Introduction

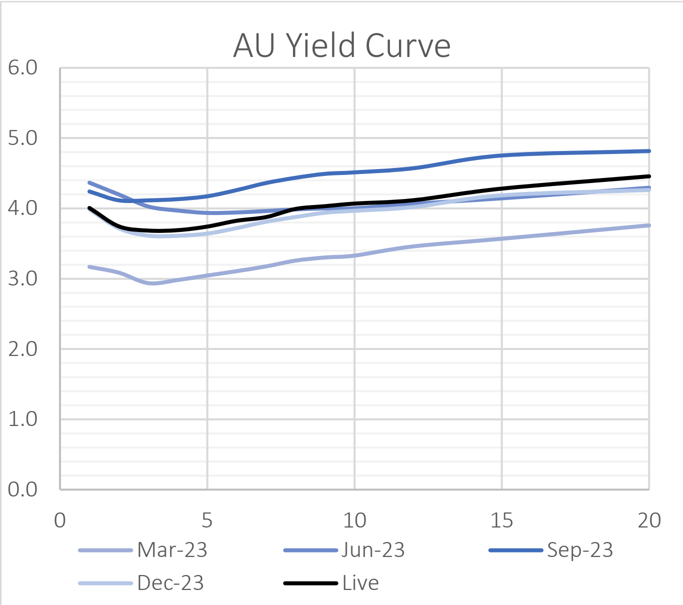
Most advanced economies appear to be reaching the peak of their rate hiking cycles, with central banks foreshadowing rate cuts over the months ahead. The main exception is Japan, which raised rates for the first time in 17 years as it ends its experiment with negative interest rates. Japan excepted, most markets are pricing in rate cuts this year, but the more sanguine of us are questioning whether they really will appear this year. Inflation rates are falling, but in places like the US and Australia, inflation is not yet in the target band and the higher monthly outcomes from 2022 have now fallen out of the inflation data – meaning the potential for sticky, high'ish inflation prints as we go forward.

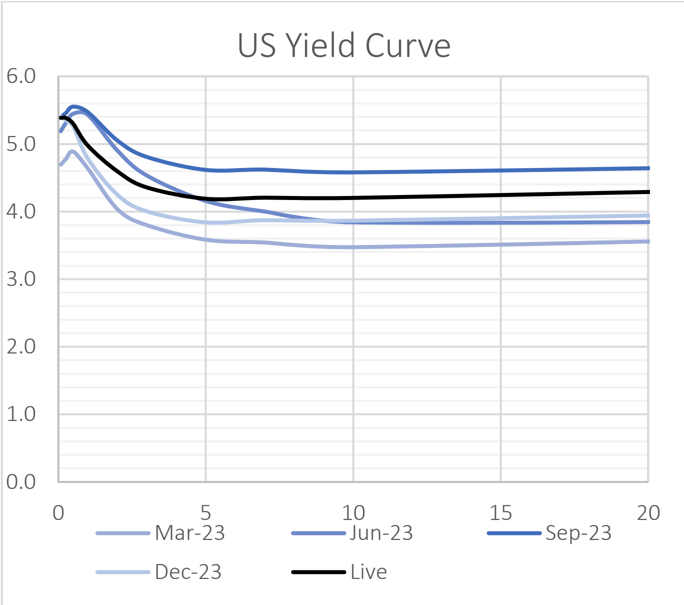
This quarter we will drive through some Toll roads in an inflationary environment in our first article. Our second article is based on the future landscape of electricity markets in the wake of the Capacity Investment Scheme (CIS) and how it may (or may not) align with Super Fund mandates. Lastly, we discuss the future of electricity demand in our third article.

