

STORAGE

comes to calm the

MARKET

Tomorrow's energy market will bear almost no resemblance to the one we grew up with. The large coal-burning power plants that turn out up to 85% of the electricity we use today will all be gone, for a start. In place of the sturdy, monotonous output of a small number of generators we will rely on a legion of wind and solar assets scattered across the sunniest and windiest parts of the country.

It will be an unruly lot, however, never willing to follow orders. Wind and solar plants generate when they want to, not when they are told to – unlike the dray horse-like work of coal plant, which will follow the master's orders so long as they are fed the master's fuel.

It's the unpredictable nature of wind and solar that makes people nervous, especially the politicians who ultimately are expected to answer for things if the lights suddenly go out.

The simple solution in a grid largely supplied by renewable resources, of course, is to build batteries to capture surplus energy when it's there and deploy it as demand dictates.

But the grid is wildly varying, and a storage solution that might suit one bit of it will be totally inappropriate somewhere else. Also, in a future where gigawatt-scale storage assets are being considered, the implications for anyone considering hefty investments in megawatt-scale batteries could be profound.

It feels like the time has come for storage, which can be used to provide three things: energy security (balance generation and demand), energy reliability and network capacity (electrons can flow from where they are generated to where they are needed at all moments in time).

"Storage is applicable to all three of those pillars of the energy system," says Dr Bjorn Sturmborg, the research leader at the ANU's battery storage and grid integration program, adding that the technology (gravitational, chemical, etc) and geographic distribution of assets decides how they are applicable to the three pillars. Storage is needed, everyone agrees, but the state of the electricity market and cost of the technology still make it a tough investment decision.

"Storage is a really useful balancing technology to soak up excess

Energy storage is a mandatory inclusion in a grid supplied by unpredictable wind and solar. As costs continue to fall more of these important assets are lining up to connect, writes Jeremy Chunn.

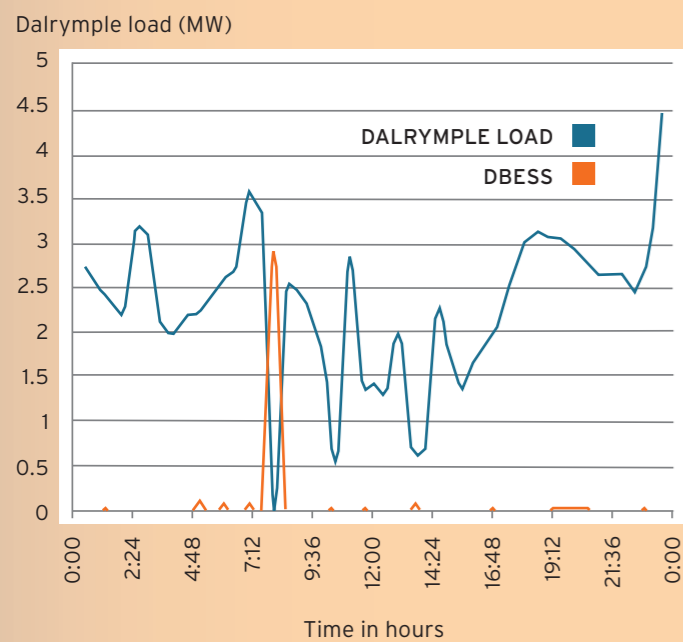


ElectraNet's Dalrymple battery is supplying the market when it needs it most (see chart below).

solar and wind generation, where the price signal is suggesting that energy is not tremendously valuable in the market and redispatching that energy to points of time where it is probably more valuable," says Simon Brooker, executive director at the Clean Energy Finance Corporation.

Brooker is watching the entire storage market, assessing value in very large grid-connected proposals to virtual power plants of connected residential batteries. At the big end he sees potential

DALRYMPLE LOAD (MW) SUPPLIED BY SYSTEM AND THE ELECTRANET BATTERY (DBESS)



– and challenges – in pumped hydro applications, where project costs are probably higher than people thought, he says, so developers would require more revenue to repay capital. Pumped hydro has most chance of going ahead with contracted offtake agreements with large energy retailers who'll want to match the asset against their portfolio.

"There's a lot of uncertainty out there," Brooker says. "These are big dollar investments and they take a long time to deploy, and there's a lot of uncertainty during construction as to what the market will look like when these things are available." Also, battery prices are falling, which will affect hydro's outlook.

