Introduction

At one level it doesn't seem like much has happened this quarter. The May monthly inflation reading in the US was 0.1% softer than expected and so US bond (and equity markets) have rallied. The corresponding Australian reading showed a rebound in inflation and so rates have sold off here. Nvida earnings were up 18% on the quarter and 262% for the year – with its share price going parabolic. As infrastructure investors – who are backing projects with 30+ year operating lives – this all feels like noise. Hopefully the mix of articles we have for you this month provides some longer-term issues to think about.

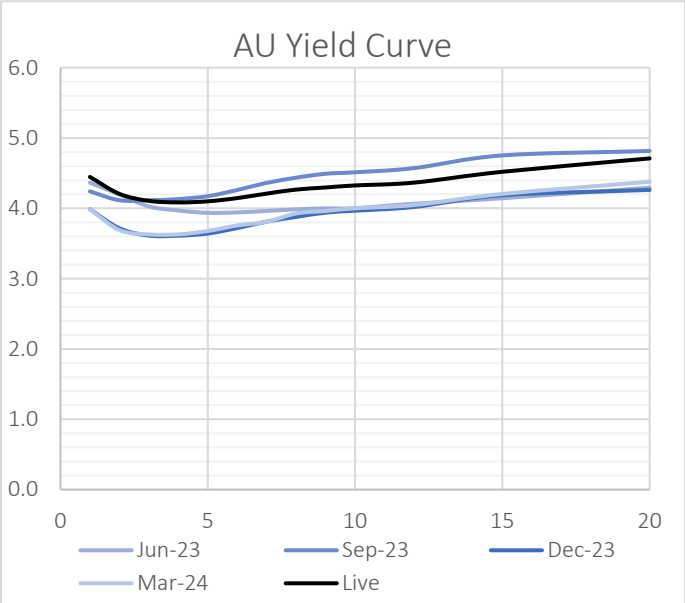
The first article in this quarter's newsletter is an in-depth analysis of inflation, bond rates and cycles. Following this are three articles that highlight there's never a boring day in the Australian energy market. We discuss the motivations behind the Federal opposition's new Nuclear Energy policy (whilst trying not to get too political!), our theories on how the 5GW wave of batteries due to come online soon will impact the National Electricity Market and finish off with an in-depth examination of the unique mechanics of (negative) electricity pricing in Australia.

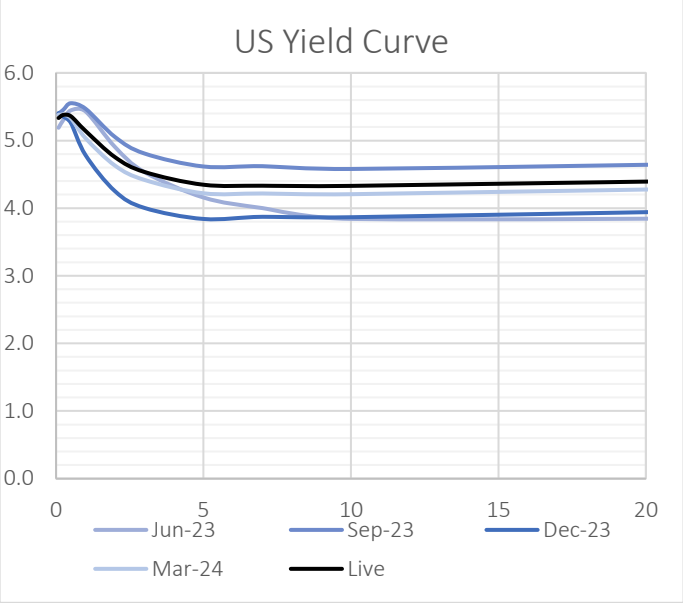
Markets Update

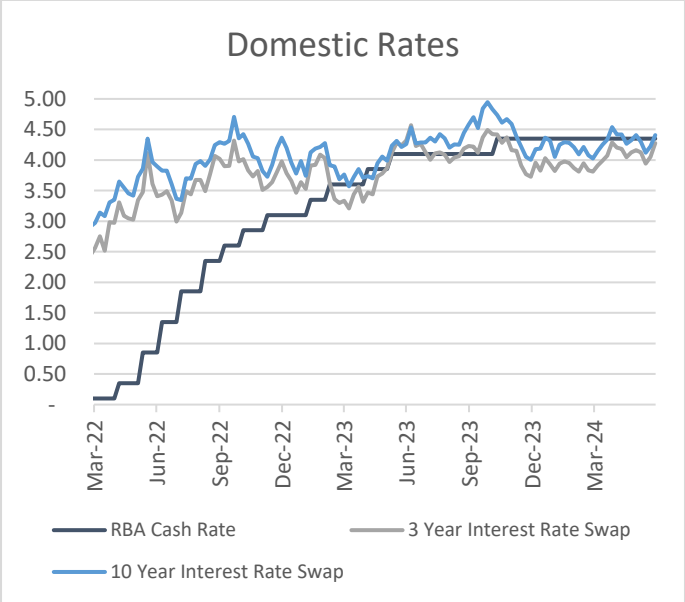
In this quarter, inflation in the US seems to be falling without major adverse impact on the US economy, with unemployment remaining low and economic growth continuing to be stable. However, at over 3%, it remains materially above the Federal Reserve's 2% target. As a result, the Fed has continued their cautious approach of keeping the Federal funds rate target steady until they are confident that inflation is moving back down to the target. They have also continued reducing their holdings of Treasury securities and agency debt and agency mortgage-backed securities. The Fed has not altered rates since July 2023, and the most recent inflation print casts some doubt over the extent of rate cuts in 2024.

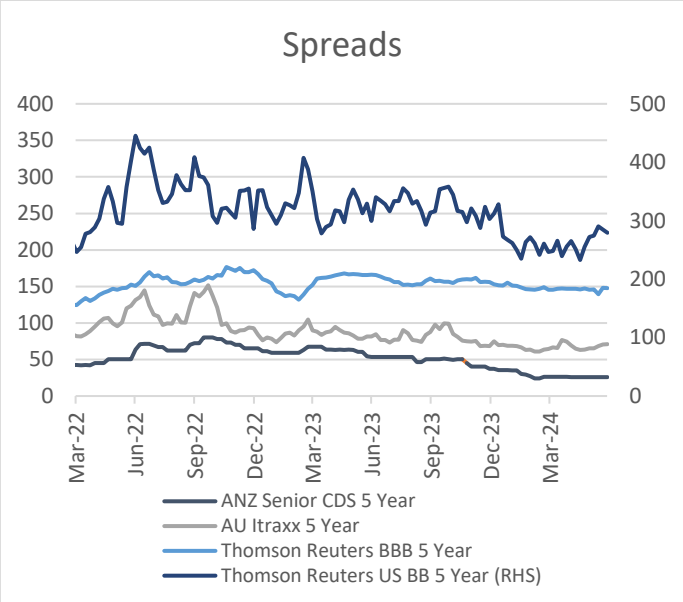
In Australia, last quarter, the positive news of the inflation movement towards the target band was overshadowed by movements in oil prices and geopolitical shocks to freight routes, and how these would affect the forthcoming inflationary numbers. These concerns have somewhat materialised, given the monthly CPI rose 4% in the 12 months to May 2024, up from 3.6% in April according to the ABS. The most significant contributors to the annual rise in May were housing, food/beverages and transport (particularly petrol prices). Another factor keeping inflation high is the strong labour market, with unemployment rising at a slower-than-expected rate to 4%, and annual wage growth in March remaining above 4%.

Overall, the RBA expects it will be some time before inflation is sustainably within the 2-3% target band (likely the 2nd half of 2025), and as discussed previously, believes keeping the cash rate elevated compared to previous years is important to reduce inflationary pressures. As a result of higher-for-longer interest rates, sticky inflation and the possibility of additional rate hikes, the Australian yield curve has jumped 40 bp.