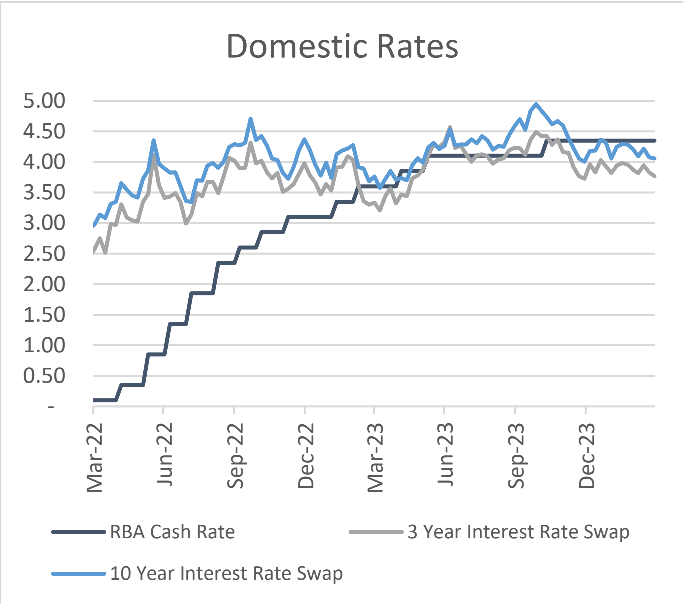
Markets Update

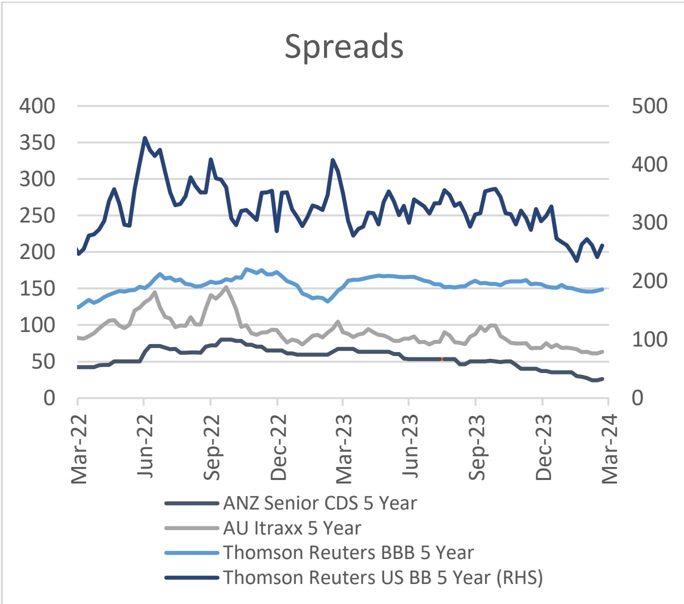
There has been significant movement on the longer end of the US yield curve. Yields have risen by approximately 30 bps over the quarter as markets have repriced the number of rate cuts in 2024. The most recent US inflation reading of 3.2% suggests that the Fed will need to wait for data to support the case for rate cuts. The Fed has been very cautious in the way it has been narrating future policy rate paths citing dual mandates of bringing inflation under control and at the same time promote maximum employment. For the past three meetings the Fed has left open the window for rate cuts and stated that if the effects of monetary contraction follow the path as expected, there are approximately 75 bps of rate cuts anticipated for 2024. For those focussed on US elections, historically, the Fed has either hiked or cut rates in every single election year except 2012.

Domestically, the monthly inflation number of 3.4% may seem like a positive sign for the RBA, demonstrating that monetary policy is working to bring inflation within the target band. However, recent movements in oil prices and geopolitical shocks to freight routes will have an effect on future goods inflation. A lot of focus has been on services inflation which has been running higher than the headline inflation number. The largest services categories in the consumer price index are rents, insurance and financial services, holiday travel, medical and hospital services, education and restaurant meals. The two main categories that have been driving services inflation recently are rents, insurance and financial services. Population growth driven by immigration and lack of new housing supply has put strong upward pressure on rents. Rent inflation has been running at 7.6% which is much higher than the 2-3% target band. The other major contributor to services inflation is insurance and financial services which is currently running at 8.4%. Insurance and financial services inflation is quite circular in nature. They are highly linked to labour market conditions and construction costs/housing market. With unemployment at 3.7% and average wage growth rate at 4.2%, there is a good chance that services inflation will continue to track above the RBA's target of 2-3%. This means there is a good chance that the RBA will be sitting on the sidelines for a while.









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)
21/03/2024	Zen Energy	Loan	160		
19/03/2024	Metis Energy (Gunsynd SF)	Loan	111	5	
14/03/2024	International Parking Group	Loan	190		
13/03/2024	IntelliHUB	Loan	300	6-10	175-215
13/03/2024	Windlab	Loan	700		
7/03/2024	NSW Electricity Networks Finance Pty Ltd	Loan	200	10	175
6/03/2024	European Energy	Loan	50	3	

Date	Borrower	Instrument	Size ($m)	Term (Yrs)	Pricing (bp above BBSY)
4/03/2024	Viva Energy Group Ltd	Loan	1000	4-6	160-180
29/02/2024	Stella SA Schools Pty Ltd	Loan	154	~14.5	
28/02/2024	ACEN Australia	Loan	75	4	
26/02/2024	Perth Airport	Loan	300	7	147
23/02/2024	ADAPT Services Pty Ltd	Loan	115	0.75	
22/02/2024	Lightsource BP	Loan	531		
22/02/2024	Neoen portfolio refi	Loan	1324	~5-7	140-145 (5Y)
20/02/2024	ISPT	Loan	1000	5-7	145-170
7/02/2024	Melbourne Renewable Energy Hub Stage A3	Loan	420	5	
5/02/2024	Neoen Goyder 1B WF + Blyth BESS	Loan	543	7	
22/01/2024	Nexus Hospitals	Loan	155	5	
19/01/2024	Cleanpeak Energy	Loan	32	2	
21/12/2023	Acciona	Loan	550	3	
21/12/2023	Jemena	Loan	450	3-5	
20/12/2023	Ararat Wind Farm	Loan	212	3	
19/12/2023	Canberra Metro 2A	Loan	534	5.5	
19/12/2023	Lendlease IMT (SM) Pty Ltd	Loan	255	3	
19/12/2023	NSW Treasury Corporation	Loan	250	3-5	
18/12/2023	Ararat Wind Farm	Loan	73	1	
18/12/2023	Finley Solar Farm	Loan	123	~3.9	
15/12/2023	Canberra Metro	Loan	249	5	
15/12/2023	Squadron Energy portfolio	Loan	830	5	170
14/12/2023	AGL Energy	Loan	510	5-7	175-195
14/12/2023	Munna Creek Solar Farm	Loan	173	5	
11/12/2023	Aurizon	Loan	500	5-6	165-175
5/12/2023	Macquarie International Finance Ltd	Loan	458	5	TSOFR + 125
4/12/2023	Axiom Education Victoria Finance Pty Ltd	Loan	88	11.5	
4/12/2023	Viva Energy Group Ltd	Loan	1511	3	145