"It's challenging, that's why I think the people best placed to assess this will be the [energy] retailers. They are going to determine the speed at which this technology is taken up."

INVESTMENT TRIGGERS

In the delicate balance of the energy system the millisecond-to-millisecond control is largely done based on the physics of spinning machines and inertia of masses in coal generators, but what will happen as they are slowly retired one by one over the next few decades?

This is where storage will step into the breach, says Sturmberg. "Inverters can manage reactive power even if they are not generating active power," he says.

"[Storage] is fully flexible – you can manage active and reactive power because they [storage assets] can charge and discharge. There is a powerful role for storage to help with energy security."

Control systems that run on inverters rather than storage technology or size offer opportunities at the utility scale, he says.

"At utility generation sites those inverters will have to become grid-forming or have some degree of grid-forming capability."

THE PAYOFF

It takes bravery to invest in storage – and superior modelling skills. Business cases around storage can be quite theoretical, says Energy Synapse managing director Marija Petkovic, so it's useful to look at what's already there. Late last year Energy Synapse released an independent analysis of the Hornsdale Power Reserve, the 100MW/129MWh Tesla battery connected to owner Neoen's 315MW Hornsdale Wind Farm in South Australia, to look at how it's operating and how it's earning revenue under real world conditions.

The report found most of Hornsdale's revenue comes from arbitrage and the various frequency control ancillary markets.

"Batteries are the fastest-responding assets in the NEM and are very well-suited to helping to manage very fast frequency deviations ... and very fast price spikes in the market – they are the sweet spots," Petkovic says.

There are eight frequency control markets: six contingency FCAS markets, to correct major frequency deviations (6-second, 60-second and 5-minute markets to lower or raise frequency); and two regulation FCAS markets (to lower or raise frequency).

Neoen is hoping to follow up on the success of Hornsdale, the largest lithium-ion battery in the world, with its plans for a storage project about four times larger – 600MW – near Geelong, in Victoria, to help the state resolve grid constraint issues suffered by renewables generators in the north-west. It is also busy adding another 50% capacity at Hornsdale.

Anyone who sneers at batteries as incapable of storing enough power to supply entire populations in a blackout misses the point, Petkovic says. "Batteries aren't for storing bulk amounts of energy; that's when you look at something like a pumped hydro solution."

As more storage is added to the NEM more participants will be scrambling to profit from the FCAS market, which Petkovic says is fairly shallow – but probably not for long. "Our grid is going through the biggest transformation in its history and as we get more dispatchable ageing generation coming out of the market – like coal and eventually gas – then you grow the need to be providing frequency control services."

The demand for electricity must be matched by supply every second of the day, and it's the FCAS services that provide that balance. "When we go to very much higher levels of wind and solar that we can't control, because they are weather-dependent, then balancing the grid becomes a bigger challenge," she says. "That's where frequency control services are going to have an increasing



Working with Tesla, Hornsdale owner Neoen showed how quickly a battery project can be delivered.

Batteries have limited capacity and an operator's success at making profits will rely on its ability to predict market prices and respond.

role in the market. There will be a greater need for storage as more dispatchable generation naturally comes out of the market."

Petkovic won't provide an estimate for storage capacity she thinks would suit a grid where wind and solar dominates other than to say it's more than is currently planned. "A lot of people are worried whether the pipeline is full, and the simple answer is no, it isn't."

EcoGeneration's Solar Map of Australia 2020 showed more than 29GW of storage projects over 10MW are in various stages of planning across the country, including Tennant Creek (10GW), Snowy 2.0 (2GW), the Battery of the Nation (1.7GW), Goyder South (1.8GW) and Lower Wonga (1GW).

FIVE-MINUTE SETTLEMENT IMPACT

Batteries have limited capacity and an operator's success at making sustainable profits will rely on its ability to predict the next 24 hours of market prices, say, and respond. "It's very different to have an opportunity versus actually being able to capture it," Petkovic says. Tesla's auto bidder system appears to be on top of things but as more storage is connected to the grid the riches will most likely flow to those with the best trading software. "The accuracy of your trading models is going to be a huge determinant of revenue."

The introduction in July next year of the Australian Energy Market Commission's five-minute settlement rule change will bring more opportunities for batteries to earn revenue than the current system, where prices over six 5-minute blocks are diluted over 30 minutes. Batteries' ability to respond within a hundred milliseconds will bring the possibility of them beating gas generators to market to reduce the amount of real inertia in the system, which bodes well for their value in a low-inertia grid dominated by renewables.

