated solar thermal.

Current barriers to investment:

- As above.

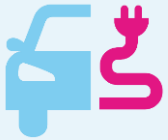
The emerging storage technologies identified above face additional, technology cost-driven, barriers to deployment, beyond the barriers noted above, and there are additional government support options from which they would benefit (for example, support to trial and commercialise). This report primarily considers the barriers to investment for mature technology types.

Storage in the NEM| Growing need for storage

Energy storage will play a central role in a decarbonising economy, as legacy dispatchable energy assets are replaced with variable renewable technologies and electrification increases operational demand

Storage is needed alongside variable renewables, as coal generators retire

- Going forward, as the NEM increasingly transitions away from coal generation, storage is increasingly important as a cost-effective replacement technology to provide the energy, capacity, and ancillary services. We project storage to be part of a diversified portfolio of solutions, consisting of demand- and supply-side resources, to provide these services, going forward.
- The closure of large coal generators in the NEM is thus a key driver of growth in storage, especially storage that operates (or 'cycles') on a daily basis.
- While the provision of energy, capacity, and ancillary services are common to all forms of storage, there will likely be a differentiation by duration: shorter-duration storage will play a key role in intra-day provision of these services, while longer-duration storage will be particularly important for ensuring the provision of these services during periods of sustained low renewable energy availability (so-called renewable energy 'droughts', or *Dunkelflaute** conditions). In this way, storage will play a key role in firming the output from variable renewable energy capacity over time.
- In our view, *Dunkelflaute* conditions will be most cost-effectively solved with a portfolio of long duration firming technologies – we expect this will include long-duration storage technologies, as well as other forms of long-duration firming, such as fast-start gas generation (noting this could be in the form of green hydrogen gas). The make-up of this portfolio of technologies will be guided by government policies and their relative economics.



Electrification and growth are increasing operational demand

- While the trend is not as apparent as in some other economies, Australia is seeing a gradual shift towards electrification, particularly in the transport and residential sectors. This trend is expected to accelerate, driven by a range of factors including decarbonisation policies, technology improvements, technology cost reductions and high fuel costs. As Australia seeks to further decarbonise the economy, electrification will be increasingly important to enable independence from carbon-emitting fuels across all sectors.
- With greater electrification comes an increase in operational demand in the NEM, as consumption shifts from other energy sources (such as liquid fuels and natural gas) to grid electricity - noting that energy efficiency improvements will likely continue to offset some of the anticipated demand.
- As operational demand increases, as will the need for dispatchable capacity in the NEM, with the two typically growing at a similar rate. This means that, in addition to the storage required alongside new renewables to replace retiring coal generators, the volume of dispatchable capacity required in the NEM is anticipated to increase over the coming decades, driving further growth in the market for storage.

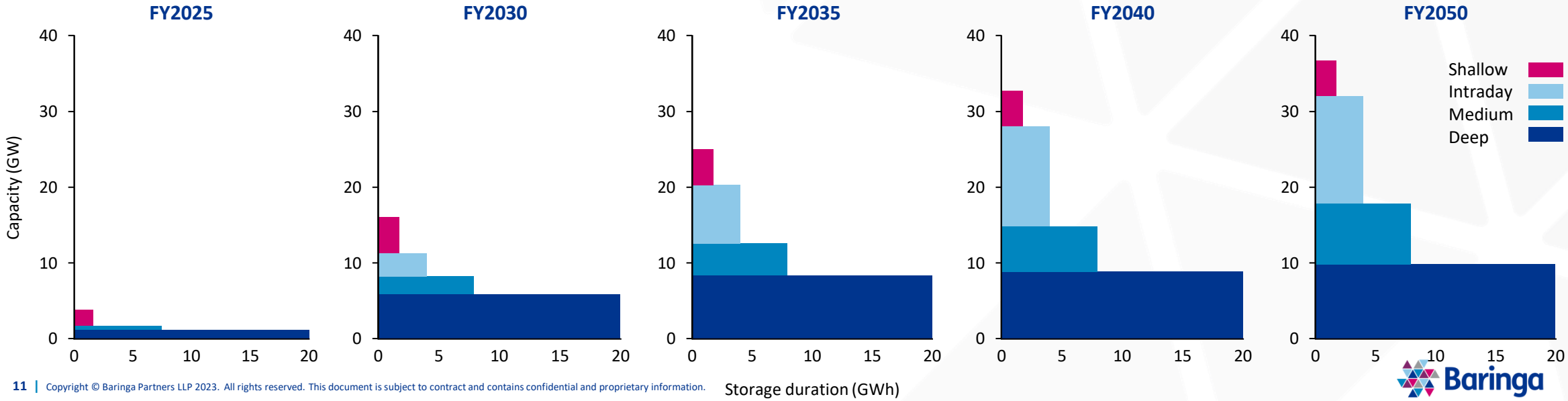
** German for 'Dark and still'*

Growth of the storage market| Long- and short-duration storage (1)

We project strong growth in both short and long-duration storage capacity over the next 2-3 decades

Projections find strong storage growth to 2050

- Installed storage capacity in the NEM is projected to grow over the coming decades under our central view (Baringa *NEM Reference Case*), with a mix of utility- and small-scale batteries, as well as pumped-hydro, to firm the increasing penetration of small- and utility-scale variable renewable energy generation.
- **While strong growth in renewable energy and storage is projected, this corresponds to only a c.2.2°C-aligned outcome for the NEM by 2050 – well short of Australia's commitment to the Paris Agreement.**
- The largest buildout of utility-scale batteries is projected to occur in VIC, due to its relative lack of alternative sources of firming (pumped hydro and, due to policy-induced barriers, new-build gas-powered generation). NSW and QLD have significant pumped hydro capacity buildout and less restrictions on new gas plants which together reduce the relative need for new-build BESS and other storage projects of different durations to meet firming requirements of the market.
- Baringa's *NEM Reference Case* projects an additional pumped hydro capacity of 7.8GW to come online between 2023 and 2030 in mainland NEM. Key projects include Snowy 2 (2GW) in NSW, and Borumba PHES (2GW) and Pioneer-Burdekin in QLD (2.5GW) – these projects are 'forced' into the model, irrespective of whether the projected market conditions create a strong commercial case for their development, given the government support underpinning them. In later years, the medium and long-duration storage volumes identified in the ISP are likewise 'forced' into the market – these projects are not built in the model on an economic basis, but assumed to be built with government support.
- As previously noted, we project that the need for long duration (inter-day and seasonal) firming will be most cost-effectively met with a portfolio of technologies, including this projected storage buildout as well as new-build fast-start gas plants. A future system without gas generation (for example, to achieve zero emissions) would require more storage.



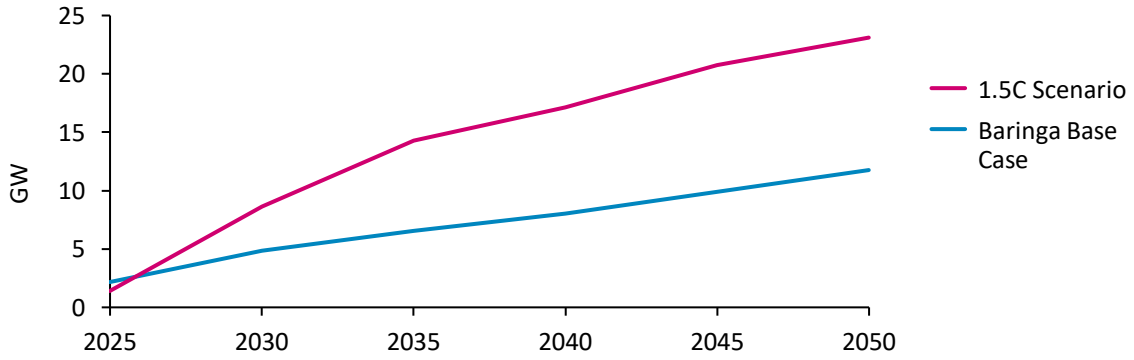
Growth of the storage market| Long- and short-duration storage (2)

Achieving Government's ambitious decarbonisation pathway requires an even greater role of storage, exceeding current projected build out and relying on Government policy to deliver long duration storage

Short-duration storage

- Baringa's *NEM Reference Case* projections, our best view of the future based on existing (and largely State) Govt policies and the economics of different technologies, project short-term (up to 4 hours) duration storage to grow steadily to c.12GW by 2050, to complement and firm the growing penetration of utility- and small-scale variable renewable energy
- By being a signatory to the Paris Agreement, the Australian Government has committed to pursuing economy-wide efforts to limit temperature increases to 1.5°C by year 2100. Baringa's modelling of a 1.5°C-aligned scenario in the NEM finds an even greater volume of storage is required to rapidly replace coal and achieve a zero-emissions NEM, than under the *NEM Reference Case*. In the 1.5°C scenario, projected storage build-out of utility-scale battery storage grows to more than 23 GW by 2050.*
- **The 1.5°C scenario assumes that capacity is built as needed. In practice, the current market conditions and government support are insufficient to see the market deliver the necessary volumes. New investment drivers would be needed for this capacity to come online**.