Equity and other news

- Enel Green Power Australia (EGPA) has agreed to acquire the 1GW Julia Creek hybrid wind and solar project in Queensland from mine developer QEM.
- Origin has acquired Walcha Energy, which has been developing the Ruby Hills wind project and the Salisbury solar project in NSW. The combined capacity of the two projects is 1.3 GW.
- Swedish renewables player OX2 is seeking a buyer for its 118.8 MW solar farm near Hoarsham in Victoria. The Horsham Solar Farm was successful in the Victorian Renewable Energy Target's second auction in 2022 and the government will buy 80 per cent of Horsham's output under a 10-year support agreement.
- Genex Power's 7.72 per cent shareholder J-Power has put forward a dual-track bid at 27.5c per share to acquire 100% ownership of Genex, and simultaneously, an off-market takeover bid at 27c per share, contingent on obtaining at least 50.1% acceptance.
- Renewables platform GPG Australia is up for sale by Naturgy and Wren House Infrastructure. Igneo Infrastructure Partners and Octopus Investments Australia have lobbed non-binding indicative offers, joining the French giant TotalEnergies, Petronas' renewables arm Gentari, and Dutch pension fund APG.

- French energy giant EDF Group has acquired a 300 MW pumped hydro energy storage project in NSW from Mirus Energy and Energy Estate based in Australia.
- Rio Tinto has signed the biggest 25-year renewable energy PPA which will take 80% of the output of the 1.4 GW Bungapan wind project planned by Windlab, followed by signing a contract to buy all the generation output from a 1.1 GW solar facility near Gladstone.
- Spanish renewables company Acciona Energia has purchased a 38 MW waste-to-energy plant currently being built in Kwinana WA from Macquarie Capital and Dutch Infrastructure Fund.
- Macquarie Group has sold its 15% stake in the Australian Renewable Energy Hub (AREH) project to BP, a large green hydrogen production plan in WA underpinned by 26 GW of wind and solar generation capacity. BP is already the largest investor in the project and its operator.
- Quinbrook Infrastructure Partners has teamed up with German energy company E.ON on the ongoing construction of a 230 MW/460 MWh battery energy storage system at Uskmouth in NSW. E.ON will acquire 50% of the project capacity and jointly invest in its construction, which began in November 2023.
- The APA Group owned 88 MW Dugald River solar farm, the largest solar facility on a remote grid (in Outback Queensland) is now under full operation.
- OMERS has submitted a bid in the auction for NatWest's 20% stake in NSW Land Registry Services. OMERS was an under bidder for the NSW government's $2.7 billion privatisation of the registry in 2017. Interest has also been shown from Keppel Infrastructure Holdings.

Troll Roads

The effects of inflation are now really being felt in the community, I don't mean inflation as some statistical calculation of the rate of price change for a basket of goods, I mean *inflation* as a feeling – 'sh!t everything is expensive and I don't see any relief in sight'. In financial markets we're concerned with measures and statistics, in politics though, it's the feeling of the public that really drives action. Inflation (traditional measure) has fallen, but the issue for the public is that the absolute level of prices now are high, and inflation (absent real wage growth) slowing to 2-3% doesn't change the status quo.

We're now in the *picking villains* phase, supermarkets, electricity retailers….toll roads. It's not that any single one of these is the cause, and certainly not the location of the solution, but we (as a society, echoed and broadcast through the media) are picking out the singular villains.

NSW Premier Chris Minns announced that the NSW Government was looking at toll road cost relief following the release of the Independent Toll Review, Interim Report. Sydney Toll Roads are estimated to cost users $195 billion (nominal) over the next 36 years (Westconnex accounts for 52%). Sydney has the highest concentration of toll roads and tolls are adjusted with inflation (e.g. the higher of 4% or CPI) – so the last two years have seen noticeable increases. Keeping in mind that the economic incidence of tolls is not uniform across the population, ultimately users are questioning the economic utility of the road system and the Premier is reading the political tea leaves.