Source: Refinitiv Eikon

New issuance and refinancing

Detailed below is publicly available infrastructure debt issuance for the quarter:

Date	Borrower	Instrument	Size ($m)	Term (Yrs)	Pricing (bp above BBSY)
5/4/24	NSW Electricity Networks Finance Pty Ltd (Transgrid)	Loan	1,700	3, 4, 5	
9/4/24	Pacific Energy	Loan	350	5	
10/4/24	Northern Territory Airports Pty Ltd	Loan	940	3, 5, 7, 10	
17/4/24	Hallet 4 Wind Farm	Loan	340	6.7	
26/4/24	Pisa Acquisition Finance Co Pty Ltd	Loan	750	7	160
29/4/24	Akaysha Energy	Loan	250	3	125
6/5/24	Tilt Renewables	Loan	750		160
8/5/24	Auckland Airport	Loan	NZ 250	6.5	100*
9/5/24	Stack Infrastructure Australia (Palmers Road) Pty Ltd	Loan	775.3	5	
14/5/24	NorthConnex Company Pty Ltd	Loan	205	12	
15/5/24	Viva Energy Holdings Pty Ltd	Loan	1,000	4, 5, 6	160, 170, 180
17/5/24	Towers Infrastructure Financing	Loan	1,500	3, 5, 7	105, 125, 145
20/5/24	Lane Cove Finance	Loan	240	4, 7	
23/5/24	Beach Energy Ltd	Loan	300	3	150
23/5/24	Diamond Infraco 1 Pty Ltd (IFM Investors)	Loan	1,000	3	
23/5/24	Origin Energy Ltd	Loan	1,700	4, 5, 7	130, 140, 160
24/5/24	Intellihub	Loan	440	6, 7, 10	175, 185, 215
27/5/24	Live-In Learning Finance Pty Ltd	Loan	208.4	3	
30/5/24	Flinders Port Holdings	Loan	200	10	160
30/5/24	Intera Fin Co Pty Ltd (Interra Renewables)	Loan	258	10	
31/5/24	CPE Funding No. 5 Pty Ltd (Cleanpeak Energy)	Loan	90	2	
31/5/24	UTA Power Networks Finco Pty Ltd (Utilities Trust of Australia)	Loan	600	5	
13/6/24	GDI (EII) Pty Ltd	Loan	301.3	3, 5	
13/6/24	Origin Energy Ltd	Loan	300	7	
30/6/24	NSW Electricity Networks Finance Pty Ltd (Transgrid)	Loan	250	10	175

*over semi-annual mid-market swap rate

Source: LoanConnector, Refinitiv Eikon (Infrastructure 360), PFI

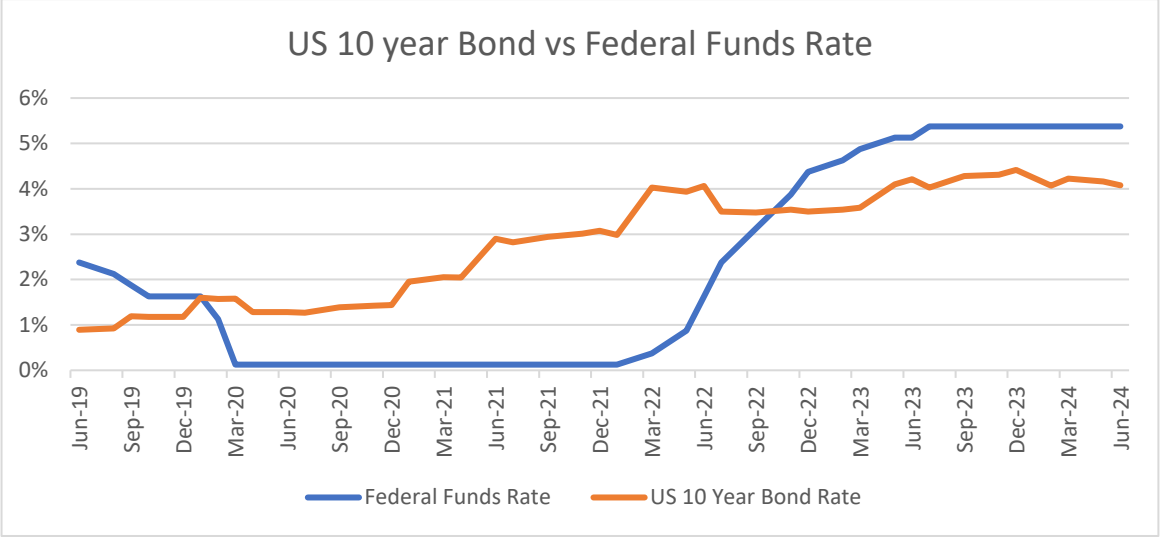
Equity and other news

- Naturgy and Wren House Infrastructure have decided to cancel the planned $4 billion sale of GPG Renewables Australia after collecting first-round bids for the 4.7GW renewables platform. GPG has instead opted to undertake a $1.6 billion debt financing to both refinance existing facilities and to fund new projects.
- Genex has entered into a binding Transaction Implementation Deed with Electric Power Development Co., Ltd (J-POWER) to acquire all ordinary shares on issue of Genex for A$0.275 in cash per Genex Share. The Deed also contains an alternative structure, under which J-POWER will provide an on-market takeover offer for all the Genex Shares for A$0.270 in cash per Genex Share.
- Shizen Energy Group has acquired exclusivity over a 200MW pipeline of solar assets in NSW and Victoria alongside development partner Bison Energy, and is seeking equity backers.
- Aware Super, Macquarie's The Infrastructure Fund, and Morrison & Co's Utilities Trust of Australia have leveraged their pre-emptive rights to buy the entirety of the Natwest's 20% stake in NSW Land Registry Services. All three have participated on a pro rata basis.
- Superannuation funds are selling out of Utilities Trust of Australia, the owner of stakes in monopoly infrastructure assets including Transgrid and ElectraNet.
- Conscious Investment Management has agreed terms to provide 100% LVR debt financing for charity Greening Australia's acquisition of an agricultural property in NSW, to be paid back via sale of carbon credits.
- Brookfield is seeking to acquire Windlab, which is 75% owned by Squadron Energy and 25% by Federation Asset Management.
- Locality Planning Energy received an unsolicited takeover bid from private equity group River Capital.
- Brookfield has entered exclusive negotiations with Neoen shareholders to acquire an approximately 53.32% stake in Neoen. The acquisition price represents a 43.5% premium on the 6-months volume-weighted average price, and implies a total equity value of 6.1 billion euros (approximately A$10b).
- DIF Capital Partners and Cbus are selling a combined 80.1% stake in Bright Energy Investments. The sale process includes DIF's stakes in three operating solar assets and two BESS developments in the NEM. Total capacity sold is 1.1GW, and the expected EV is $1 billion. DIF is selling due to an upcoming fund redemption deadline
- Cleanpeak energy has signed a six-year PPA with Insurance Australia Group for output from the 1.5MW community-funded Grong Grong solar farm. The PPA covers 20% of IAG's electricity consumption.
- Metis Energy has signed a PPA with SmartestEnergy for generation from the 94MW Gunsynd solar farm.
- Copenhagen Infrastructure Partners (CIP) has acquired a majority share in Elgin Energy which has a 15 GW pipeline of solar and BESS projects in the UK, Irish, and Australian markets.
- Origin Energy has acquired the 1.5GW Yanco Delta wind + 800MWh BESS development project from Virya Energy in a deal worth $300 million.
- ZEN Energy has signed 10-year offtake deals with Ratch-Australia for 20.6% of the output/LGCs from the 227MW Collector Wind farm and 100% of the output/LGCs from the 33MW Starfish Hill Wind Farm. The latter is one of Australia's oldest wind farms, built in 2003.
- Singapore-based renewable energy fund manager SC Oscar has acquired New Zealand solar project developer Rānui Generation. The acquisition includes four development-stage NZ solar projects with total capacity of about 131 MW. The total investment in the portfolio is approximately $203 million.
- Legislation to establish the Energy Security Corporation has passed in the New South Wales parliament and will be seeded with $1 billion for accelerating private clean energy investments.

Source: AFR, PV Magazine, RenewEconomy.

Inflation, bond rates and cycles

It is almost a year since the Fed last raised interest rates and signalled a neutral bias to rates. During this period, bond rates have been broadly range-bound, with fluctuations backwards and forwards with data points on the progress of taming inflation. Equity markets have been on a tear since the "Powell Pivot" in October last year. Within this, over the past six months, market expectations of the timing of the first US rate cut have been gradually pushed out from early 2024 (and six cuts this year) to late this year or maybe not till 2025 whilst long run bond rates remain relatively stable between 4.0-4.5%.



Source: Refinitiv Eikon

From Infradebt's perspective, one of the surprises of 2023-24 is that the Fed has raised interest rates by more than 5% over 2022 and the first half of 2023, and there is seemingly so little pain to show for it.

One theory on why both US inflation and economic growth have been stronger than you might expect is due to the hyper financialisation of the US equity markets. That is, rather than the stock market following the economy, the endogeneity is the other way around, and financial markets lead the economy. This phenomenon has been coined the theory of reflexivity and is a school of thought advocated by George Soros.