Installed Short Duration Storage (GW)



Long-duration (Pumped Hydro) storage

- State Governments have announced targets for long duration storage (LDS) to complement increased targets for variable renewable energy penetration. However, there is currently a void between the LDS announcements and the existing policy mechanisms in place to achieve them.
- Pumped hydro remain a cheaper means of LDS than batteries. However, **due to recent challenges with building pumped hydro –** highlighted by Snowy 2.0 albeit its challenges are arguably exceptional – **the projected growth of LDS is relatively modest**
- A 1.5°C-aligned scenario requires more LDS, especially 'deep' storage (min. of 16 hours' duration), to provide zero-emissions inter-day firming to ensure reliability during renewable energy droughts.
- Even if construction times and costs are reduced, achieving LDS targets will require strong government support, even under less ambitious futures than a 1.5°C-aligned scenario. This is due to the missing money faced by LDS under the NEM's energy-only market design.
- Missing money arises due to spot price caps, especially the cumulative price threshold (CPT), being lower than is required for LDS to fully recover its costs. Put differently, cumulative spot prices during *Dunkelflaute* conditions – which is when LDS increasingly operates going forward – need to be materially higher than the CPT.
- We discuss this further in the following slides

* Source: CEIG-x-Baringa-Report_2023-Final.pdf

Investment in storage| Current drivers of investment (1)

The investment case for storage relies on stacking different revenue streams, with the bankability of a project ultimately dependent on having secured long-term contracts with reliable counterparties

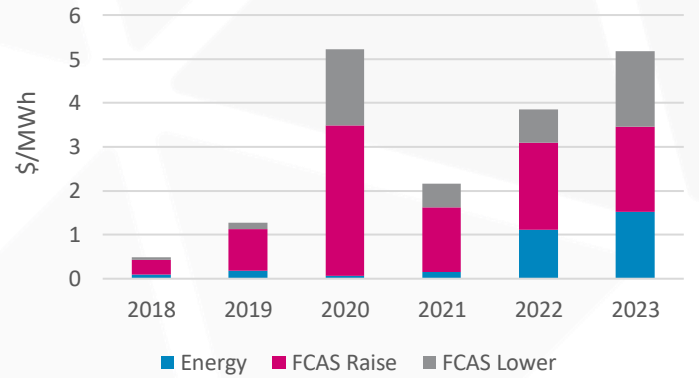
Current revenue opportunities for storage

	Description	Revenue potential
Energy market	Revenue generated through the wholesale spot market (typically based on an energy arbitrage model, buying electricity (charging/pumping) at a low price and selling (discharging) at a higher price).	Large intra-day energy price spreads in most regions of the NEM provide good arbitrage opportunities, especially as coal plants becoming increasingly unreliable and eventually close. Going forward, energy revenues will become progressively larger share of total storage revenues, in contrast to recent history. Relative to FCAS, longer duration is key for arbitrage – explaining the gradual shift towards longer-duration BESS.
Services market	Revenue generated through availability for, and provision of, market ancillary services (chiefly, frequency control). There are currently ten frequency control ancillary services in the NEM.	As coal and gas plants exit, and the penetration of variable renewable energy rises, there is an increasing need for more, newer, and faster sources of frequency response. Due to its rapid response times, battery storage is well positioned to provide these services, and FCAS has been an important revenue source for several batteries to date. However, FCAS will become increasingly saturated relative to the energy market, and revenue opportunities from FCAS are projected to decline though remain non-zero.
Contracted revenues	Contracted revenue streams outside of spot energy and FCAS markets. A range of contract types are available, either solely financial in nature or also involving physical delivery. See short and long term contracts on the following page.	In terms of securing investment and finance for a new storage project on favourable terms ('bankability'), securing long-term contracts with reliable counterparties is the most important element of the revenue stack, as this provides a revenue certainty that the merchant energy and FCAS revenue opportunities do not.

Current revenue stacks

- Analysis of revenue stacks of existing battery assets in the NEM finds their annual revenue has gradually shifted towards energy market arbitrage.
- We expect this to continue, with FCAS prices to fall substantially in coming years, placing greater importance on energy price spreads and tilting the economics towards longer-duration storage.
- There are currently no examples of private-sector debt* provided to standalone BESS projects with 100% merchant exposure. Instead, standalone BESS projects have been debt-financed when heavily contracted. When debt financing of merchant BESS projects has occurred, this has been where the BESS is coupled with solar PV, with the solar PV contracted.

Average historical BESS revenues



** In contrast, the Australian Government-owned Clean Energy Finance Corporation has financed 100% merchant BESSs*

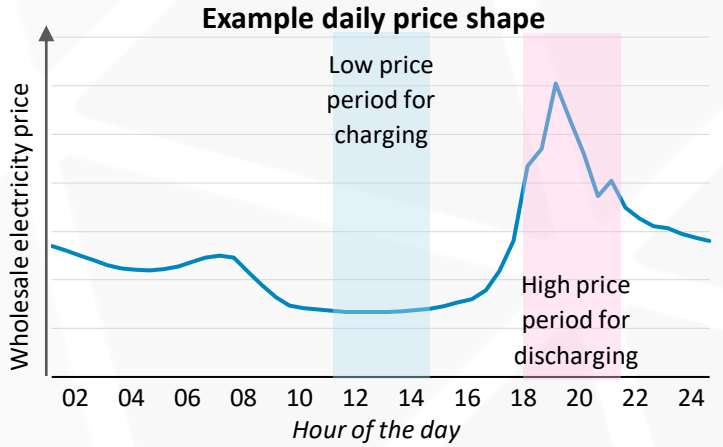
Investment in storage| Current drivers of investment (2)

Energy market revenue is an increasingly important component of the storage revenue stack, particularly for short-duration batteries leveraging daily price variability for arbitrage

Energy Market revenue opportunities

- Storage generates revenue in the energy market through wholesale spot price arbitrage, which depends on price volatility. The energy transition is leading to greater wholesale price volatility due to:
  - Increased penetration of variable (renewable) energy generation, small- and utility-scale, which are not well correlated with demand – the variability of wind and solar PV is not the issue per se, but rather its poor correlation with demand, which then means balancing supply and demand becomes harder, and price volatility is a signal of this increasing difficulty with supply-demand equilibration.
  - Increasing unreliability and inflexibility of coal plants as they age – as coal plants age they become more unreliable, which then means increased forced outages, which can suddenly tighten the demand-supply balance and lead to price spikes. Similarly, coal plants become less flexible as they age, which can then exacerbate periods of excess supply leading to deeper price troughs especially during the middle of the day when solar PV output is at its highest point
- Price volatility is currently characterised by frequent but relatively short-lived, intra-day, price spikes an troughs (with troughs typically enduring for longer than spikes). Combined with near-term historically high FCAS prices, this has meant shorter duration storage has been more profitable than longer-duration.
- However, this is changing. Already, we see an increased penetration of 2-hour storage where previously pre-2020), the bulk of storage had max. 1 hour duration. We project this to continue, with arbitrage becoming a greater share of revenues relative to FCAS, with intra-day price shapes, especially troughs, becoming more elongated. In turn, this increasingly favours longer-duration (up to 4-hour) storage.
- Renewable energy 'droughts' favour longer-duration storage (8-hour+), though these droughts are unlikely to occur sufficiently often to enable this storage to fully recover its costs (i.e., it faces 'missing money').

Short duration storage no longer faces market design-driven barriers to accessing energy market revenue opportunities, but medium- and long-duration storage cannot fully recover its costs in an energy-only market with insufficiently high price caps and infrequent renewable energy 'droughts'.



Beyond these stand-alone services, storage assets are also able to provide benefits when co-located with renewable energy generators such as avoided curtailment, reduced/avoided FCAS causer pays charges, and contracted revenue (e.g.. firming, tolling, and revenue sharing arrangements).

Investment in storage| Current drivers of investment (3)

Energy market revenue is an increasingly important component of the storage revenue stack, particularly for short-duration batteries leveraging daily price variability for arbitrage

Services Market revenue opportunities: Frequency services

- In the NEM, frequency control ancillary services (FCAS) are procured centrally by AEMO through a series of markets. Dispatch is co-optimised with electricity dispatch.
- The different FCAS products require different levels of availability, responsiveness and duration, which define how different technologies are able to participate. To date, FCAS has largely been provided by large thermal and hydro plant which are synchronous and have headroom to withhold for FCAS provision.
- New technologies, in particular demand response and batteries, have increased their share of registered capacity over the last few years. Demand Response now makes up ~around 10% of the registered capacity for Contingency Raise services
- Opportunity for short-duration storage:
  - Although batteries still represent only a relatively small percentage of total registered FCAS capacity, they represent a growing percentage of FCAS provision.
  - The value from regulation and contingency FCAS markets is expected to decline as new entrant batteries saturate the markets. As discussed on the prior slide, new-entrant economics are increasingly arbitrage-determined
- Opportunity for medium- and long-duration storage:
  - Pumped hydro can and does provide contingency FCAS. The extent to which other technologies are able to do so is dependent on their specifications.

All storage is able to access FCAS revenue, with batteries able to provide the most products given their fast response times. Existing products do not incentivise longer durations of storage. Revenue opportunities across all products are in decline as the market is saturated.

Service Type		Service name / function
Frequency Control Ancillary Services (FCAS)	Regulation	Regulation Raise
		Regulation Lower
	Contingency	Very Fast Raise / Lower *(1 sec response time)*
		Fast Raise / Lower *(6 sec response time)*
		Slow Raise / Lower *(60 sec response time)*
		Delayed Raise / Lower *(5 min response time)*

Investment in storage| Current drivers of investment (4)

Storage is able to secure revenue through a range of contract types, providing differing degrees of revenue certainty, due to the multitude of services it can provide

Contracted revenue opportunities: Existing contract structures

Degree of revenue certainty: High → Low

Long term Contracts (7+ years)	Tolling/Offtake agreement with a Gentailer	The counterparty (e.g.. retailer/gentailer) will typically pay a fixed annuity fee ($/kW) to be able to operate the asset in the spot market.
	Network support agreement with AEMO/TNSP	Market operator or TNSP procures services required for grid security and network services via long-term contracts, with availability and/or enablement payments.
	Virtual storage agreement with a Gentailer or Government	The storage operator buys energy at the lowest priced intervals in a day and sells at the highest priced intervals. The settlement price is the agreed spread between these bought and sold legs.
	Government underwriting schemes	Contracts aimed at reducing downside risk exposure – for example, a floor or collar contract, or a minimum revenue guarantee.
Short term Contracts (2-3 years)	Structured financial products with sufficient depth (i.e. cap derivatives)	Financial products traded on an exchange or over the counter, which storage can defend by operating in limited duration periods (for example, cap contracts).
	Short term tolling/offtake contracts (including options for renewal)	The counterparty (e.g.. retailer/gentailer) will typically pay a fixed fee ($/kW) to be able to operate the asset.

Funding model based on maximising gearing off the back of a long-term contract with an investment-grade offtaker. All else equal, counterparty creditworthiness and duration are more important for bankability than contract structure.

The examples on the LHS are a mix of financial-only (e.g., tolling) and physical (e.g.., network support) long-term contracts

Funding model based on maximising gearing off revenue stacking. Equity investors look to maximise returns by including significant uncontracted revenues. Short-term contracts are largely financial-only in nature.