Transurban is the dominant player and holds most of the privately allocated concessions in Sydney – they either own the concession outright, or they hold majority ownership (Westconnex and Eastern Distributor). NorthWestern Roads Group (QIC) owns NorthConnex and Westlink M7. The concessions are not uniform, and they shouldn't be thought of as regulated utilities.

Putting to one side the question of whether there should be change, and rather assuming it is decided there will be change, what choices does the Government have? The high-level simple options are detailed below:

1. Reacquire some or all of the toll road concessions
2. Change the rules to limit the cost of tolls
3. Subsidise the tolls

4. Negotiate to alter the concession to limit the cost impact today.

Option 1 would seem extreme. I haven't tried to calculate the value of each individual toll concession, but to give some perspective of cost, a rough approach would be to look at the Transurban market cap. Note Transurban has other toll roads in Queensland and Victoria, the United States and Canada – 9 of their 21 Toll Roads are in NSW. Transurban's market cap is approximately $41bn and has an enterprise value of $71bn (debt plus equity).

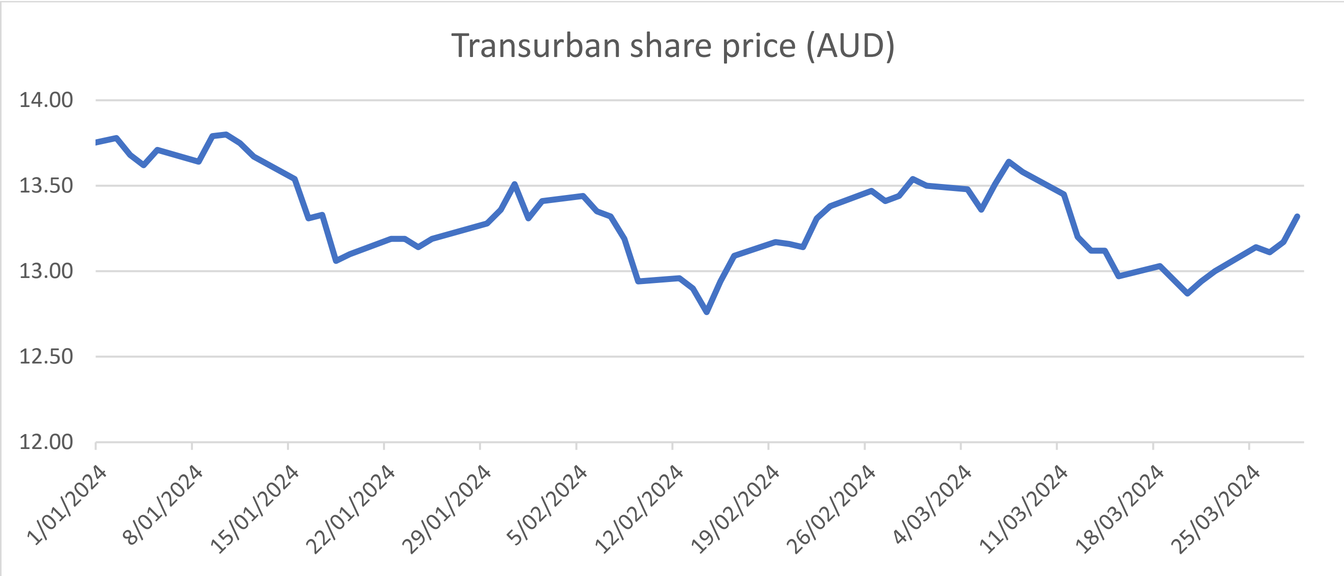
Option 2 seems like a legal nightmare and risks concerns around 'sovereign risk'. Toll concessions are set on a firm contractual basis and are the basis for the original investment. Thus, there would likely be a strong basis for legal claim for compensation if there was an unilateral change in tolling arrangements Of all options, this one would seem to have the lowest expediency.

Option 3 has already been implemented with the NSW Government introducing in December 2023 a $60 toll cap as part of a cost of living relief strategy. Subsidising tolls either via some form of subsidy (perhaps with means testing) would avoid any major legal dispute with private concession holders, and most likely result in a windfall gain for Toll Operators through higher (subsidised) patronage. For users and taxpayers, subsidies don't result in any economic efficiency, simply a redistribution of cost from users to taxpayers.

Option 4. This would be an arrangement where Toll Operators might give up something today (eg lower tolls) to receive something in the future. An example of this would be an extension of concession/s by a further 10 years. This option aligns with the objectives of the parties – politicians have a relatively short-term imperative (4 year election cycles) relative to Toll Operator investors which operate on a much longer time horizon and can simply value any negotiated outcome such as a concession extension. An example would be extending concessions by say a further 10 years, in exchange for a freeze in tolls for 5 years. In this example, politically it would be seen to be doing something now, but from an investor standpoint any concession extension is likely to materially lift the NPV of each concession. Whilst potentially politically expedient and definitely beneficial to the concession owners (as they wouldn't agree if it wasn't) , this option does nothing to improve the economic utility of toll roads.