The theory is that investor perceptions can drive economic fundamentals in a self-fulfilling feedback loop. This feedback loop can be both on the positive and negative side. At the moment, the prospect of easing monetary policy is pushing equity markets higher and causing a positive wealth effect, stoking economic growth and inflation, which delays the path of rate cuts.

Applying this logic to the macro environment of the past year we can interpret the market tea leaves as the following. The late 2023 Fed pivot to neutral prevented a recession and sees the US economy continue to outperform through the first half of 2024. Investors interpreted the Powell Pivot as a signal to bid stock prices up on expectation of declining discount rates. This in turn creates a positive wealth effect through the economy stimulating demand. Inflation then overshoots expectations, and the bond market gets twitchy.

What does this mean for investors? We are probably in a short-term equilibrium where the economy is slowing and inflation is getting under control. Equity markets will rally and give growth another boost. If inflation surprises on the upside and cuts continue to get delayed, we will see stock prices fall which may hurt the actual economy. This delicate balancing act could go on for a while with the ultimate goal of the Fed to engineer a soft landing – that is get

inflation under control without causing a recession (and a steady unwinding of zero rate induced asset bubbles rather than an immediate unwind).

While every tightening cycle is different, history has shown that rising rate cycles don't necessarily lead to an immediate stock market correction or recession. Since the 1990s the average length between the initial rate increase and the start of a bear market has been 3.5 years and for a recession the average time is 4.1 years. The current rate rise cycle started in March 2022 and based on previous cycles we could be looking at the bear market or recession in 2025 or 2026.

So what is the path of inflation and rates from here? There are basically three options:

1. The Fed pulls off the ultimate soft landing, with inflation slowing and rates coming down, but no actual recession. It is possible, but history suggests this is rare.

The other two options are:

2. the Fed wins on inflation but loses on growth; or
3. the Fed wins on growth but loses on inflation

If the Fed loses on growth the economy goes into a recession and unemployment rises. Increased unemployment takes heat out of the labour market and wage growth collapses to pre-covid norms. The key issue for equity markets – is that cyclical and consumer stocks exposed to unemployment would get hit by earnings downgrades. A less bullish equity market environment would see CEOs switch from growth to cost cutting, and this would reinforce the slowdown. Interest rate sensitive parts of the market would benefit from lower rates. The trick would be to find stocks whose earnings hold up in a downturn and also are long-duration and so benefit from lower rates. Energy and commodity prices would fall - as a recession hits underlying demand.

If the Fed wins on growth but loses on inflation, then inflation never gets back to 2% and at some point, post the US election, there is a realisation that inflation continues running at 3-4% and rates just aren't high enough to bring it under control. In this scenario, bond markets definitely (and equity markets probably) would crap themselves (a technical market term). At 4.2% the 10-year bond rate does not make sense if market participants thought inflation was going to be 3-4% long-term. The Fed would either need to launch a second hiking cycle or the bond market would do it anyway. This would be in an environment of incredibly high government spending (both Biden and Trump are big spenders) and could easily be the US's Liz Truss moment.

The challenge for investors is to stop focusing on the very short term (i.e., this month's CPI print and the market reaction to that) but instead to take a longer-term view and, in particular, to try and judge what the world will look like in 2025 and beyond.

The Nuclear Dog Whistle.

Fair warning, this article is more political than we usually like to be at Infradebt – but that is unavoidable because a return to the climate wars is the real issue at hand. The 'Nuclear' announcement is not about a technology, it's not about climate change or some vision for the future, the LNP nuclear policy is about winning the federal election next year.

Much ink has been spilt on the Coalition's recent announcement of their intention to build seven nuclear power stations across the country. The Coalition has also stated that, whilst committed to the 2050 net zero goals, they may step back from commitments to hit 43% emission reductions since 2005 by 2030 – as much of this reduction relies on decarbonising the electricity sector.

Many, far more informed people than myself, have done the analysis on nuclear as an option. They've discussed the merits from the perspective of the economics, the engineering, social and climate objectives. You might be surprised to learn that Nuclear isn't new in Australia – in the late 1960s the Federal Government started building a nuclear reactor in Jervis Bay. Shortly after commencement of construction, following a change in Government, the Australian Treasury completed a cost analysis review and found that Nuclear was twice as expensive as coal. So the Government pulled the pin and abandoned construction – today it makes for a fantastic large beachside carpark.

Australia's Last Nuclear Powerplant

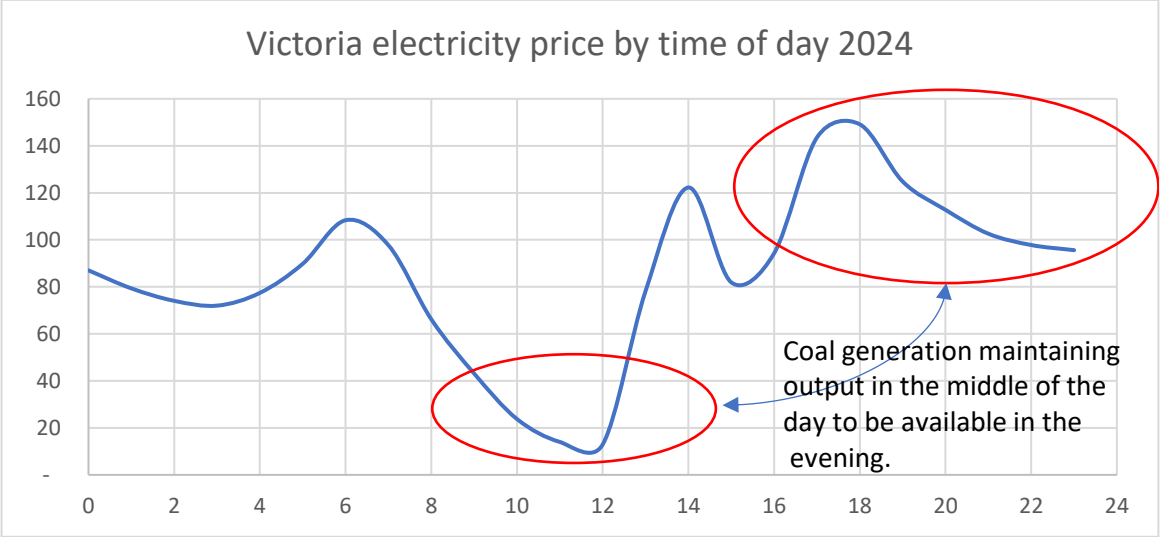
Source: Wikipedia

What I want to focus on is the investment environment in the short-medium term as a result of LNP nuclear policy initiative. Being an investor in renewables is hard – just see this quote from the CEO of Neoen – a renewables developer who have financed more projects to date than most in Australia:

'Mr Barbaro said returns for Neoen are typically in the "high single digits" – or low double digits for investors with less conservative assumptions – for projects that last 30 or 40 years. "This industry is certainly not for everyone, not for every investor – you need capital, you have returns that are not the highest." AFR, 24 June 2024.

This quote certainly doesn't surprise us. We've mentioned previously that much of the return (in NPV terms) that these projects expect to receive is in the back end of project lives (that is, in years 10-30). Renewables investors are effectively taking a view on what will be the new entrant cost of technologies they're competing against at each point in time over the life of their project.