Investment in storage| Current drivers of investment (5)

Storage is able to secure revenue through a range of contract types, providing differing degrees of revenue certainty, due to the multitude of services it can provide

Contracted revenue opportunities: Emerging contract structures

Type	Examples	Description
Renewable energy firming	Firming a flat block	Storage is used to firm a PPA to a flat block, enabling the end-consumer to use the PPA as both a cost offset and hedging tool. Seller receives a firming premium.
	Firming a shaped hedge	Energy supplier takes on the obligation to financially settle to an agreed notional load or generation shape (e.g.. an average daily profile) . Addition of storage avoids oversizing of renewable volumes and mitigates spot price exposure to seller.
	Load following hedge	Like a shaped hedge but with substantially higher risk to the seller. This is because the seller agrees to settle on the actual load at each trading interval rather than a pre-agreed shape. The higher risk transfer merits higher firming premiums.
Storage-specific hedging contracts	Vanilla CFD plus storage operational control	Akin to a toll, the seller operates the storage within pre-set parameters or to an agreed schedule, typically targeting coverage of high and low spot price periods for a fixed payment.
	Virtual Storage swap *(also known as Heads/Tails)*	A financial contract where the storage operator sells a high-priced flat swap and buys a low-priced flat swap, such that the arbitrage price spread is pre-agreed and fixed. Settlement then occurs based on the difference between actual spot price paid/received relative to the swap prices bought/sold.
	Super Peak Swap	A financial contract that targets intra-day and seasonal price peaks (i.e., swaps sold by storage) from: •3:00 PM to 7:30 PM in summer (Q1 & Q4) •6:00 AM to 9:00 AM and 4:30 PM to 7:30 PM in winter (Q2 & Q3)

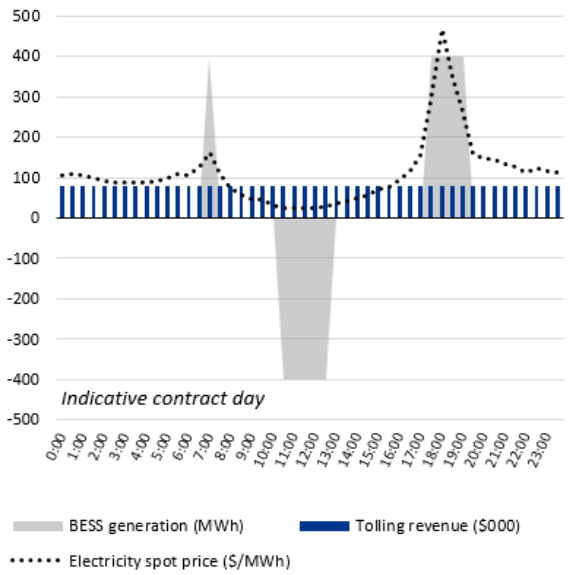
While there is a range of contract structures emerging which storage can sell and defend, lack of liquidity and duration of these contracts means the majority of contracting remains limited to tolling agreements. Renewable energy firming contracts suit storage of all durations, while super peak swaps are better suited to longer-duration storage and longer-duration firming capacity more generally.

Investment in storage| Current drivers of investment (6)

Storage is able to secure revenue through a range of contract types, providing differing degrees of revenue certainty, due to the multitude of services it can provide

Contracted revenue opportunities: Illustrative examples

Tolling agreements



To date, storage projects have typically secured tolling agreements with 'Gentailers' as their primary source of contracted revenues. These agreements offer a high certainty of revenue (as reflected in the flat and consistent tolling revenue), but prevent the storage owner from accessing upside revenue opportunities (likewise protecting the owner from downside revenue risk).

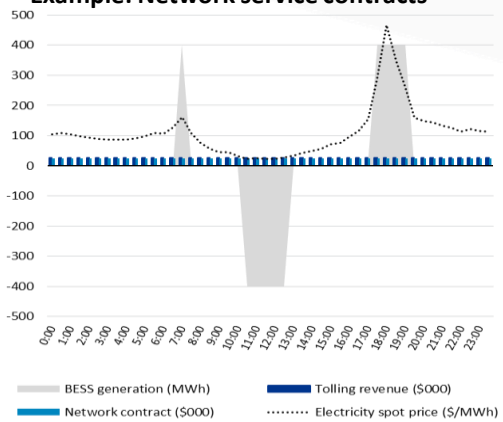
Other contract types are increasingly supporting storage

The contract types flagged on the prior two slides provide differing dispatch signals for storage, pose risks specific to some contract types but not others, and/or have differing revenue sharing arrangements. While contracts which shift merchant risk away from storage project developers and towards the offtaker have typically been favoured by investors (as per tolling agreements), as the investor community becomes more comfortable with storage the appetite for accepting some level of risk and seeking upside revenue exposure is growing.

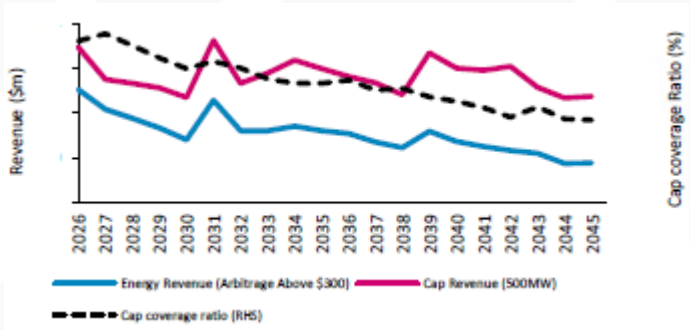
For example, the two figures below illustrate differing risks/considerations under two different contract structures:

- Network service contracts: the storage project has to reserve capacity to honour its contract, which then means its operational profile is, unlike a tolling agreement, not solely determined by market (energy and FCAS) prices
- Cap contracts: the risk is the cap is in the money for longer than the storage's duration (i.e., 'cap coverage ratio' is less than 100%). This then impacts the volume of contracts sold relative to storage capacity as well as strike price.

Example: Network service contracts



Example: Cap contracts



**Note: these diagrams are illustrative only, and so do not capture net profits/losses. As such, they are not, and should not be, taken as representative of actual contract or spot price movements.*

Investment in storage| Current drivers of investment (7)

There is a range of contracted revenue streams available to storage, depending on the network service being provided and whether the storage is transmission- or distribution-connected

Contracted revenue opportunities: Grid support service agreements

Virtual Transmission	Energy storage can be contracted to ease congestion on transmission (incl. interconnector) lines by either injecting of absorbing real power depending on the grid requirements, removing the need for a line upgrade or a new line (at least in the short term). As an example, The 'Victorian Big Battery' enabling increased flows of up to 250 MW over the Vic-NSW interconnector between November and the following March each year (by allowing VNI to run continuously at its 5-min thermal rating). This battery then injects power into VIC if and when VNI trips.
Avoided network upgrades at the end of the line	Network operators have used storage (currently batteries) co-located with local generation as an alternative to network upgrades. Mondo (Victorian TNSP AusNet services' contestable business) invested in a community mini-grid (a mix of generation and storage) in the town of Yackandandah which was at the end of a transmission line, saving significant transmission upgrade capex.
Avoided network upgrades through load shifting	Storage can be installed or contracted to shift load from periods of peak demand to periods of lower demand. This can be an extremely effective mechanism to defer network augmentation in regions where there is a concentration of load or generation. Furthermore, the presence of storage will allow for excess energy from a generator to be used for charging as opposed to curtailing a generator.
Distributed network virtual power plants	There has been a growing trend of distributors using small distributed storage as a part of virtual power plants to supplement the operation of their network by dispatching to alleviate localized load and generation constraints. An example is Ausgrid's VPP with ShineHub where residential customers are paid $450/MWh for energy exported from their batteries during periods of network constraints.
Voltage support	Storage has the ability to play a significant role in managing voltage fluctuations within a network and can provide both voltage rise and voltage drop services. This is particularly useful over distribution lines with lower voltage or large loads as the asset could potentially reduce peak demand.
Back up power – short term islanding	Utility scale storage can be used as a reliable back-up power source in parts of the grid that have poor reliability. Storage assets have the ability to island customers, separate them from the fault and continue to provide power while the fault is resolved.

Grid support service agreements provide an opportunity for storage projects to access long-term contracts for their availability at specified times and days of the year. The national framework has made this increasingly feasible, as a lower cost alternative to other infrastructure upgrades. To the most part, these contracts don't explicitly incentivise medium- and long-duration storage, as the services they require are largely short in duration (i.e., injections/absorption of power rather than energy).

Investment in long-duration storage| Incentives for such investment exist

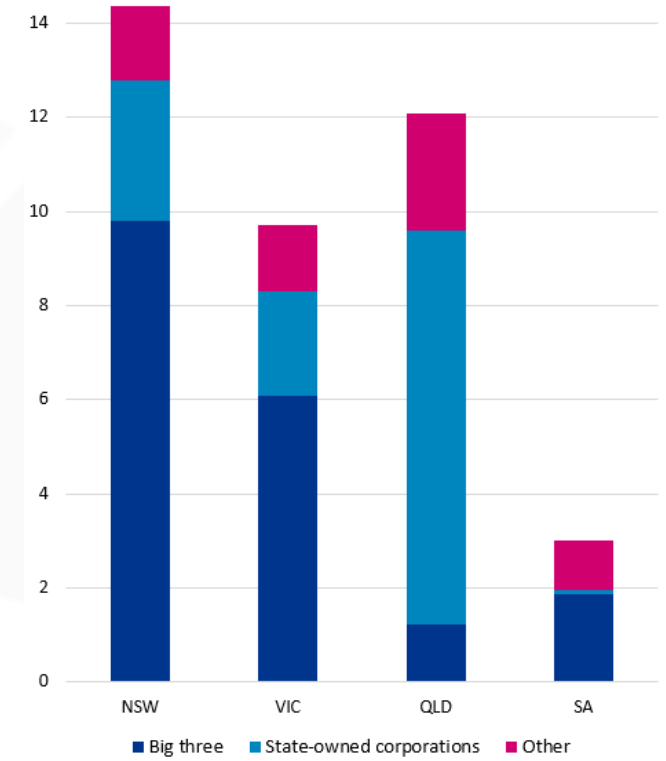
Aside from governments, retailers are incentivised to invest in longer-duration storage to hedge their load

The ownership and control of medium- and long-duration storage is concentrated

- As noted, the existing energy-only market design does not adequately incentivise investment in longer-duration storage (8hr+), which then means governments have stepped in to finance this either directly (e.g.., Snowy Hydro and Hydro Tasmania) or indirectly via providing offtake (e.g.., NSW LDS)
- In addition to governments, retailers are also incentivised to invest in longer-duration storage, as they need to manage their end-customer demand at all times including during renewable energy 'droughts'. A retailer would risk bankruptcy if their hedge book did not include contracts that also covered for renewable energy droughts as retailers would be forced to buy high-priced electricity on the spot market to meet their retail customer loads.
- These contract payments could resolve the missing money problem faced by longer-duration storage – essentially the contracts would pay for capacity that would only or mostly generate during renewable energy droughts.
- Such contracting could pass control of the storage over to the retailer, as occurs currently with tolling arrangements underpinning battery storage projects, and in turn be a form of vertical integration
  - This would mirror an ongoing and broader trend towards vertical integration in the NEM across thermal generators, renewables and storage (short-, medium-, and long-duration) (see RHS chart)
  - While vertical integration can be a more efficient means of managing risk than (external) contracting, it can weaken competition in the market (especially from independent power producers), and result ultimately in higher prices. This risk would need to be weighed against the consumer benefit of improved reliability from the investment in longer-duration storage, as well as the potential lower cost to consumers from market participants (i.e., retailers) investing in storage rather than governments

Retailers and other load-serving entities are incentivised to contract in longer-duration storage, which could resolve the missing money these projects might face on a merchant basis. How such contracting occurs, however, could diminish market competition and have negative long-term consumers impacts.