Huge pumped hydro projects such as Snowy 2.0 (2GW) and



Pumped hydro is waiting in the wings as investors weigh their options.

Tasmania's Battery of the Nation (1.7GW) are suited to longer range storage, perhaps inter-seasonal. "We'll need these assets because ultimately we have to decarbonize our energy system," says Brooker at the CEFC. But having such massive projects looming on the horizon will make it harder to assess other storage projects in the meantime.

SOLVING LOCAL PROBLEMS

As more and more homeowners and businesses turn to rooftop PV, a trend that shows no signs of slowing, DNSPs have work on their hands managing network capacity. Some proponents in the industry are suggesting the task of using storage at this smaller scale – suburb to suburb, street to street – is cheaper and more efficient.

"That's where there will be more of a role for distributed storage, whether that's behind the meter in homes of businesses or at a neighbourhood scale," says Sturmberg, whose team at ANU is looking at the possibilities for neighbourhood-scale storage.

"Network capacity is the unique thing you can get from neighbourhood-scale storage and behind-the-meter storage that you can't get from utility-scale or Snowy 2.0."

It may be easier to manage one suburban battery than a virtual

It may be easier to manage one suburban battery than a virtual power plant of up to thousands of connected assets.

power plant of up to thousands of connected assets, where the local level of density of connected customers' systems dictates the success of a VPP managing network capacity, he says. A VPP that can't recruit enough battery owners in areas where there are network capacity issues won't be effective. Nevertheless, at the CEFC Brooker is confident that VPPs can calm the effects of high solar penetration and deliver benefits to all consumers in affected areas.

"These systems are really very powerful, very flexible, able to provide a lot of services," Brooker says. "Cost is still an issue, but cost will come down."

In Melbourne, United Energy has installed two 75kWh batteries up poles in suburbs about 20km south-east of Melbourne's CBD. The solution will make the most of surplus solar that is exported to the grid around midday, when voltage levels can rise on feeder lines where PV is popular with homeowners. The company says pole-mounted batteries on its low-voltage network will support up to 150 homes and businesses with stored energy.

Larger community storage solutions are proving themselves elsewhere around the country.

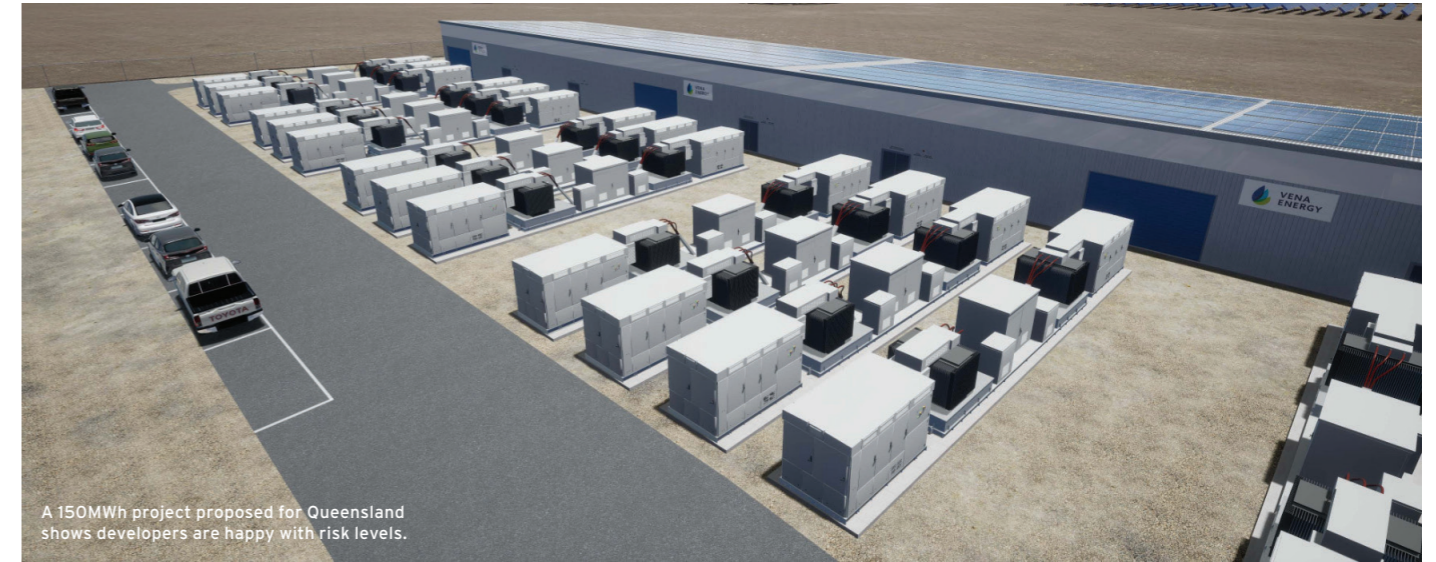
At Alkimos Beach, about 40km north of Perth in Western Australia, the land titles for a Lendlease development of 937 properties included a caveat that all residents must install a solar PV system of at least 1.5kW capacity. To cut the amount of solar energy that would be exported to the grid during the daytime, local network Synergy has signed 117 residents up to trial how a 1.1MWh grid-connected lithium-ion battery would optimise the use of their PV systems and cut energy bills – without having to resort to a household-owned behind the meter battery.