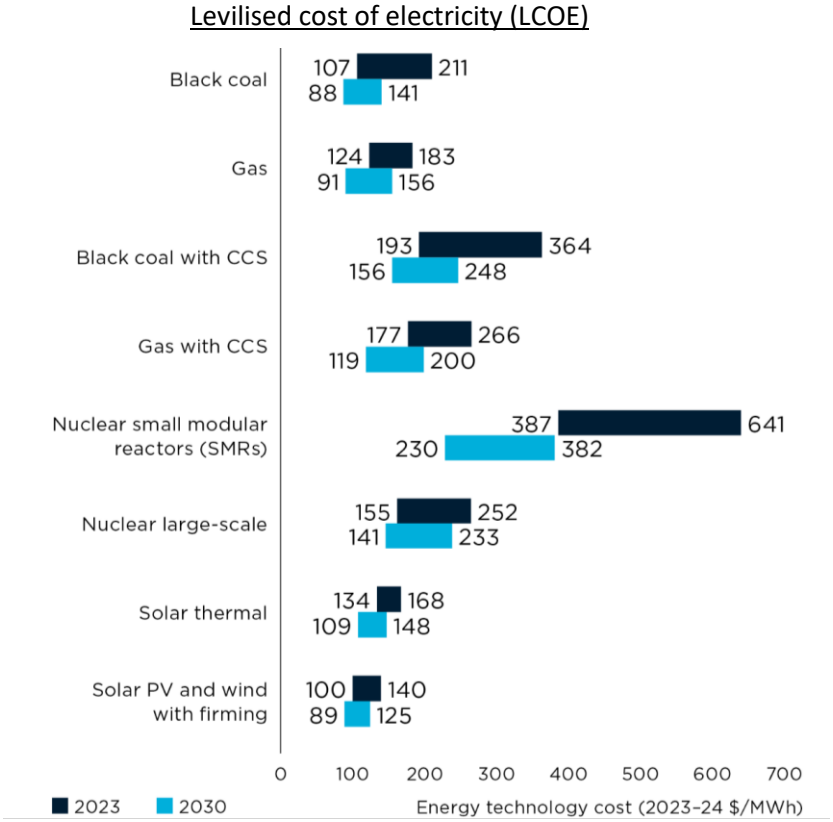
If the Government of the day plans to build, on balance sheet, largely inflexible generators (this is what nuclear is) what you have is a large, price-incentive, generator entering the market to supply a significant amount of capacity sometime around 2035. We actually have an indication of what such a generator looks like today – take the Victorian Electricity Grid for the last few months – brown coal generators cannot ramp up and down and so has to dispatch during the day to be available in the evening, so spot electricity prices regularly go negative during the middle of the day.



Source: NEM Review

So, moving back to the future (I'm showing my age), if I'm an investor and I'm relying on a certain energy price in years 15 plus of my project to deliver the required rate of return, how do I think about the potential for the entry of a large, price-incentive, inflexible generator entering the market and dispatching power at 'low cost'? Why should I take the risk and invest today?

If the Coalition really wanted to implement a 'firmed' 'reliable' 'emissions free' energy solution they might have been better to point to Solar Thermal. This is an established long duration technology (has anyone seen the movie Sahara?) and could be relatively quicky implemented relative to Nuclear and at a lower cost.



Source: CSIRO, GenCost 2023

My point is not to advocate or promote solar thermal, it's to point out that the LNP nuclear policy is about not doing something today.

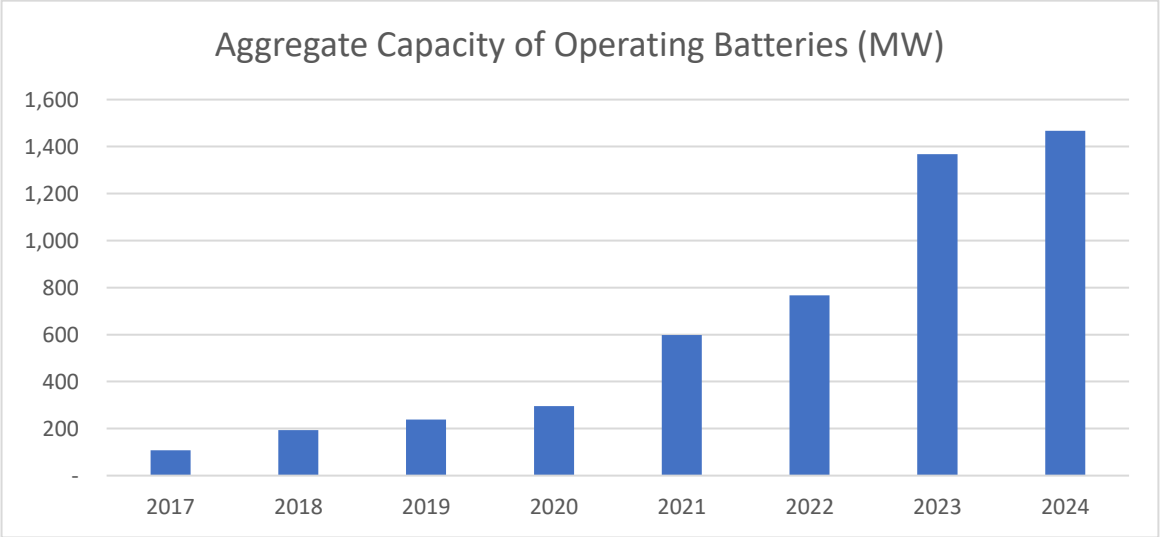
My thoughts – they will never build it. They never intend to build it. The point is not nuclear – the point is cost of living now, today. That's the 'dog whistle'. They'll centre the argument on energy bills implying that the rollout of renewables is the cause of price increases (narrator – it's not). The central narrative is that the cost of living is the fault of the current government, that socially progressive policies like the 82% target are the cause, that the solution is actually to do nothing today, for Australia to walk back on its CO2 reduction targets, to focus on something in the future that will never happen. This will likely resonate – we wrote about inflation and the cost of toll roads last quarter, this quarter the *villain* for cost of living is renewables. Nuclear won't fix it – but it was never supposed to – the key is to get you to focus on the cost of living.

And it may just well work……

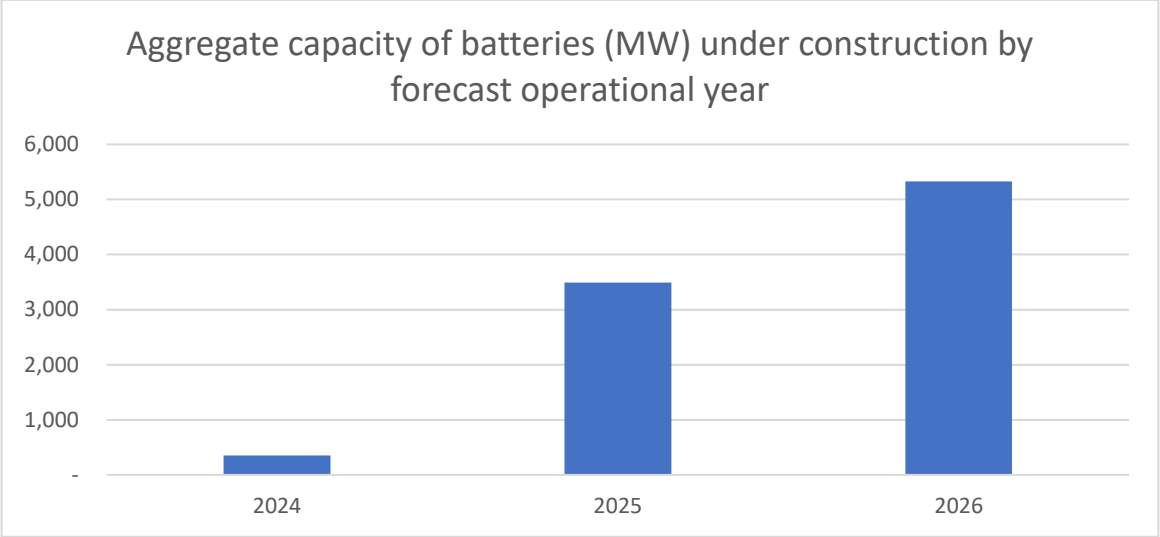
Batteries – Prepare for the wave

There are currently 16 large-scale operational batteries in the NEM with a combined capacity of 1.4GW. Starting in 2017 with Hornsdale Power Reserve, it has taken approximately seven years for utility-scale batteries to grow from mere 0.1GW to 1.4GW.

With increased volatility in the electricity markets and a push to replace retiring coal generators, batteries are having a breakout moment. There are an additional 5.3 GW of batteries under construction and expected to come online in the next two years. That is, operational batteries are about to triple and what's more scale involved is in the GW and so this will be meaningful within the overall electricity market. This article aims to provide a few pointers for investors to keep an eye on.