Ownership of registered dispatchable generation ('000 TWh)



Dispatchable generation volumes are the aggregate registered capacity of coal, gas, hydro and battery generators at 30 June 2022, based on the AER Wholesale Electricity Market Performance Report 2022, figures 3.7-3.10.

'Big three' generators: AGL, EnergyAustralia and Origin Energy.

Barriers to investment | Vary by duration

Longer duration storage faces more barriers to investment than shorter duration, in the current market, though commercial challenges continue to exist across the spectrum.

	Short-duration storage	Medium- and Long-duration storage
Energy market	Given falling technology costs, short duration storage no longer faces barriers to investing in the energy market. The energy transition is increasing price volatility, increasingly supporting energy arbitrage i.e., supporting longer, rather than shorter, duration storage projects. Currently this in the 1-2 hour range, relative to the 0.5-1hr range a few years ago when FCAS was a bigger slice of revenues. Going forward, falling technology costs are likely to increasingly see 4hr storage economic and arbitrage become the major share of storage revenues.	While price volatility is projected to increase as incumbent coal generators exit and the penetration of variable renewable energy generation increases, intra-day energy arbitrage opportunities are increasingly taken up by short-duration storage rather than medium-and long-duration storage. While renewable energy droughts will become a larger phenomenon as demand- and supply-side resources become more weather-dependent, such droughts are unlikely to occur at sufficient frequency and magnitude to enable medium- and long-duration storage to fully recover their lifecycle costs under the existing energy-only market design.
Services market	Falling technology costs also means short duration storage no longer faces barriers to accessing the ancillary service markets, namely FCAS. 1-second Contingency Raise and Lower FCAS products provide additional return potential for short duration storage though, as noted above, FCAS' share of storage revenues are projected to decline absolutely and relative to energy market-driven revenues, as the FCAS market becomes saturated with the entry of more batteries and other FCAS providers (e.g.., demand response).	As for energy, medium- and long-duration storage will compete with short-duration storage for FCAS provision. The share of FCAS revenues available to medium- and long-duration storage is likely to decline at a faster rate than for short-duration storage, given the faster response times for short-duration storage. Furthermore, if new Contingency FCAS products emerge they are more likely to favour faster response times rather than requiring prolonged response times aligned with medium-duration storage (i.e., unlikely that 4hr+ FCAS will emerge).
Contracted revenues	Bankability is impacted by both spot and contract considerations (on the latter, securing long-term contracts with creditworthy counterparties). Available contracts for short-duration storage are typically tolling arrangements with gentailers (often <10yrs tenure), as short-duration storage is not as well-suited to defending existing contracts such as caps (i.e., the risk is that a cap is in-the-money longer than a battery's duration). Uncertainty around coal closures creates risk, likewise the lack of centralised forecasting of replacement needs (the ISP includes storage at a very high level only).	While medium- and long-duration storage are well-placed to provide more innovative 'firming' contracts, such contracts lack liquidity presently, and as such may pose barriers to entry for non-integrated storage project developers given requirements for high degree of contracted revenue streams by project financiers. Instead, as per the prior slide, such investment may occur largely by vertically-integrated businesses. The CIS could provide an alternative route-to-market but is currently not targeted at medium- and long-duration storage.

Government and storage investment

Executive summary | Addressing barriers to investment

Government support can help to overcome barriers to investment in storage by increasing the revenue opportunities for storage of different durations or reducing revenue requirements.

	Description	Examples
Energy market	Policymakers can restructure the energy market to better enable medium- and long-duration storage to secure sufficient energy revenue to drive investment.	Increases to the reliability price settings (one or more of the MPC and CPT) could allow storage to capture more revenue in the existing energy-only market. A capacity market could support medium- and long-duration storage in the NEM, particularly if designed to target technologies with 'missing money' in the energy-only market. A capacity mechanism (of a less targeted design) was considered by the ESB but ultimately not pursued.
Services market	Policymakers can restructure ancillary services value streams and potentially introduce new products which allow storage of different durations to better monetise the ancillary services they can offer.	**Short-duration storage:** introduction of 1 sec ('very fast') Contingency Raise/Lower FCAS product, consideration of system strength and/or inertia revenue streams (market-facilitated or bilateral contracting). **Long-duration storage**: prolonged ramping products (subject to ability to integrate with existing ancillary service markets and products)
Contracted revenues	Governments can develop and offer long-term contracts to de-risk storage investments, such as offtake agreements, floor price contracts or grid support contracts. Governments, with strong industry support, can also encourage contracting and facilitate the development of new contract structures.	**Short duration storage:** NSCAS revised to better enable contracting with storage, System Integrity Protection Schemes (SIPS), Retailer Reliability Obligation (RRO), virtual storage swaps and other contracts, Capacity Investment Scheme (CIS) **Medium- and long-duration storage**: RRO, NSW Government Long Duration Storage (LDS) schemes
Funding & finance	Rather than supporting revenue opportunities, governments can reduce upfront costs and therefore lower the returns required for the project to be commercial. This support could take the form of fully or partially funding projects, providing favourable finance terms, or setting up Public Private Partnerships.	**Short-duration storage examples:** ARENA grants, CEFC funding, Govt. concessional finance **Medium/Long-duration storage examples:** government ownership (Snowy, QLD Hydro, HydroTas), NSW Government pumped hydro recoverable grants, ARENA grants, CEFC funding/concessional finance, Grid Scale Storage Fund (South Australia)

Mechanisms to increase revenue/certainty

Mechanisms to reduce costs

The role of government | Examples of types of support

Government support is needed especially for long-duration storage given the limitations of energy-only market design

Additional measures will be needed to drive investment in the storage required to enable decarbonization of the NEM, particularly long duration storage. Government has different levers of influence available which entail varied degrees of market intervention.

Ownership	Govt generators developing or taking ownership of storage assets which are then able to compete in the market.
Markets and regulatory obligations	Government implementing reforms which improve revenue opportunities for storage projects.
Grant funding	Government funding provided to reduce costs for the project – often during early phases of the project.
Offtake contracts	Government retailers entering into long-term offtake contracts with storage assets, to reduce project risk and improve bankability.
Downside de-risking contracts	Government offering contracts that hedge against downside risk, to reduce project risk and improve bankability.
Low-interest finance	Government finance provided with low interest and favourable terms, relative to what a project may receive commercially.
Cost reduction/streamlining measures	Reducing project costs through broader measures, such as reducing costs of supply chains, grid connection, land acquisition, and other costs.

It is also important to note that government mechanisms can likewise hinder investment in storage. In particular, policies which extend the life of existing thermal assets, or incentivize other providers of firming in the market (such as natural gas and hydrogen) may suppress market price signals that would otherwise have incentivized investment in storage.

Storage targets

- **Australian government** is supporting at least 9 GW (36 GWh) of new storage assets with the CIS.
- **VIC** has committed to energy storage targets of at least 2.6 GW of energy storage capacity by 2030, and at least 6.3 GW by 2035.
- **NSW** is aiming to support the development of 2GW of new storage by 2030, additional to Snowy 2.0. Based on the 2023 IIO Report, it is anticipated that 75% of this capacity will be commissioned by 2030 with the remaining in progress.
- **QLD** has a target to deliver at least 12GW of storage, firming and dispatchable capacity including batteries and different scales of pumped hydro energy storage alongside the government-backed deep storage assets.
- **SA and TAS** do not have any announced storage targets.

Best practice from international markets

Transferrable lessons from international experience

We've looked to a wide range of markets for innovative policies and programs designed to support investment in storage of different durations

Criteria for identifying transferrable learnings

Addresses a barrier

The mechanism is designed to support investment in new assets by unlocking new revenue opportunities, attaining more value from available opportunities, or reducing their costs.

Supports investment in storage (ideally medium- or long-duration)

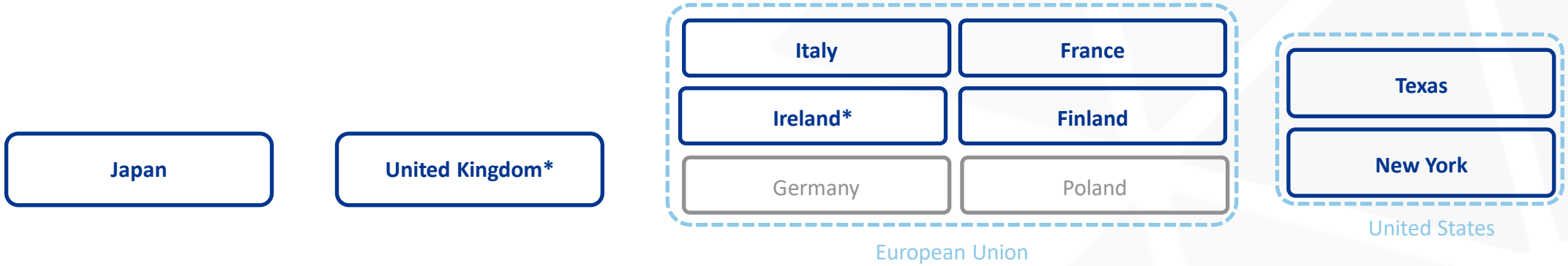
The mechanism is, or is expected to, support investment in storage rather than other renewables or firming technologies.

Readily transferrable to the NEM

The mechanism can be adopted in the NEM without requiring significant redesign of the current energy-only market.

Markets investigated to inform this report

We researched the following markets, looking at storage-focused Government initiatives, energy market structure, ancillary service structure and direct storage support.



**Work programs are underway in both GB and Ireland specifically to identify support mechanisms for long duration storage. The final outcomes of these processes are expected to be published subsequent to this report.*

***Grey:** markets were investigated, but did not appear to offer useful precedent for incentivising storage and are not included in the cohort of case studies in this report.*

International Markets| Energy market design

Energy market design options which support storage in other markets are not readily transferrable to the NEM

Energy market

Services market

Contracted revenues

Funding & finance

Opportunities for energy market revenue

- **Energy market design mechanisms applied in other markets that benefit storage are *not* readily transferrable to the NEM**
- Internationally, we see examples of energy market structures which better incentivise investment in medium- and long-duration storage than the energy-only NEM design. In particular, capacity markets are employed alongside energy markets in European, some North American and some Asian markets. While there are challenges with implementing capacity markets, they have the potential to support storage if the capacity payments are designed well (e.g.., duration-based de-rating factors are applicable).
- However, given the significant market design work program undertaken by the ESB (Post-2025 Market Design) which considered and opted not to implement substantial market reform, the introduction of a capacity market or similar reform is not considered viable at this time.
- Short-duration storage operates with higher capacity factors than longer-duration storage and so as long as the price settings – the MPC and CPT – remain sufficiently high, 'missing money' is less of an issue for short-duration storage meaning little (if any) need for a capacity market for short-duration storage.
- Clear planning and targets for closure of coal and development of storage of different durations can help to provide more certainty of energy market revenues and system needs. A number of European and Asian markets currently have targets in place.