A variant of Option 4 would be, for the few roads with single direction tolls, to alter the tolls such that they are bi-directional. Single direction tolls are simply a function of history, and date back to a time before electronic tolling where tolls were collected in cash – this necessitated a wide expansion of road (eg 8-10 lanes). Back then, it was more cost effective to only charge the toll in one direction and save the cost of constructing a second toll plaza. While this approach was cheaper, it does lead to an economically inefficient allocation of congestion, with single direct roads having substantially more traffic (and congestion) in the untolled direction. However, now with electronic tolling, this should be relatively straightforward to implement bi-directional tolling. Simplistically the original toll (in one direction) could be slightly more than halved and chargedin both directions. This would collect the same revenue, but for existing toll users, lead to a small saving (at the cost to the welfare of those who only ever used the road in the free direction). This change would improve the economic utility of those specific toll roads – but probably wouldn't be a big political winner as the savings involved are reasonably small.

Of all options, Option 3 and 4 are most likely, with Option 3 being the most expedient. More broadly, our view is that whichever option the NSW government chooses, toll road concession owners will be the net winner. The market appears to have the same view, whilst in the days after the announcement there was a small fall in the Transurban share price, it doesn't appear that the market thinks that Transurban will be a big loser from this review.



Source: Refinitiv Eikon

Super funds and the Capacity Investment Scheme might not be compatible.

The Commonwealth Government has set a target of 82% renewables in the national electricity market by 2030. Achieving this target will require massive investment in new utility scale wind and solar generation as well as dispatchable firming assets such as batteries. While estimates vary – the 32GW+ of additional capacity is likely to require a $50 billion wave of investment.

While policy makers haven't been explicit on who they think will finance this new investment, my guess is that they would expect Australian superannuation funds and similar institutional investors (for example, offshore pension funds and sovereign wealth funds) to be major investors in new renewable generation capacity in Australia over the next few years.

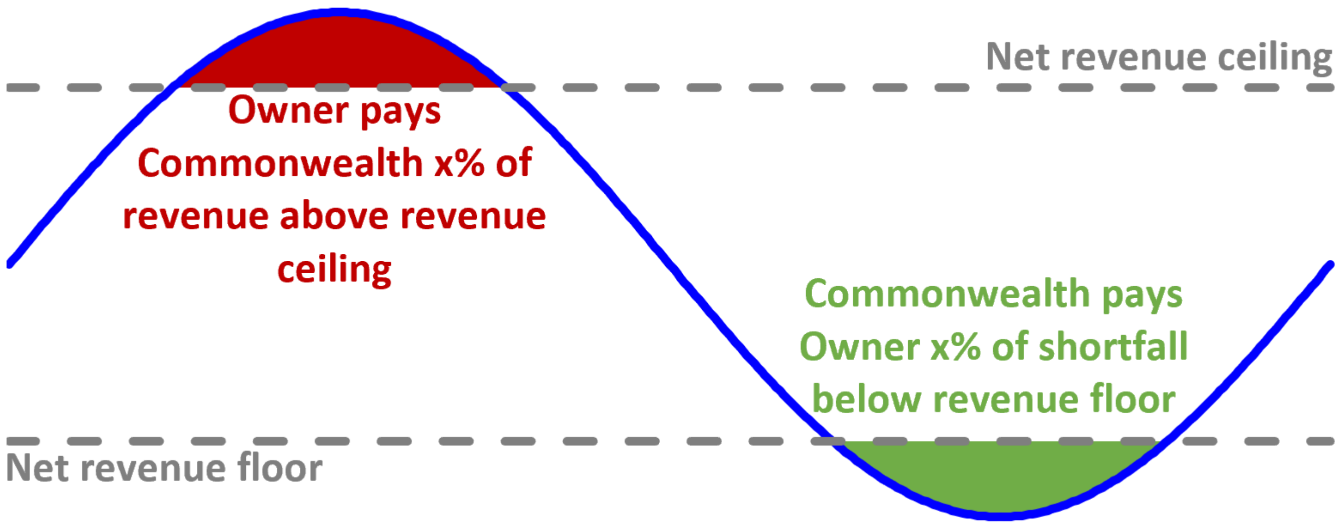
I wouldn't be so sure.

The key policy mechanism that is intended to drive this wave of investment is the Commonwealth Capacity Investment Scheme (CIS).

What is the Capacity Investment Scheme

The Capacity Investment Scheme is a competitive government run process that will allocate revenue support agreements (CISAs) to successful projects through a series of six-monthly auctions starting in 2024 and running to 2026 (for wind projects) and to 2027 for solar and storage projects. It will be seeking to support 32GW of new capacity (23GW of wind and solar and 9GW of storage). Projects will compete against each other to bid a floor revenue (which will apply for 15 years).