Source: AEMO



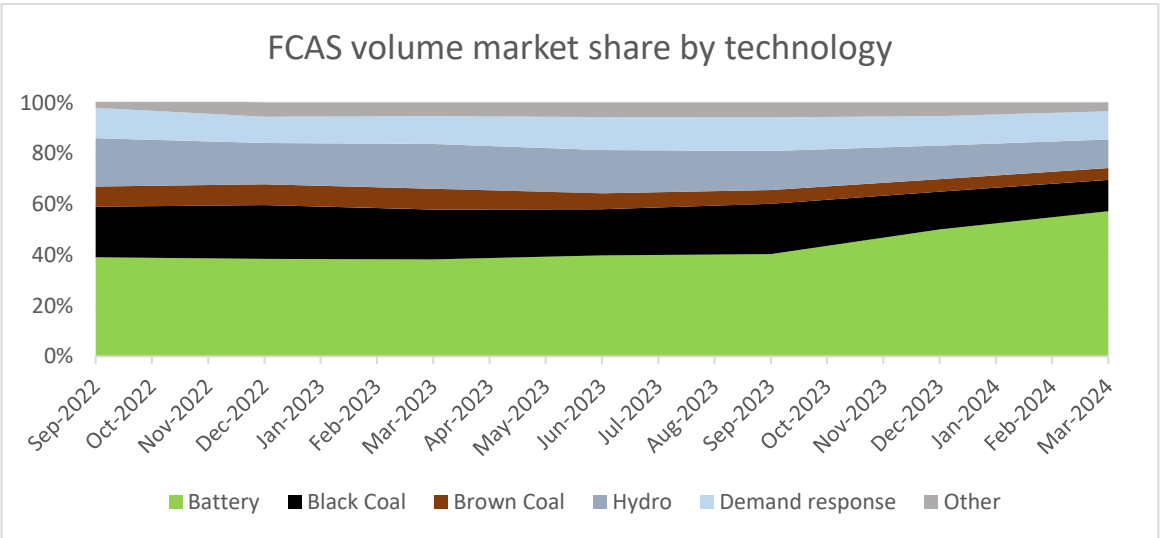
Source: AEMO

Frequency control and Ancillary Services (FCAS)

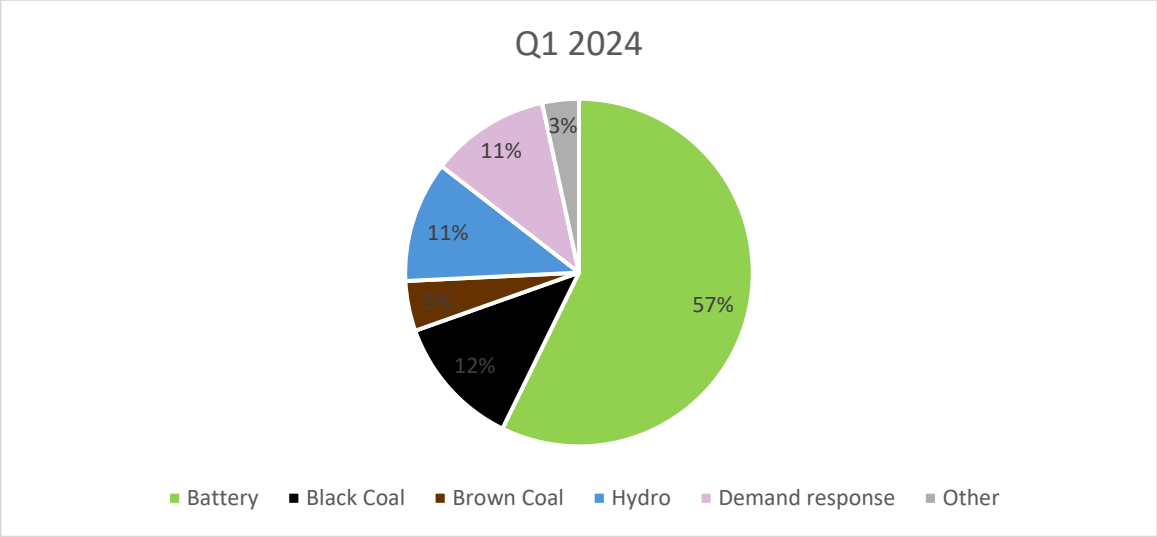
For most utility scale national electricity market connected batteries, revenues consist of two components:

- Arbitrage revenue. That is charging when electricity prices are low (typically at lunchtime, when solar is at its peak) and discharging when electricity prices are high (typically in the evening peak); and
- Frequency control and ancillary services (FCAS). This is providing frequency stabilisation and standby (i.e., contingency) generation and load to help the grid maintain frequency and balance demand and supply in real time.

Currently batteries compete with traditional FCAS providers (hydro and gas/coal) to provide FCAS. As batteries are more flexible than traditional fossil fuel generators, batteries have been able to capture FCAS market share over time. As seen in the chart below, batteries now provide more than 50% of FCAS in the NEM. This market share is expected to grow as more batteries come online.



Source: AEMO Quarterly Energy Dynamics



Source: AEMO Quarterly Energy Dynamics

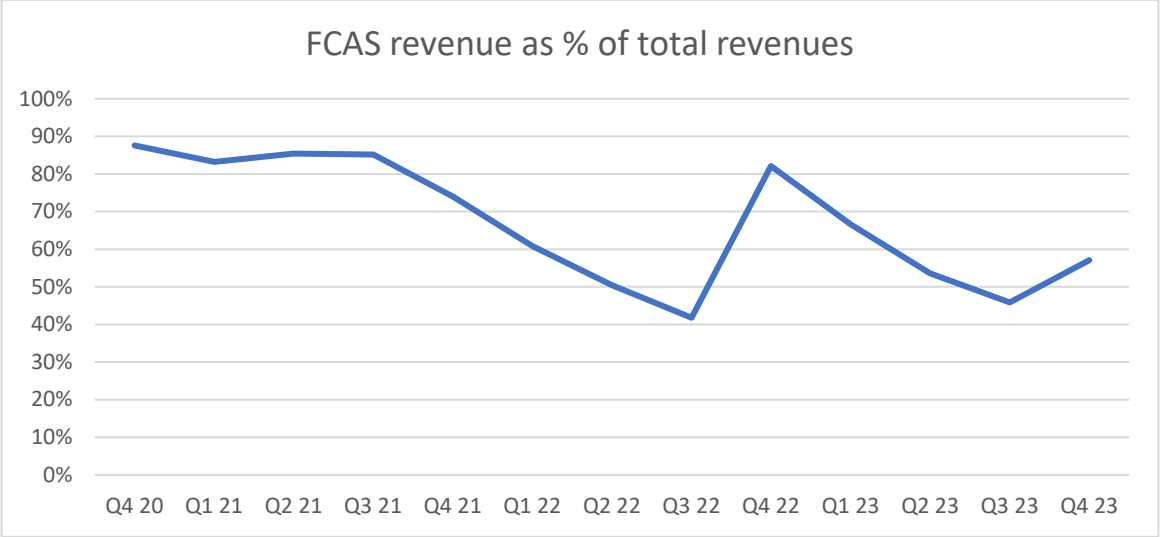
The FCAS market is overall a small market (1-2GW across all 10 markets) compared to the energy market (20-40 GW). There are two types of FCAS in the NEM:

- **Regulation FCAS** is the correction of the generation/load balance in response to minor deviations in load or generation. This market is managed by AEMO and market participants respond to a signal from AEMO to increase output (if grid frequency is falling because demand exceeds supply) or to decrease output (if grid frequency is rising because supply exceeds demand). The future demand for regulation FCAS is directly correlated with the renewable penetration in the grid. As there is more variability in supply, the demand for regulation services will increase.
- **Contingency FCAS** (known as system stabilisation in other markets) refers to the correction in generation/load balance following a major contingency event such as the loss of a generation unit, loss of a major industrial load or transmission outage. AEMO sizes contingency FCAS procurement to match the largest single points of failure (i.e., largest generation unit, largest interstate transmission line and largest load). That is, the minimum amount of contingency raise will be sized to ensure there is sufficient additional supply (or demand) available to match an outage at the largest generator/load/transmission load. The future demand for contingency FCAS will be dependent on how this changes.

While predicting the rate of growth of FCAS demand is a bit of a dark art – we can be very confident that over the next couple of years:

- There will be many more operating batteries than the size of the total FCAS market; and
- Batteries are growing much faster than FCAS demand.