International Markets| Long duration ancillary service products (1)

Ramping and Reserves. To serve existing capabilities

Energy market

Services market

Contracted revenues

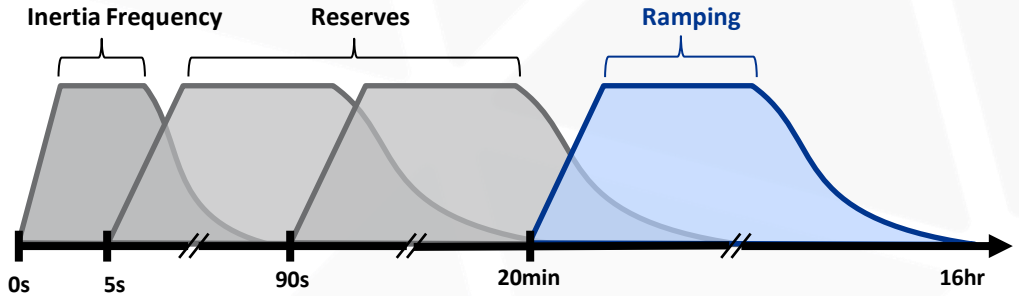
Funding & finance

Opportunities for revenue from services market

- Planning and creating new ancillary service products to secure the grid offers clearer routes to market for the storage technologies that will be needed in the future.
- The FCAS market in the NEM provides a revenue opportunity for storage alongside energy market revenue. However, the existing products do not provide an incentive to invest in longer storage durations. New products could be developed to do so.
- Mirroring the arrangements for FCAS, a new product or products could be procured by AEMO through a centralised market, co-optimised with energy. Participation would be limited to market participants (in-market capacity) which are able to deliver on product specifications, such as minimum duration of dispatch.
- This approach would provide an additional (albeit potentially of limited value) revenue opportunity for storage technologies able to meet the specifications (likely medium-duration storage) and would give AEMO a way of ensuring the resources needed to cover renewables 'gaps' are available and dispatched.
- The introduction of such products has been seen in other markets. **The Irish ramping products (case study to right) provide a particularly useful example for consideration in the NEM.**
- The risk of this approach is that the market could ultimately become capacity market and may prolong the life of existing thermal assets rather than incentivising investment in new storage. However, design of a new service in the context of the recently added emissions reduction National Energy Objective may provide rationale for design specifications which mitigate this risk.

International case study: Ireland

- In response to an increasing dependency on renewable energy generation, and as such the accuracy of renewable forecasting error, the Irish TSO (EirGrid) introduced a Ramping margin product to their ancillary services contracting market. This product is to allow them to maintain a level of dispatchable generation and demand that can ramp to replace renewable generation in the event that it is below forecast.
- The quantity of these products required in each interval is proportionate to the reserve margin and quantity of dispatchable generators in each interval of the wholesale energy market.
- Ramping Margin is the increased MW output or reduction in demand, a unit can provide, within a certain number of hours of receiving a dispatch instruction and maintaining that MW output for a further number of hours after the ramping period has elapsed.
- EirGrid procure 3 ramping margin products through their wider DS3 ancillary service contracting arrangements.



Category	Ramping	Maintained Output
RM1	1 hour	2 hours
RM2	2 hours	5 hours
RM3	8 hours	8 hours

International Markets| Long duration ancillary service products (2)

Ramping and Reserves. To serve existing capabilities

Energy market

Services market

Contracted revenues

Funding & finance

International case study: Great Britain

- In its capacity as system operator in Great Britain, National Grid has recently introduced a new pair of contingency reserve products, separated into Negative Slow Reserve and Positive Slow Reserve.
- The specifications for the slow reserve product could be provided by storage with duration in excess of 2hrs (alongside other technologies):
    - requires a ramp to full activation within 15 minutes of receiving dispatch instructions;
    - must be able to supply at full activation for at least 30min, and up to two hours.
- Activated providers will be remunerated via:
    - An availability payment, which is contingent on the provider delivering on its commitment. This payment is determined through auction.
    - A utilisation payment made for all energy delivered, on a pay-as-bid basis.
- The slow reserve product is procured on a day-ahead basis, with providers selected across eight two-hour windows in the daytime and an eight-hour window overnight.

International case study: Texas

- A package of recently proposed reforms in Texas (House Bill 1500) includes direction to ERCOT, the market operator, to develop and introduce a new 'Dispatchable Reliability Reserve Service ("DRRS")'.
- The proposed new ancillary service is intended to compensate generators for being available to produce power during intra-day periods of low supply. This is essentially for brief windows of low output from variable renewable energy, rather than covering prolonged renewable drought periods.
- The exact specifications of the proposed DRRS are not yet resolved, however the proposal is to require:
    - Requires a ramp up within two hours of receiving dispatch instructions;
    - Must be able to supply for at least four hours at a time; and
    - May be required to meet other specifications as needed to address inter-hour operation challenges.
- Currently, the proposed DRRS appears to be defined in a technology-neutral manner, meaning storage with at least 4hrs duration would be eligible to provide the service.
- The package of reforms has not yet been adopted. If adopted, the intention is that the service is operational by December 2024.
- Texas is particularly relevant as a reference point for potential NEM reforms because it is one of the few electricity markets which, like the NEM, is an energy-only market.

International Markets| Revenue de-risking (1)

Longer duration storage faces more barriers to investment than shorter duration, in the current market, though commercial challenges continue to exist across the spectrum.

Energy market

Services market

Contracted revenues

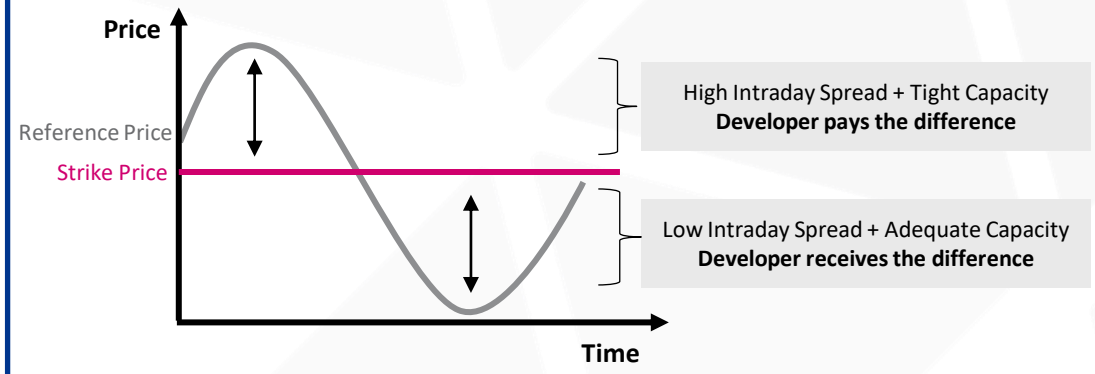
Funding & finance

Opportunities for contracted revenue

- Securing long-term contracts with reputable counterparties is critical to the bankability of storage in the NEM. Contracted revenue offers revenue certainty that can't be guaranteed through merchant energy market or service market participation.
- Governments can and do play a role in offering contracts in making projects more bankable. Government-backed contracting mechanisms share the risk (and reward) of projects between governments and investors, and can offer a level of revenue certainty and de-risk projects.
- De-risking contracts have been available for renewable energy projects across the NEM over the past decade, but storage-specific contracts are only more recently emerging.
- Long term contracting can help the bankability of short duration storage in the NEM due to the uncertainty around future FCAS revenues and intraday spreads due to saturation of the market.
- To date, we haven't seen de-risking contracts designed specifically to incentivise medium- and long-duration storage investment. These types of storage would likely require a contract to provide revenue certainty due to the intermittent nature of their discharging.
- There are a number of contract structures commonly used to provide certainty around revenue and hedge consumers from high prices: tolling, cap and floor, CfD, credit schemes

International case study: New York

- The New York State Energy Research and Development Authority (NYSERDA) and the Department of Public Service (DPS) have designed a new initiative called the **Index Storage Credit Structure (ISC)** to provide long-term certainty to storage projects.
- The ISC is a competitive tendering model based around a CfD which offers storage projects a more certain revenue stream. The CfD structure is novel for electricity markets globally and uses an indexed reference price.
- **Strike Price** – Projects submit Strike price bids as part of an annual competitive solicitation to represent their revenue requirement.
- **Reference Price** – Sum of the Reference Energy Arbitrage Price (REAP) and the Reference Capacity Price (RCP). The REAP is an index representing the difference between the top four and bottom four priced hours of the day-ahead marginal prices. The RCP is the Installed Capacity spot auction price.



International Markets| Revenue de-risking (2)

Longer duration storage faces more barriers to investment than shorter duration, in the current market, though commercial challenges continue to exist across the spectrum.

Energy market

Services market

Contracted revenues

Funding & finance

International case study: Texas

- The Public Utility Commission in Texas has proposed a 'performance credit mechanism' be introduced into the Texan energy-only market to increase reliability of the system in times of system stress, particularly extreme weather events.
- If introduced, this would be a significant move towards having a capacity mechanism alongside the energy-only and ancillary services markets in Texas.
- The proposed policy, while not yet fully designed, appears to be similar to the 'physical retailer reliability obligation' which was proposed by the Energy Security Board in the NEM (and ultimately not adopted). This approach would require retailers (load) to purchase credits from eligible dispatchable generators commensurate to their forecast share of load. In exchange for payment, the eligible generators would be required to ensure their capacity is available during times of tight supply throughout the year.
- This mechanism is intended to provide existing and new build dispatchable assets with an additional income stream to ensure the grid has enough dispatchable supply.
- As currently proposed, the policy would not target storage directly. Thermal generation technologies would also be expected to participate (coal, gas, nuclear).
- It is not currently clear whether the credits in this mechanism would be procured on long-term contracts or otherwise.