Once built, if the project revenue falls below this floor level, then the CISA would kick in, topping up project revenues. Similarly, if revenues exceeded a ceiling (also a bid parameter in the auction process) then the project would pay the Commonwealth some of these windfall high revenues (see below).



Source: DCCEEW briefing presentation

Importantly this floor/ceiling would still incentivise the project to enter into offtake agreements with electricity retailers/users and, if not contracted, to maximise the market revenues of the project. The project would also still be incentivised to optimise market revenue as the minimum percentage of revenue would remain exposed to market outcomes, even if the floor or ceiling was binding (DCCEEW has indicated this could be 90% on the floor and 50% on the ceiling).

What are the likely competitive outcomes

While CISA will be assessed across a number of criteria (sponsor credibility, project readiness, community engagement and support as well as first nations involvement) it is likely that a key differentiating criteria will be the financial criteria in the CIS bid. That is, what the level of the revenue floor the project requires - the lower the better.

In Infradebt's view, the level of the floor price is likely to be the most important bid variable (with the government strongly incentivised to select projects with low floor prices).

The $64,000 question amongst renewables market participants is "What will be the clearing floor price under the CIS auction?".

In our view, clearing floor prices are likely to be around 50-70% of the levelised cost of projects. That is, if the stereotypical windfarm requires a levelised revenue of $80/MWh (nominal) over its 30 year operating life to cover its capital and operating costs, it might bid a floor price of $40 to $55/MWh.

Why this range?

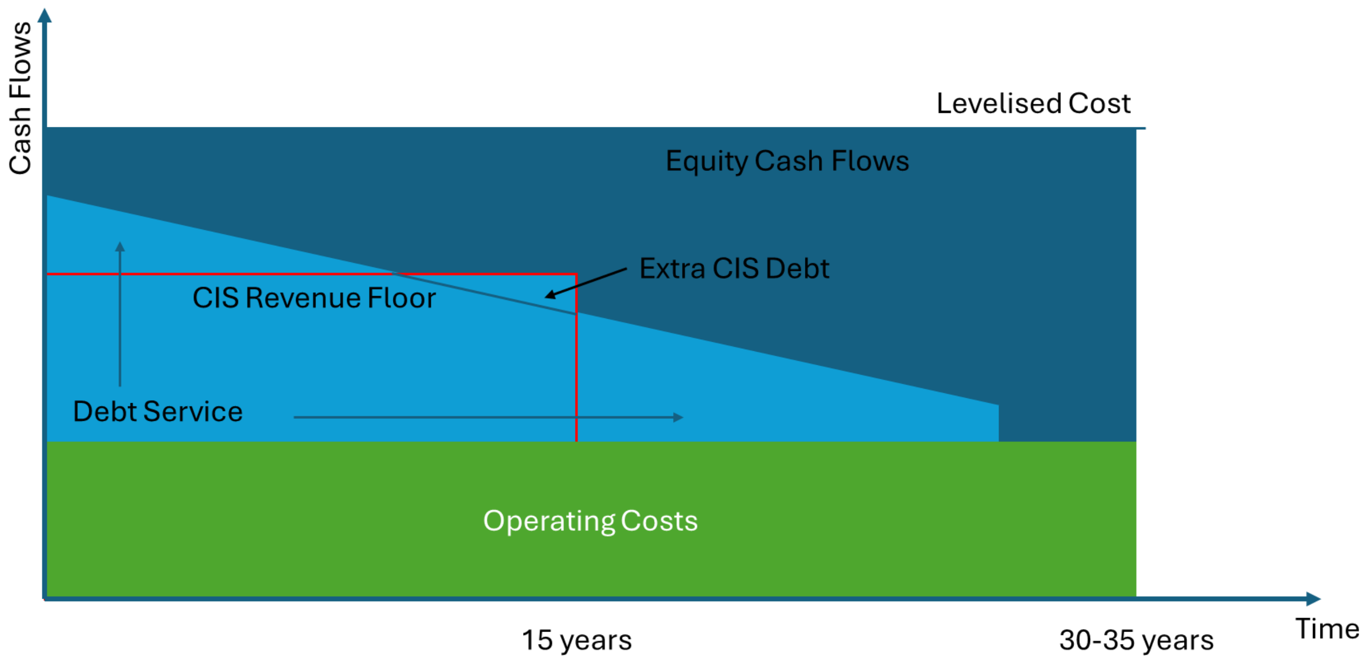
I don't expect CIS floor prices to be below 50% of levelised cost – because at this point the floor is genuinely valueless. If a project proponent (or their financiers) thought there was a meaningful probability of a 50% of levelised cost floor binding – then they wouldn't proceed with the investment – CIS floor or not. In particular, at sub 50% strike prices, given the floor is only for around half of the project life (ie probably covers well under a quarter of project NPV), it means that the floor would only kick in in a scenario where equity and debt had been eviscerated.