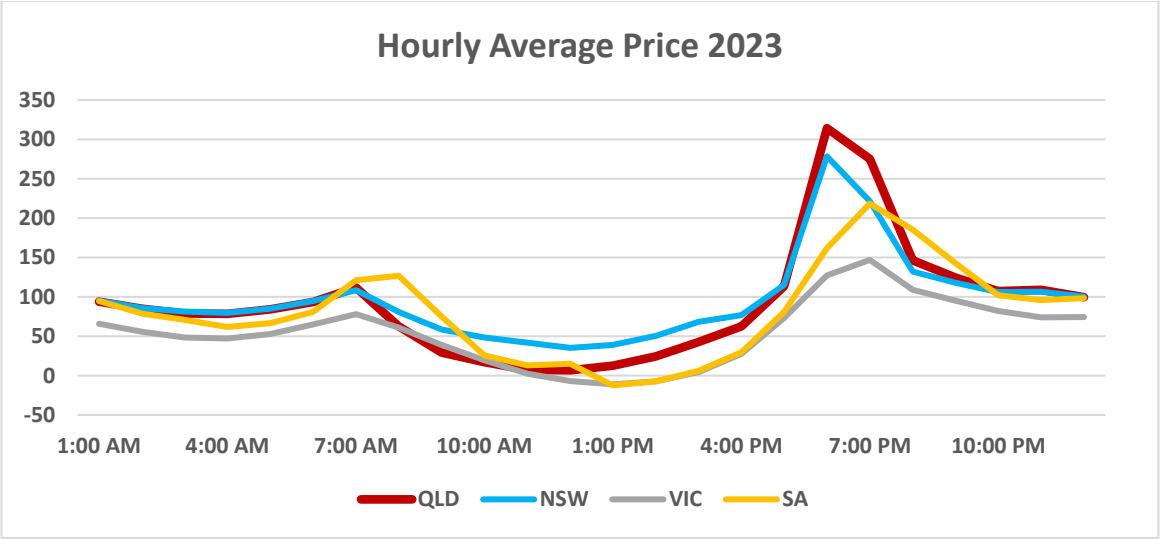
Simplistically, this means FCAS prices are like to fall and that FCAS revenues inevitably must become a smaller share of battery revenues – that is, batteries must rely more on arbitrage revenue.



Source: AEMO Quarterly Energy Dynamics

Charging Implications

The second question we are often asked is whether this flood of batteries is likely to bid up electricity prices during the middle of the solar day. The 'hopium' from utility scale solar plant owners is that batteries are the cure for the disease of negative prices – see duck curve on the next page.



Source: NEM Review

Batteries definitely can profit from negative prices. For example, in Q1 2024 alone, charging at negative price intervals contributed to $3.5 million of additional revenue for batteries.

But this isn't the same as saying batteries will force daytime prices back up.

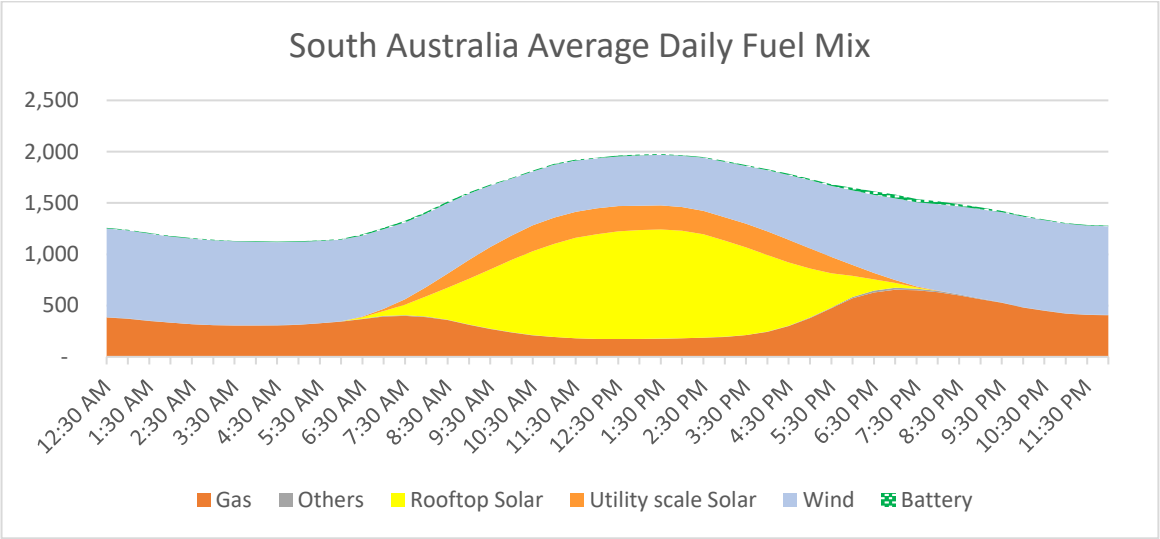
We view this as an incremental demand vs incremental supply question. That is, charging by batteries definitely adds incremental demand to the middle of the solar day. However, for prices to rise, incremental demand needs to exceed incremental supply. In this context, in the absence of coal plant closures, the biggest driver of incremental supply will be additional rooftop and utility scale solar. Rooftop is running at 2-3GW per year. While this sounds OK, relative to the scale of batteries, it is important to recognise that rooftop solar generates electricity for four to six hours during the day – while most batteries being built today only have two hours of duration. Thus, you would actually need to build twice as many batteries as solar to see a net daytime demand increase.

This isn't happening yet.

For solar plant owners hoping for the end of negative prices, there are two things they need, coal plant closures (which is much more effective in reducing daytime generation) and/or lower LGC prices (which reduces the incentive to bid negative).

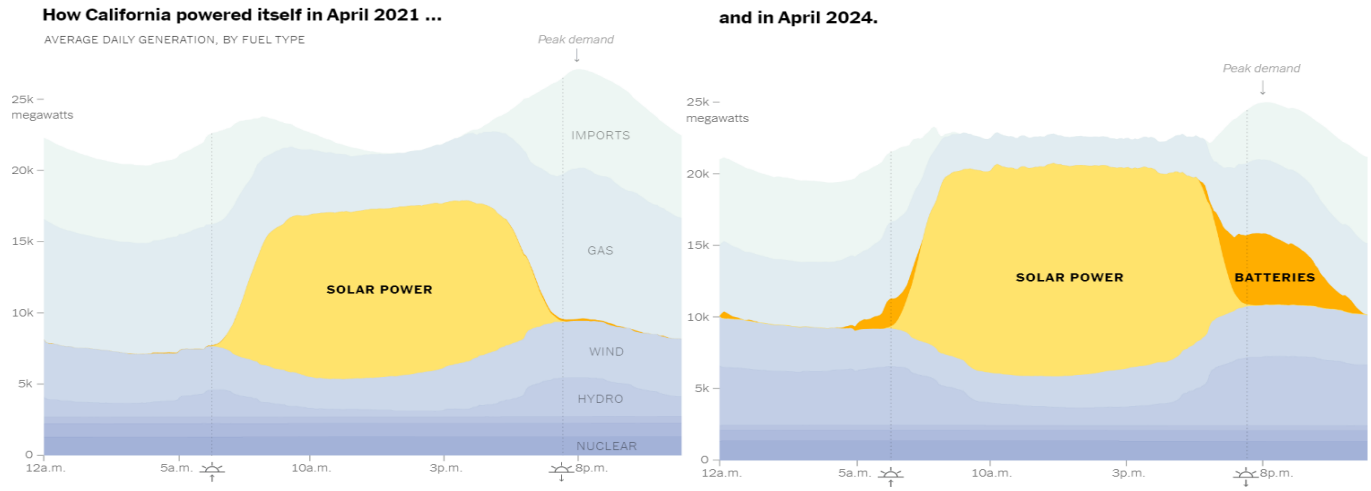
Discharging Into the Peak

As seen in the demand duck curve charts above, the evening peak price spike is actually quite short. That is, it only lasts for an hour or two (and sometimes much less). The market share of batteries as an evening peak supplier is immaterial at the moment. Most of the evening peak demand is supplied by coal, hydro and gas (see incredibly thin green slice in chart below).



Source: NEM Review

However, the future of NEM with new batteries would look like the Californian grid which has approximately 10 GW of utility scale batteries. In a matter of three years, batteries have transitioned from being non-existent in the Californian grid to becoming a major supplier of peak hour energy. During the course, there have also been instances where batteries became the largest source of peak supply to one of the world's largest grids.



Source: The New York Times

Batteries in the NEM will follow suit, evening peak supply share would increase as more batteries come online. As most new batteries have at least two hours of duration, there will be immense competition to dispatch during the relatively short peak price window. We expect to see peak flattening, with competition between batteries seeing the peak price spread over a longer period (but probably at a lower level). This will incentivise the construction of longer duration batteries – for example four hours.