International case study: Italy

- This year the Italian government has dedicated to a target of 7 GW of BESS storage by 2030. The TSO TERNA will deliver this through dedicated support scheme for storage technologies, with the first auctions expected to be held in the Summer of 2024 for assets with COD in late 2025
- **These Auctions will be specifically for Lithium-Ion Batteries and Hydroelectric pumping** and are likely to resemble a CfD scheme or tolling agreement without option for revenue stacking

International case study: Japan

- Japan has introduced a new capacity market auction - Long-Term Decarbonisation Auction. Starting in FY2023 METI will conduct cross region auctions targeting new investments in decarbonised power sources, including LNG and fossil fuel plants that co-fire hydrogen/ammonia.
- Instead of being awarded for only one-year, winning bids will be awarded a capacity contract for 20 years.
- The payment consists of two parts, including the fixed payment and variable payment.
    - Fixed: Capacity revenue from Bid price x Capacity
    - Variable: 10% earnings returned from wholesale and balancing markets
- 1GW of Demand will be met specifically by batteries or pumped hydro.

International Markets| Longer term layered system service contracting

To support new build storage, a number of markets are introducing new long-term contracts to parallel the shorter-term dispatch arrangements for capacity and services.

Energy market

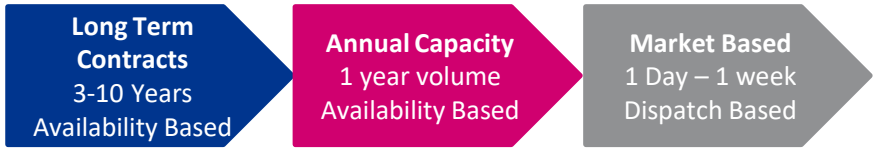
Services market

Contracted revenues

Funding & finance

Opportunities for contracted revenue

- Numerous well-developed international ancillary service markets operate a near-time market-based procurement, in a similar fashion to the FCAS in the NEM. However, they also provide annual or longer-term contracts based on availability to provide a frequency service.
- Other markets, which traditionally have acquired long term system service volumes ahead of time through capacity contracting auctions, plan to move towards market-based procurement. However, these markets still plan to keep the long-term contracting arrangements in place to supplement intra-day auctions.
- Storage and other ancillary service providers often have high capital costs and long lead times which do not lend themselves to market-based procurement.
- Congruently, system operators can meet the increasing need for ancillary services on high-RES systems with more certainty, by procuring capacity well ahead of real time.
- These contracting arrangements reflect this mutual benefit by offering providers both availability payments and delivery payments.



International case study: European markets

U.K.

- Ancillary service markets in the UK are currently undergoing major reforms. The new market design is expected to retain long-term ancillary service contracting to provide certainty to new build projects (alongside day-ahead and month-ahead).
- The Stability Pathfinder programme procures some stability services through 6-10 year pathfinders' contracts. They are designing a market currently to include 10+ year contracts, 1-year contracts and day ahead contracts for providers of stability services.

Ireland

- The DS3 programme is a TSO-led contracting regime that offers 6-year financial contracts to units to provide twelve system services to the grid. Units are paid for being available, rather than final dispatch positions.
- DS3 procurement is a competitive bid process with pay-as-bid auctions selecting a predetermined quantity for contracting.
- The TSO is in the process of redesigning the procurement of ancillary services but has outlined a desire to keep long-term contracting in place alongside the new market.

Finland

- Annual contracts for Frequency Containment Reserves (FCR) are procured through a competitive process. Competitive bidding determines the volumes for each provider and a fixed yearly market price determined on a pay-as-cleared basis.

France

- The market operator contracts frequency restoration and replacement reserves by means of an annual call for tenders, alongside daily procurement.

International Markets| Government direct support

Government funding and financial support provides a very direct lever for influencing storage build

Energy market

Services market

Contracted revenues

Funding & finance

Opportunities for funding and finance

- Providing funding and financial support to reduce project costs and revenue requirements is a straight-forward means of facilitating development of storage.
- This option gives the government or central planner a high degree of control over the build of new storage projects, when and where needed.
- This is also a useful mechanism to support storage technologies with long lead-times, providing capital to projects early into their development, ahead of project commissioning and dispatch into the market.
- In many international markets, direct government funding grants are tied into the delivery of targets or other planning tools.

International case study: various

EU

- The EU has approved funding in numerous member states for battery storage grants, including €1.1 billion in Hungary, €103 million in Romania and €150 million in Slovenia.
- The European Commission has also recommended that EU Member States identify potential financing gaps for short-, medium- and long-term energy storage and consider the need for financing instruments that address these gaps by providing visibility and predictability of revenues.

U.K.

- The Government has established targets for deep storage, including capacity for seasonal applications and for multi-year applications (~100 TWh).
- The state-owned UK Infrastructure Bank has announced a £60 million loan to support Pacific Green in its development of a new 249 MW / 373.5 MWh electricity storage park in Kent.

U.S.

- 9 U.S. states have published energy storage targets and 17 have subsidy policies, including California's Self-generation Incentive Program (SGIP), which offers rebates to utility scale storage.
- In direct support for storage, the 2022 Inflation Reduction Act (IRA) introduced an investment tax credit for standalone storage projects at a base rate of 6% and up to 30% for projects that meet specific requirements

Japan

- The Japanese government announced ¥17 billion and ¥5 billion subsidies to support instalment of standalone BESS as a part of 2022 and 2023 supplementary budgets.
- Tokyo Metropolitan area has also introduced subsidy schemes to provide certainty to batteries. This scheme provides up to ¥2.5 billion for projects 1MW or more in size.

Opportunities to support storage

Executive summary | Recommendations to support storage investment

We have identified six key recommendations which draw on our understanding of the barriers to investment, our commercial expertise, and lessons from international markets

Energy market

Services market

Contracted revenues

Funding & finance

Supporting investment in short-duration

1

Clarity and certainty around the coal closure schedule, and replacement capacity needs, will help to provide more confidence in expected FCAS and, in particular energy, revenues.

2

Securing long-term contracts is critical to bankability. Announced government support schemes will support further investment in short duration storage and could employ innovative contract designs to ensure they support storage which best meets market needs.

Supporting investment in medium/long-duration

4

To support investment in longer duration firming capacity, significant increases in the CPT are likely, beyond those proposed by the AEMC in its Draft Rule – proposed to increase from 7.5 hours at the MPC to 8.5 hours – to 12-18 hours. However, a significant increase may be unpalatable for decision makers.

3

New longer-ramping ancillary service product(s) targeted at long-duration firming sources (long duration storage or other fast-ramping firm technologies) could be considered, like the EirGrid products (see slide 26). This would increase the revenue 'stack' for medium-duration storage and, combined with other supportive changes for medium- and long-duration storage, could support bankability and investment.

5

Long-term contracts, struck at appropriately high prices will be critical for medium- and long-term storage, given its missing-money issues. There are a number of forms these contracts could take, including renewable firming products catering for *Dunkelflaute* conditions.

Targeted capacity/availability contracts could support the entry of new projects, as an alternative to a broader capacity market.

6

Noting some of the above are likely to be difficult to design and/or implement, Government funding remains critical for ensuring the necessary long-duration assets are developed as needed. There is also a role for government in ensuring planning processes don't dissuade investment in longer durations.

Recommendation 1

Clarity and certainty around the coal closure schedule, and replacement capacity needs, will help to provide more confidence in expected energy and FCAS revenue.

Energy market

Services market

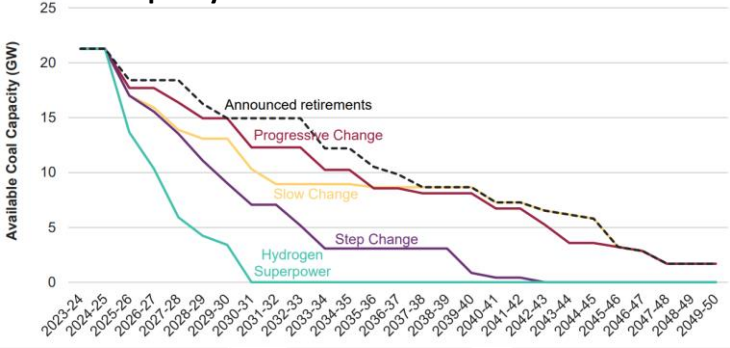
Contracted revenues

Funding & finance

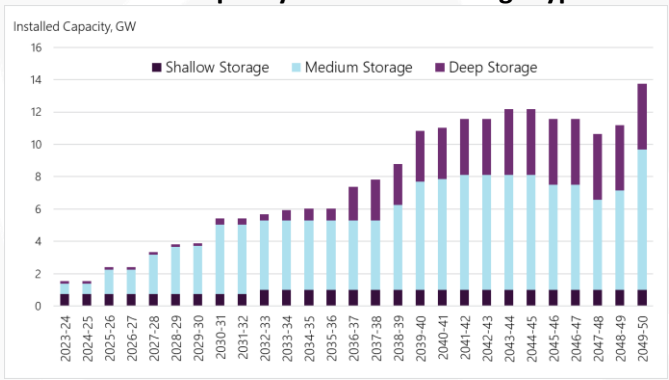
Supporting investment in short-duration **Adjustment to existing mechanism**

- The timing of coal units exiting the market, and the level of certainty around that timing, is critical to the investment case for new storage. As more coal exits, wholesale spot prices are expected to become more volatile which is important for storage accessing energy arbitrage opportunities. Further, the removal of coal from the system will also increase the demand for non-coal sources of ancillary services and firming contracts, bolstering these revenue streams for storage as well.
- The NEM's contribution to Government-set economy-wide decarbonisation targets is one of the key sources of uncertainty. While a publicly-announced coal power station closure schedule exists, these closure dates have not yet been reconciled with an economy-wide decarbonisation pathway. As emissions reduction targets are better defined (such as introducing a carbon budget) and/or decarbonisation pathways identified, the coal closure schedule would be expected to be revised.
- The near-term timing of building the transmission, generation and firming technologies required to replace coal is another key source of uncertainty, due to social licence challenges, in turn creating the risk that governments prolong coal plant lives due to security of supply concerns.
- **Greater certainty of the forward coal closure schedule and limitations on interventions that prolong the life of coal will help to improve the investment case for new storage.**
- Separately, it is important AEMO's ISP modelling demonstrates the projected volumes of all storage durations needed, not just those in excess of 4 hours. While in our experience investors do not rely solely on the ISP to inform *what* storage to invest in – they use the ISP more to decide *where* to invest – government storage-related targets and investments do draw on the ISP, hence the need for the ISP to provide this more granular data.
- **Robust modelling of storage and firming technologies by AEMO for the ISP will provide investors and governments with guidance on the nature, location and timing of market needs.**

ISP 2022 coal capacity retirements and announced retirements



ISP 2022 installed capacity of selected storage types



Shallow storage (<4hr) is assumed to remain at 1GW capacity across the modelled time horizon.