Conversely, it will be a competitive process, with the Commonwealth likely to take 3-4 times as many projects through to final round of the bidding process as actual CISA offtakes will be granted. Thus, it seems very unlikely that the winning bids for CISA floors will be at or above levelized costs.

This is consistent with market outcomes for PPAs, where pre-financial close 10 to 15 year offtakes are usually struck at a discount to project levelised cost. Put it another way, the experience with other offtakes is that market participants are willing to discount the PPA price for upfront certainty - effectively punting that revenues after the offtake period will be higher. We expect that this dynamic will apply for CIS processes as it does currently for PPAs. In fact, given that under the CIS the project has the opportunity to earn revenue above the CIS floor (but below the CIS ceiling), prices for CIS contracts are likely to be materially lower than the equivalent PPA from a retailer (where there is no upside opportunity).

What does this mean for likely capital structures

For the sake of argument, let's assume that a project successfully obtains a CISA at 60% of levelised cost based on 100% of its capacity. This is a 15 year offtake – it probably only locks in around 30-40% of the NPV of project cash flows. The diagram below illustrates a potential capital structure for this transaction on a very stylised basis.



If you ignore the CIS in the first instance and imagine the project was fully merchant (uncontracted), the typical capital structure you will get is:

- Around 30-40% debt. With debt service front-ended, where lenders can have more confidence about revenue forecasts. Lenders usually assume project lives shorter than equity and so debt fully amortises prior to the end of the project life.
- Around 60-70% equity. Equity gets the balance of the cash flows after debt. This means that equity returns are inherently back ended.

How does this change with the benefit of a CIS floor?

The CIS floor gives more locked in revenues and so debt financiers can safely lend more. However, the impact of the CIS is reasonably muted (see triangle in diagram above). The CIS can't increase debt post year 15 and so the CIS doesn't make any difference then. Likewise, if the CIS floor is below revenues that a bank would otherwise lend on a merchant basis then it won't boost debt.

All of this is me saying that a CIS at 50-70% of 8evelized cost will modestly increase the amount of debt available and might also modestly decrease the margins banks charge. However, it is not a game changer. The likely capital structure is still going to be circa 40% debt and 60% equity. Mathematically a 15 year CISA on a 30-35 year life project just can't make much difference unless it is at a very high price (which in turn is unlikely due to the competitive nature of the

CIS process). Thus, in order to drive a higher debt size still requires a high price, long-term PPA from a highly rated offtaker.

Furthermore, it is important to recognise that the equity in a CIS project will have a high exposure to merchant price risk – particularly in the back-end (i.e. post the term of the CIS). This structure will deliver high returns and high dividends when merchant outcomes are high, but will also be quick to shut off dividends and have substantial capital value write-downs if long-term merchant expectations are revised down. In scenarios where the CIS floor actually binds (and this is the point that any Commonwealth government subsidy actual gets paid), equity will be taking large losses and be almost certain to be receiving no dividends.

Fit with Superannuation Funds

Infradebt's comment is that this capital structure and risk return profile doesn't actually align with what the typical Australian superannuation fund is looking for in their infrastructure equity assets (and while my comment is focused on Australian super funds, the attitudes of offshore pension funds and sovereign wealth funds wouldn't be that different). A typical super fund infrastructure equity investment has 60-70% debt and 30-40% equity. They typically are structured to give stable equity distributions. That's not what a CIS backed generation asset is likely to look like.

Rather, the capital structure and overall risk profile from CIS generation assets is more likely to match the generation assets of the gentailers. The generation assets of the gentailers do have cyclical returns (and that cyclicality can be absorbed in part by balancing the generation owned assets against the profitability of the gentailers' retail business). The typical gentailer actually has a two thirds equity, one third debt capital structure.

That said, it is hard to see Australia's big 3 retailers mobilising $30bn plus of equity capital that would be required if they were to be the principal funders of the generation investment required to hit the 82% target.

Ultimately, funding CIS backed generation investment will require equity investors with a good understanding of short and long-term electricity price dynamics and a willingness to back their own view of the likely trajectory of electricity prices (and, hence, the returns on these assets).

The Gentailers probably have good insights – but don't have enough money. The super funds have the money – but historically haven't been comfortable taking strong positions on long-term electricity prices.

We at Infradebt don't have the answer to this conundrum – but it will be a key point of dissonance that will affect the execution of the CIS over the years ahead.

Future sources of grid demand

Do you find the discussion on electricity dry or revolving around the same central themes? Well in this piece we take a step back from looking at the 'how' we generate electricity and go to the 'why'. By why I mean – what will our society look like in the future, what does 'electrication' of our economy mean, will it change our relative competitive or comparative advantages? This question, when thought through, goes far beyond whether you'll have a shower every morning in 2046 (I hope you do), but rather what device will heat and deliver the water and how will it be powered – maybe 'ice baths' will move beyond a passing trend and this is irrelevant (but you still need to cool the water!). Seriously though, as an investor in this space, I'm far more interested in how the energy will be used in the future – this is the really transformative element of the energy transition for our economy. This article starts an investigation into this theme by looking at AEMO's Integrated System Plan modelling, however there's far more to this topic than can be explored in a single article, so I'm sure there will be more on this topic in the future.