In summary, the next few years are going to be a period of rapid change for batteries, and key trends to watch are:

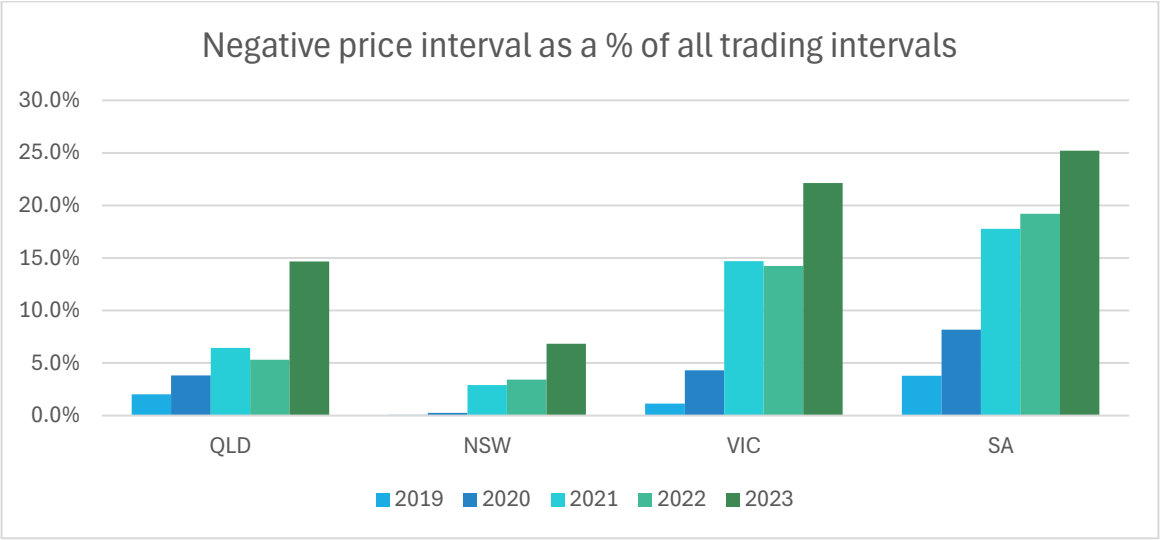
1. The past few years aren't going to be a good guide of what the next few years brings;
2. There will be transition from FCAS to arbitrage as the key source of revenue/profit; and
3. Batteries are going to switch from profiting from prices set by legacy generation, to having material impacts on the pattern of electricity prices.

I don't want to be negative …. but have you looked at electricity prices

The National Electricity Market (NEM) recorded its highest frequency of negative wholesale electricity intervals in the year of 2023.

Using South Australia as an example, in 2023 the wholesale electricity price was negative for a 25% of the time (34% during the December quarter last year!) and Victoria just under at 22%. For those who are not too familiar with the electricity market, this means for these periods, electricity generators paid electricity users (i.e., retailers and large industrial customers) for the right to dispatch.

Doesn't make too much sense? Let us dive into the how's and the whys of negative electricity pricing and its implications on generators and users.



Source: NEM Review

Negative prices 101

Generators bid to dispatch in the NEM on a five minutely basis and the bids are stacked from the cheapest to the most expensive. Bids can range from the market floor of -$1000/MWh to the ceiling of $17,500/MWh (July 2024). Subject to transmission constraints, generators with the cheapest bids are dispatched first, and the spot price is simply the bid price of the last marginal generator required to fill demand in that interval (price setter). The spot price will be negative if the price setter has a negative bid.

Why would generators bid negative?

Bids generally reflect the fuel cost to generate and the opportunity cost of not generating. The key drivers to the negative price bidding behaviour are as follows:

- Merchant Renewables. Renewable generators have close to zero marginal cost of generation and earn revenue on both electricity and Large Generator Certificates (LGC). Renewable generators will earn one LGC for each MWh of dispatch. LGCs are currently priced $40-$50 per unit/MWh thus it quite rational to bid a negative price as long as the negative electricity price is smaller than the value of the LGC. Given the clustering of renewable generation patterns, renewable projects often end up competing with each other to be dispatched and, hence, will bid at minus LGC.
- Electricity offtake. Most offtakes are structured as a contract for difference, where the offtake pays the generator a fixed offtake price on each MWh generated in exchange for receiving from the generator the wholesale market price for that generation. In the absence of a special clause providing for different treatments for negative prices (which are quite common, see below), this incentivises the generator to bid the market floor (that is, minus $1,000) to ensure they are dispatched.
- Minimum generation. Coal generators typically have to maintain a minimum level of generation to remain operating. To stay turned on, and be in a position to profit from evening prices, these generators must be dispatched to at least their minimum generation level, so will bid to the market floor on this level of generation to ensure this happens. They will bid higher prices, reflecting coal and its opportunity cost, on output levels above their minimum generation level.

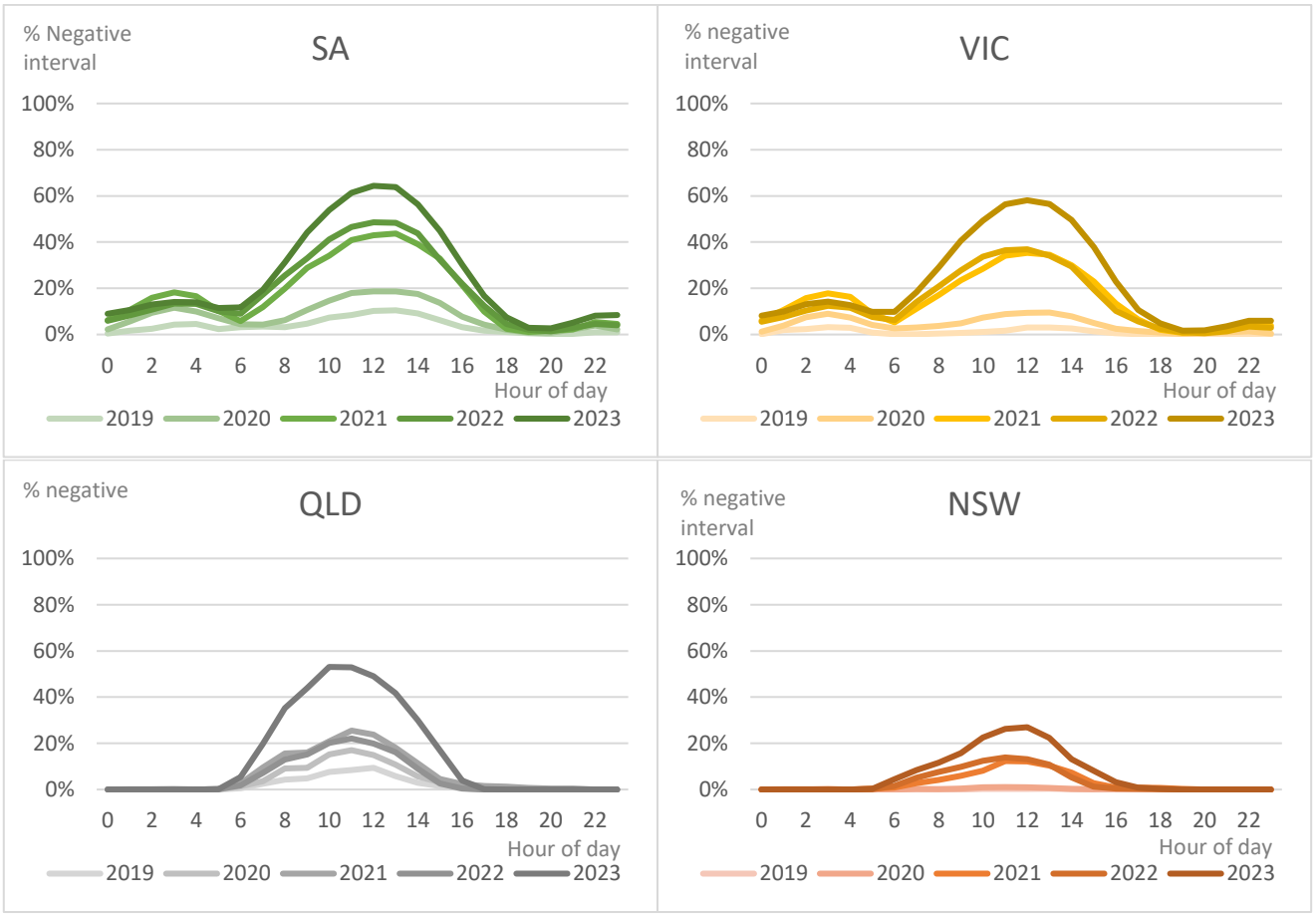
Why are negative prices becoming more frequent?