Recommendation 2

Announced government support schemes could explore innovative contract designs to meet the needs of storage of different durations

Energy market

Services market

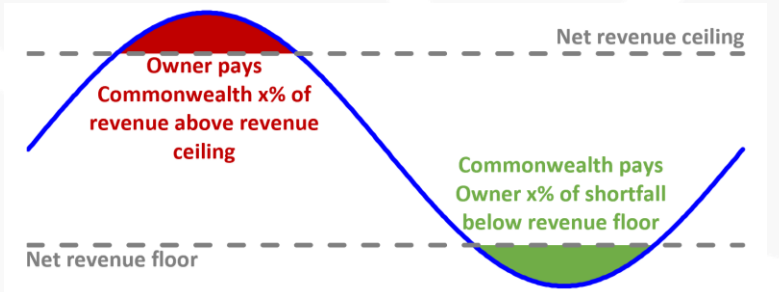
Contracted revenues

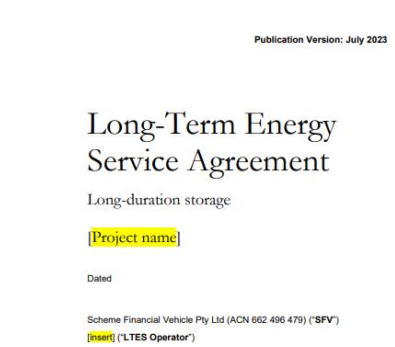
Funding & finance

Supporting investment in all durations **Design of future mechanisms**

- Government initiatives to de-risk investment in new storage via new contract structures are in relatively advanced stages of developments. There are three schemes to call out in particular:
  1. Commonwealth's Capacity Investment Scheme (CIS), which has proposed a revenue 'collar' structure (see RHS image) to support 9 GW (or 36 GWh) of new storage by 2030.
  2. NSW Long Duration Storage (LDS) Long Term Energy Service Agreements (LTESAs): option contracts (swaptions) with annuity payments for 8+hour duration
  3. NSW Firming Infrastructure LTESAs: option contracts (swaptions), for 2+hr storage duration
- These schemes apply a storage-appropriate contract structure: contract terms are based around net operational revenues rather than generation dispatch alone, which wouldn't reflect the commercial models of storage (incl. arbitrage and services).
- However, only the LDS scheme (#2 above), targets the durations of storage with missing money issues in the NEM's energy-only market. As previously discussed, we don't consider shorter-duration (4 hours or less) storage faces missing money problems in the absence of uncertain coal closure dates.
  - The scheme is open to 8hr+ durations only (meaning projects won't be competing with shorter durations of storage for support).
  - The scheme offers contracts up to 14 years for chemical batteries and 40 years for pumped hydro. As previously discussed, long-term contracts aid de-risking and bankability.
  - Recognising the extensive early works required to develop a pumped-hydro project proposal, this LDS LTESA scheme was preceded by a recoverable grants program and other measures to support the LDS project pipeline.
- In light of the recent CIS expansion, opportunities to better target the scheme to support longer storage durations should be considered (noting this may require flexibility on the 2030 COD requirement).

Revenue 'collar' (ceiling + floor) under the Commonwealth's CIS





Recommendation 3

Ramping ancillary service product(s) could be considered to ensure the right technology mix is dispatched into the market to meet system security needs as coal retires.

Energy market

Services market

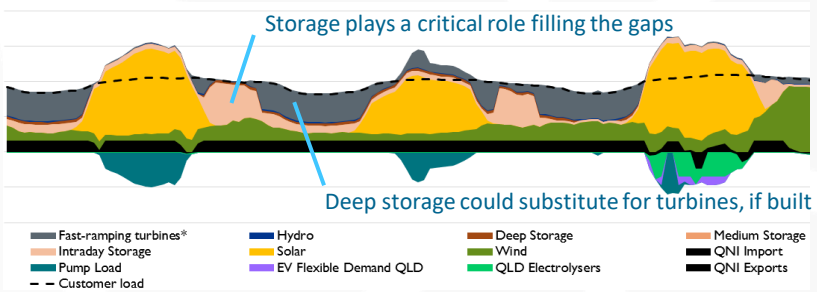
Contracted revenues

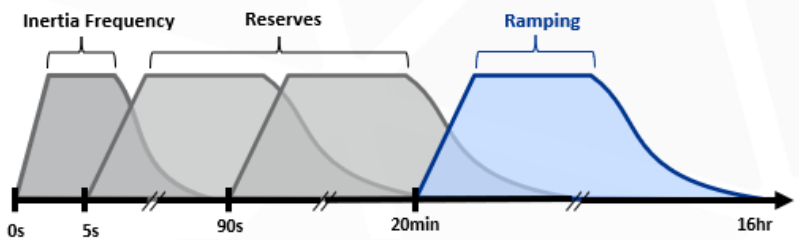
Funding & finance

Supporting investment in medium/long-duration **Design of future mechanisms**

- Existing FCAS products do not specifically incentivise investment in medium- or long-duration storage, over shorter durations (noting that these longer durations can and do still participate in existing markets, but one a short duration is required to provide services). These products mitigate and respond to frequency deviations rather than serving a wider reliability function.
- Some international markets have introduced ramping or other ancillary services with multi-hour ramp periods and multi-hour sustained output requirements, alongside the shorter term 'fast' and 'very fast' frequency response products, as a means of managing the increased risk of renewable energy droughts. By design, these ancillary services are supplied by medium- and long-duration storage, helping support their bankability and investability.
- EirGrid's ramping reserves provide particularly relevant examples of how longer duration ancillary service products can be introduced to manage the electricity system in the context of increasing variable renewable energy penetration.
- **The introduction of new ancillary service products has the potential to contribute to management of security and reliability in a system more dependent on variable renewable energy resources, and likewise presents an opportunity to bolster the revenue opportunities available to medium- and long-term storage projects.**
- The potential benefits of introducing new products will need to be weighed against the challenges and complexity of adding an additional co-optimised market into the NEM's existing market design. Furthermore, bankability of medium- and long-duration storage could be enhanced by combining the introduction of multi-hour ramp/sustained output products with long-term contracts for these services to provide greater revenue certainty.

Projected role of storage during low-renewables periods





Category	Ramping	Maintained Output
RM1	1 hour	2 hours
RM2	2 hours	5 hours
RM3	8 hours	8 hours

Recommendations 4 and 5

Targeted capacity/availability payments could be a more effective approach than introducing a broad-based capacity market into the NEM. This could be supported by further increasing the CPT.

Energy market

Services market

Contracted revenues

Funding & finance

Supporting investment in medium/long-duration

Design of future mechanisms

- The introduction of a broad capacity market is not currently feasible in the NEM, nor desirable. A superior alternative approach to addressing medium or long-duration storage's missing money is targeted capacity payments. Note here we are recommending capacity payments, not revenue or energy price (i.e., payments based on $/MW, not on $/MWh), in contrast to the LTESA and CIS schemes which are revenue-based contract structures.
- Furthermore, we recommend these payments be made over a longer term, rather than short-term (1-2 year) capacity reserve auction-type contracts
- **Sufficiently long-term capacity payments targeted at medium- and long-duration storage would provide revenue certainty and improve bankability for these low capacity-factor projects.**
- Revenue/generation-based contract structures may not be the most suitable approach to incentivize future investment in the volume of long-duration storage facilities that is likely to only be needed for reliability and security during *Dunkelflaute* conditions, a few times a year. While these storage facilities would, in practice, dispatch with greater regularity if built (depending on the technology and SRMC), the revenue/generation-based contract structures would be unlikely to incentivize building a long storage duration (deep storage) rather than a shorter duration alternative in the first place.
- The design of a targeted capacity payment could draw on international examples, such as Japan. Likewise, network support ancillary services, other grid support services, and RERT in the NEM provide some useful precedent for availability-based contracts and payments. This said, these NEM-based capacity/availability payments are too short-term in nature for new-build medium- and long-duration storage capacity which, as mentioned above, need longer-term contracts to de-risk investment and promote bankability.
- Capacity payments can and should be **supported by further increases in the cumulative price threshold** (CPT), which is the more appropriate price setting for resolving (or creating) missing money problems than the market price cap (MPC). The AEMC has, appropriately, made a Draft Rule increasing the CPT from 7.5 hours to 8.5 hours at the MPC, which along with the Draft Rule's increase in the MPC, would see a c.40% increase in today's CPT (inflation-adjusted). While this will help reduce the missing money problems to be faced by medium- and long-duration storage, **further increases in the CPT may be required, potentially up to 12 hours at the MPC**.
- Furthermore, this proposed increase in the CPT is a long time coming; neither the MPC nor the CPT have been increased in inflation-adjusted terms since 2013, with the CPT remaining at 7.5 hours at the MPC over this period. This suggests increases in these price caps can be and are politically difficult and therefore occur at a slower pace and/or smaller extent than needed to resolve medium- and long-duration firming capacity's missing money problems. As such, we recommend a mix of capacity payments and CPT increases, rather than relying solely on CPT increases, as a means of resolving these missing money problems.

Recommendation 6

Government funding, finance, partnerships and ownership remain clear options for ensuring the necessary assets are developed as needed.

Energy market

Services market

Contracted revenues

Funding & finance

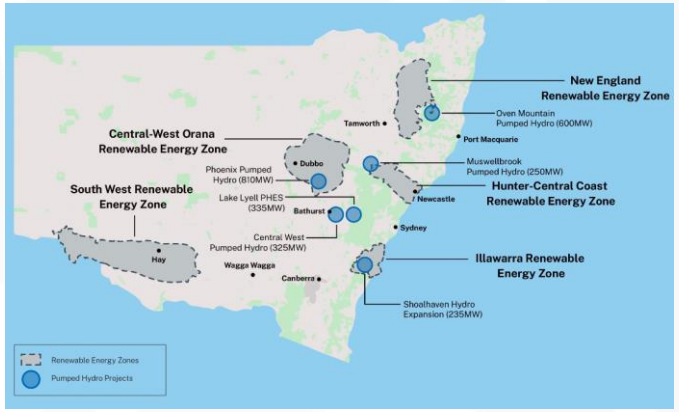
Supporting investment in medium/long-duration **Design of future mechanisms**

- While medium- and long-duration storage continue to face a material 'missing money' barrier, with insufficient revenue opportunities available for a low-capacity factor operating model, government funding, finance and public-private partnership arrangements provide effective options for enabling investment in, and development of, assets needed by the system. This is a particularly relevant mechanism for supporting storage technologies with long lead times and high upfront costs (therefore incurring a large capital expenditure many years ahead of commissioning and cost recovery).
- One benefit of this approach to supporting new storage projects is that it is very targeted to deliver the technologies understood by the government to be needed in the system, without implementing a system overhaul (such as introducing a new market or service) that impacts the wider market. A downside, however, is that government interventions of this nature can dissuade private investment.
- Major energy storage projects announced in the NEM in recent years have government funding underpinning their development (and are government owned).
- As an alternative to government ownership, traditional grant funding as well as recoverable grants (as per the NSW Pumped Hydro Recoverable Grants scheme) are useful models which could be considered for adoption NEM-wide.
- Government funding and finance can also be an effective means to support the development and commercialisation of less mature storage technologies (for example, via ARENA).
- Separately, government can also support storage investment by ensuring that planning and connection arrangements don't create barriers to investment, including investment in longer durations of storage now and in the future (staged projects).

snowy hydro

Hydro Tasmania

Queensland Hydro



NSW EnergyCo map identifying the location of pumped hydro recoverable grant recipient projects.