Synergy is able to control the charging and discharging of the battery, generally charging during the day and discharging during peak times. On average the battery is charged and discharged twice a day and draws about 270kW during charging periods, Synergy says. The Alkimos community is the first residential community to achieve a 6 star green star rating and residents are saving \$493 a year on energy costs on average.

BESS'LL FIX IT

In South Australia, ElectraNet's 30MW/8MWh large-scale battery at Dalrymple substation demonstrates how energy storage can strengthen the grid and improve reliability for the lower Yorke Peninsula. The Battery Energy Storage System (BESS) works with AGL's 90MW Wattle Point Wind Farm and rooftop solar PV to provide back-up power in the event of any interruption to supply from the grid. As the first transmission grid-connected battery in the NEM it is providing regulated and competitive market services, says ElectraNet group executive asset management Rainer Korte.

"In its first year of operation, the Dalrymple BESS experienced several planned and unplanned transmission network outages requiring it to supply the local 33 kV distribution system to successfully maintain customer supply for up to seven hours. The



A 150MWh project proposed for Queensland shows developers are happy with risk levels.

BESS operated successfully to seamlessly switch from grid-connected to islanded operation without impacting on customer supply," says Korte. "In addition, the BESS has successfully ridden through network fault events with its measured voltage, active power and reactive power response in line with design and technical performance expectations. The BESS responds almost instantly to the system voltage depression during a fault and injects a significant amount of active and reactive power into the network to support network voltage recovery."

ElectraNet leases BESS operation to AGL who uses the BESS to provide competitive market services. The two market revenue streams for the BESS utilised in the first year of operation are energy arbitrage and provision of FCAS services to the market. In this period, the majority of revenue earned from the BESS was through provision of FCAS services, ElectraNet says.

"Energy arbitrage or time shifting of energy is one of the market services the BESS provides, but to date the value delivered by this service has been relatively minor," says Korte. "The greatest value to date has come from the BESS providing improved network reliability and security and FCAS services."

Customers on the lower Yorke Peninsula are experiencing a significant improvement in their reliability of electricity supply.

WE CAN'T DO WITHOUT STORAGE

It isn't just networks and energy retailers who are getting behind storage, with the West Australian government backing community batteries in its Distributed Energy Resources Roadmap released in April. The strategy document sets out a plan for a future where rooftop solar and batteries are the dominant source of energy to be shared among neighbours.

Community "Powerbanks" distributed at a neighbourhood level will allow customers to store excess solar electricity generated during the day and withdraw it at night or share it among local residents, whether they own solar or not. This way, networks can manage the grid and reduce grid costs so that savings flow to all customers, including renters.

There are questions around ownership and operation, as the regulations around operation and what services a battery can deliver vary if the asset is owned by a retailer or network. The industry seems to be settling on the model where networks own batteries which are leased to retailers, says Sturmberg at the ANU. "The logic is the network knows where it would be of greatest value to have a battery to manage network capacity and energy security," he says.

As coal rides into the sunset it's obvious that storage is essential in a renewables-dominated grid. We can't do without it. eco



The Dalrymple battery works with local solar and the Wattle Point Wind Farm to provide back-up in the lower Yorke Peninsula region.

HOW ELECTRANET'S DALRYMPLE BATTERY RESPONDS AT SHORT NOTICE: ACTIVE POWER, REACTIVE POWER, JUNE 4, 2019