Negative prices usually arise when there is excess generation compared to load, and this is increasingly common due to the following:

- Renewables growth. The biggest driver of this change is the renewable transition. Excess generation clustered around periods with good solar/wind resources usually lead to negative prices. The 15GW of new utility scale renewable capacity added between 2019 to 2023 is the key driver of the change to the pricing dynamics. Renewables accounted for 37% of electricity generated in 2023.
- Falling operational demand. The rise in rooftop solar means that many customers no longer need to buy from the grid in the middle of the day (or even become net exporters) this is reducing the volume of electricity that needs to be purchase from utility scale generation.
- Strong green certificate prices. LGC prices have remained strong over the past few years.

Transition over time

Let's take a look at what has happened to negative prices in the NEM over the past five years. The graphs below capture the change of negative price intervals over time - the *x* axis is the 24 hours of the day, and the *y* axis is the percentage of time in that hourly trading interval the price is negative in that year.



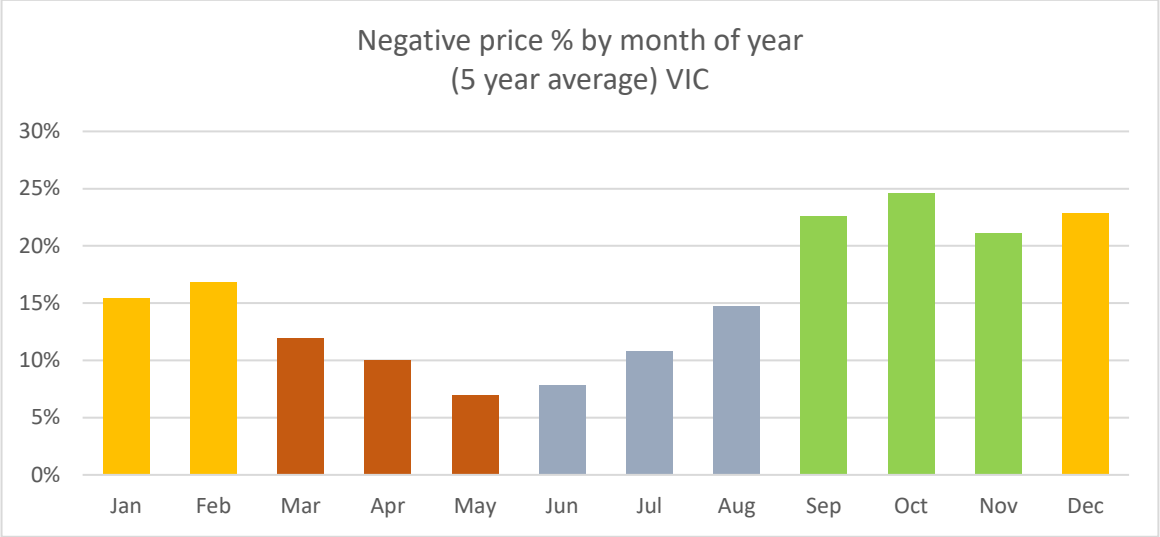
Source: NEM Review

Unsurprisingly the negative price interval rises and falls with the sunlight hours. It is clustered around noon when operational demand is at its lowest (thanks to rooftop solar). The bell curve actually mimics the solar irradiance curve quite closely.

The growth of negative price intervals has also been quite rapid. Over a period of five years, peak negative price percentage grew from 10% to 65% in South Australia. Despite NSW and QLD being the least affected states, they are also following the trajectory of SA and VIC at the current pace of renewable deployment.

Negative pricing by month of year

We've included a chart showing the five-year average of negative price intervals by month of year (colour coded by season – green is Spring, yellow is Summer and so on) in Victoria. Negative prices are most painfully felt in Spring (low load with good wind/solar), followed by Summer while they're at their the lowest in Winter (high load low irradiance).

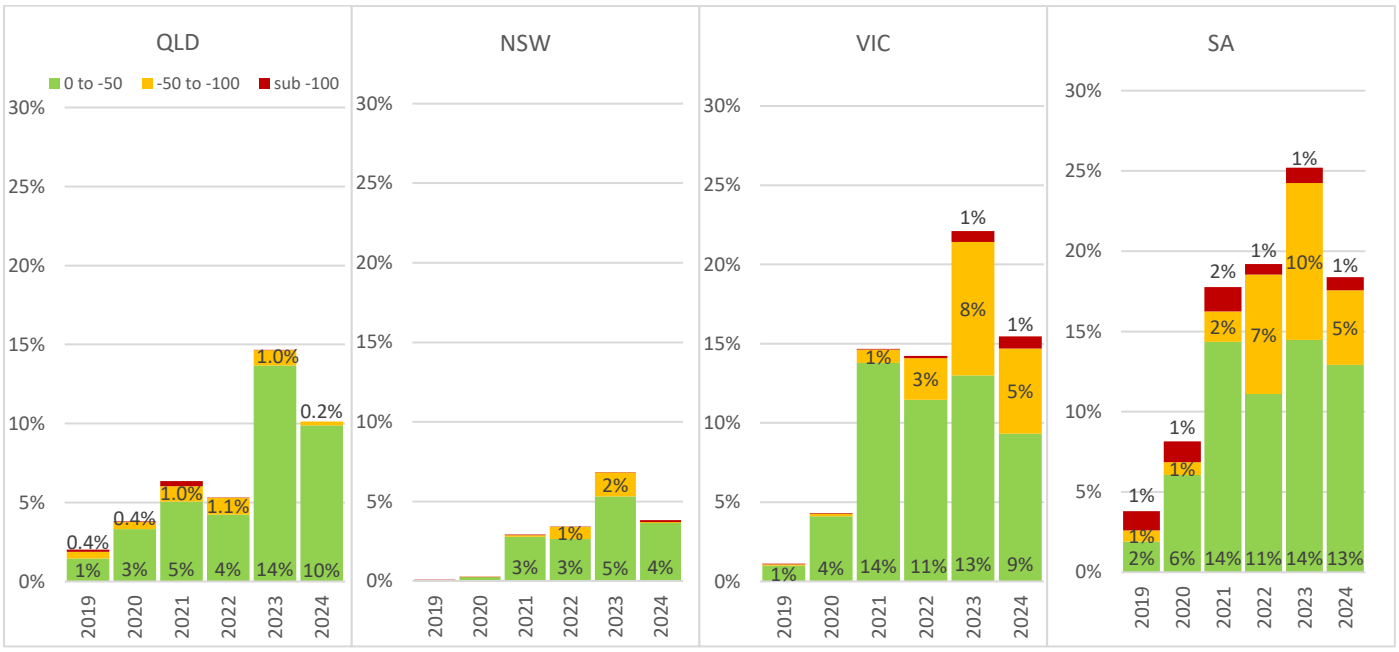


Source: NEM Review

How negative do they go?

The chart below shows the percentage of negative price interval by price band (green is between 0 to -50, yellow is between -50 to -100 and red is sub -100).

The majority of the negative spot prices are clustered around the $0 to -$50 band, which is roughly in line with the value of one LGC. This reflects the level merchant renewables are willing to bid down to secure the LGC value. For the windier states the prices below -$50 is also becoming quite frequent. Once LGC prices converge to zero we are expecting the level of negativity to reduce.



Source: NEM Review

What's happening next?

Here's a take on what this implies and what we think will happen over the next couple of years.

- Batteries. The current price dynamics gives rise to plenty of opportunities for batteries to enter the market to take full advantage of negative charging costs. All else equal, this would reduce negative price intervals.

However, in the short-term, it seems likely that the ongoing growth of rooftop and utility scale solar will swamp the impact of batteries.

- Merchant solar farms. In the short-term, the energy revenue of merchant solar farms will be increasingly impacted by negative prices, and LGC revenue will become a bigger share of revenue.
- It will get worse before it gets better. With the continuous roll out of renewables ahead of expected coal generator shutdowns, you should expect a saw tooth pattern, with the frequency of negative prices increasing as more rooftop and utility scale renewables enter the system, with reversals (i.e., few negative prices) each time a coal plant closes.
- The extent of negative prices should become less negative over time with a fall in the value of LGCs as we approach the end of the RET.
- Offtake carve outs. Most PPAs include some form of special regime in respect of negative prices. These can vary from a strict prohibition against dispatching when prices are negative, to excluding negative intervals from the PPA (so projects are effectively merchant as soon as prices become negative), to applying a spot price floor in contract for difference mechanisms. It is important to recognise that very small wording changes can have very large implications and that not all PPAs are equal.

Ultimately it is important to understand that it is cheaper from a whole of system perspective to overbuild renewables – and have some spilled energy – than to size storage such that every MWh that is generated is able to be stored. Given this, a meaningful level of negative price intervals is an inherent part of the system. That is, negative prices are a feature and not a bug!