Baringa

Appendix

Existing mechanisms to support storage.

The role of government | Existing and proposed mechanisms (1)

A number of support mechanisms already exist and new opportunities have been proposed.

Nature of support	Mechanism	Maturity	Overview

 Contracted revenues	**Capacity Investment Scheme** *(Australian Government, in collaboration with states)*	Announced. CIS tenders will run from 2023 until 2027.	• The Capacity Investment Scheme (CIS) aims to deliver at least 9 GW (36 GWh) of new clean dispatchable capacity and 23 GW of variable renewable energy across the NEM and WEM by 2030.
			• The initial storage component of the scheme has been designed as a contractual mechanism to de-risk projects by providing a revenue floor for the duration of the contract term, as well as a revenue ceiling (revenue-sharing arrangements on both ends). The contract structure to support the renewables component is not yet public.
			• A reliability target – expressed in MW 4-hr duration equivalents - will be developed, to determine timing and geographic distribution of storage support tenders. Initial support has been announced for NSW in 2023, with an initial tender spanning VIC and SA announced for late 2024.
			• The storage tender eligibility has been proposed to include:
			  • scheduled registered participants of at least 30MW;
			  • have reached FID from 8 December 2022 onward;
			  • Create no Scope 1 emissions;
			  • Capable of delivering on availability and reliability requirements.
			• The CIS is intended to complement, rather than replace, state-based programs such as the NSW LTESA.

 **Energy market**	**Congestion Relief Market** *(National)*	Potential future reforms.	• At the national/NEM level, a proposed voluntary Congestion Relief Market is being designed for consideration by Energy Ministers. • The proposal would see the introduction of a new market operating alongside energy dispatch, which would allow participants to bid to provide congestion relief services. This would potentially create a new revenue opportunity for storage which could dispatch or charge as required to provide the service.

The role of government | Existing and proposed mechanisms (2)

A number of support mechanisms already exist and new opportunities have been proposed.

Nature of support	Mechanism	Maturity	Overview

 Contracted revenues	**Long-Term Energy Service Agreements (LTESA)** *(NSW Government)*	Current. LTESA tenders will run 2022 to 2030.	• The NSW Government has introduced Long Term Energy Service Agreements (LTESA) as a contractual product intended to incentivise and facilitate investment in new projects by provide revenue de-risking.
			• LTESAs are Option contracts which, if exercised, essentially provide a revenue floor. Specifically, the option provides an annuity top up on the minimum revenue to recover debt service repayments and guarantee a minimum income at the level bid by the operator. LTESAs also include a 'clawback' arrangement with 50% of revenue above the repayment threshold price shared back to the government.
			• LTESAs can support storage through two avenues: firming LTESA and long-duration storage LTESA products.
			  • The firming LTESA product is available for projects which provide either firming supply (such as BESS, electrolysers or gas generators) or flexible demand response.
			  • The Long-duration storage LTESA product is available for projects which can continuously dispatch at their registered capacity for a minimum of eight hours.
			  • Both products provide optional annuity payments which are intended to mitigate revenue risk by providing 'top up' on projects' net operational revenues, if exercised.
			• LTESAs are awarded through competitive tenders. The NSW Government's Infrastructure Investment Objectives (IIO) report identifies the tender schedule (location and volume of LTESAs), with tenders anticipated to occur every six months. The most recent iteration of the IIO report proposes tenders will allocate contracts for 3,000GWh of annual generation every six months and up to 1GW of long duration storage capacity every year in order to meet NSW's 2030 objectives.

 Contracted revenues	**New and emerging services** *(National)*	Existing services and potential future reforms.	• Recent reforms now require transmission network service providers (TNSPs) to procure system strength in line with planning standards established by AEMO. TNSPs may procure these services under contract from suitable service providers, which could include some storage technologies (depending on inverters and capabilities). • While not currently a service, AEMO has also flagged the potential for a synthetic inertia ancillary service to be defined in the future, and that batteries with grid-forming inverters may be able to provide it.

The role of government | Existing and proposed mechanisms (3)

A number of support mechanisms already exist and new opportunities have been proposed.

Nature of support	Mechanism	Maturity	Overview
 Contracted revenues	**Retailer Reliability Obligation** *(National)*	Existing.	• The Retailer Reliability Obligation (RRO) is designed to create an incentive for retailers to contract with 'firm' generation ahead of identified reliability shortfalls. • The policy should provide greater demand for, and therefore a value uplift on, financial derivative contracts deemed 'firm', but only in the regions and periods identified as having reliability gaps. Storage is well-placed to offer these 'firm' contracts, such as caps. • The policy primarily incentivises short-term contracting, rather than longer term contracts, and proposed changes to the policy will reduce the forward contracting requirement.
 Contracted revenues	**System Integrity Protection Scheme (SIPS)** *(State-level policy)*	Existing.	• The System Integrity Protection Scheme is a framework for transmission network service providers to respond to network security needs with the use of batteries to provide 'virtual transmission' services. The framework sits in Victorian Government legislation and the term has also been applied as a means of describing similar services in the NSW context. • The SIPS has been applied in Victoria, supporting the development of the 'Victorian Big Battery' with a long-term contract for services at certain periods of the year. The battery is required to be available to provide redundancy for the Victorian-NSW Interconnector at peak periods of the year and is otherwise available to pursue other revenue opportunities outside of the contracted commitment. • The SIPS has also been applied to support the development of the Waratah Super Battery (WBS) in NSW, enabling existing network lines to be uprated, increasing energy transfer into load centres. A competitive tender process was used to select a service provider to construct and operate the battery, with the network operator (Transgrid) procuring services on a long-term contract.
 Contracted revenues	**Contracted ancillary services** *(National)*	Existing.	• AEMO procures a number of ancillary services through long-term contracts (rather than through real-time markets). These include Network Support and Control Ancillary Services (NSCAS) and System Restart Ancillary Services (SRAS). • Contracts are negotiated between AEMO and the service provider, and services are typically paid for through a combination of availability payments, enablement payments and usage payments. • Storage is capable of providing a number of these services, depending on its inverter and other specifications.

The role of government | Existing and proposed mechanisms (4)

A number of support mechanisms already exist and new opportunities have been proposed.

Nature of support	Mechanism	Maturity	Overview
Funding & finance	**Renewable Energy and Hydrogen Jobs Fund** *(QLD Government)*	Existing.	• The Queensland Government's Renewable Energy and Hydrogen Jobs Fund (QREHJF) is a $4.5 billion fund intended to support the state-owned energy corporations to increase their ownership of energy and hydrogen projects, as well as supporting infrastructure through public-private partnerships. It includes $500 million earmarked specifically for batteries. • The fund's mandate extends to supporting both grid-scale and community batteries, and it has already funded a number of grid-scale batteries to date. • The Government will also develop an energy storage strategy for a reliable and resilient system.
Funding & finance	**Pumped Hydro Recoverable Grants** *(NSW Government)*	Existing.	• The NSW Government has a $50 million pumped hydro recoverable grants scheme designed to support pre-investment, feasibility and commercialisation activities in order to ready a pipeline of projects to bid for long duration storage LTESA contracts. The scheme was developed in recognition of the long lead times and high costs involved in early stage pumped hydro project development. • To date, $51.84 million has been awarded to projects, and no future rounds of support are currently planned.
Funding & finance Contracted revenues	**Victorian Storage Support** *(VIC Government)*	Existing and announced.	• In support of its energy storage targets, the Victorian Government is leveraging a number of funding options to support storage projects. This includes using the latest Energy Innovation Fund (EIF) and the Renewable Energy Zone Fund. • The VIC Government will also be supporting new storage investment via its State Electricity Commission (SEC), including through its Pioneer Investment Mandate – investments through which will be announced in late 2023.

The role of government | Existing and proposed mechanisms (5)

A number of support mechanisms already exist and new opportunities have been proposed.

Nature of support	Mechanism	Maturity	Overview
 Funding & finance	**Low-cost finance** *(Australian Government)*	Existing.	• The Clean Energy Finance Corporation (CEFC) is the Australian Government's green investment bank with a mandate to facilitate increased flows of finance into the clean energy sector. The CEFC has the capacity to support investment in storage by providing financial products to storage proponents through its general portfolio as well as a number of its special investment programs to which storage may be relevant. • The nature of CEFC financial support varies, and could take the form of direct debt or equity, small-scale asset finance delivered via co-financiers, or other investment structures. • Broadly, the CEFC provides an opportunity for storage projects to access low-cost finance and green energy-tailored financial support which would be more challenging and/or more expensive to access through other investors.
 Funding & finance	**Grant funding** *(Australian Government)*	Existing.	• ARENA supports the development and commercialisation of emerging renewable energy technologies, and related technologies which support the transition to renewable energy – including storage. • It provides competitively-allocated funding to projects that align with its priority investment areas. Currently, the Advancing Renewables Program may provide funding opportunities for storage projects that could deliver on the program outcomes and meet other eligibility criteria. • The agency also plays an important role in facilitating knowledge sharing, in the interests of developing the industry as a whole. • Emerging storage technologies and novel applications of existing storage technologies may be able to access funding through ARENA, thus reducing their capital requirement. For example, in 2022 ARENA provided $176 million of support to eight Large-Scale Battery Storage projects totalling 2GW.
 Funding & finance	**National Battery Strategy** *(Australian Government)*	Strategy in development.	• The Australian government is developing a strategy to support battery development. An initial issues paper was published for consultation in early 2023. including proposed measures to develop domestic supply chain capacity and boost uptake of batteries in Australia. • While the nature of support is unclear, progress towards streamlined or scaled supply chains may reduce costs for batteries and improve the investment case for short duration storage, incentivising further investment by the market.