First things first, we need to start with the basics and the status quo. Grid demand can be broken down into operational demand and underlying demand. Operational demand is the demand for electricity produced by generators sold through the wholesale energy market and is the "official" grid level demand. Rooftop solar output is treated as an offset against grid demand because it replaces electricity that would otherwise by supplied by large generators. Underlying demand is gross demand before accounting for behind the meter solar. It is estimated by adding back the estimated generation from rooftop solar (and home batteries).

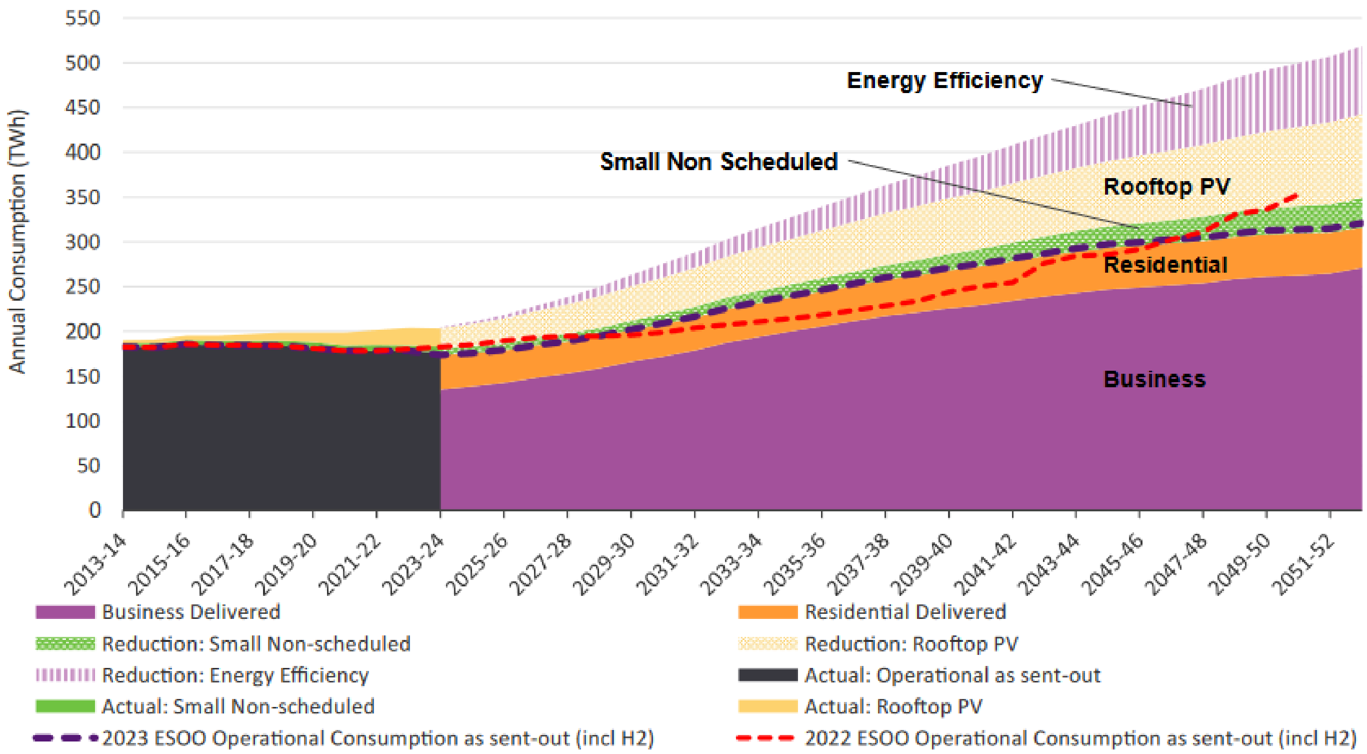
Underlying demand has largely been stagnant over the last 20 years, with the increase in population and GDP growth offset by the increase in energy efficiency of household appliances (eg we moved from Plasma TVs to LED TVs) and improved building standards. More recently over the last decade, the increasing penetration of rooftop solar has seen a significant contraction in operational demand.

In the last calendar quarter of 2023, year on year operational demand, that is demand net of rooftop solar, increased for the first time since 2015! The increase was by 315 MW or 1.6% over the previous calendar quarter. This was driven by an increase in underlying (gross) demand of 820 MW or 3.7% and despite rooftop solar increasing 505 MW or 17%.

Is this a turning point in both underlying and operational demand from the grid?

It is difficult to breakdown where demand is coming from, however it does appear that a large part of the increase last quarter could be attributed to the warmer weather in Queensland and New South Wales. In the future, warmer and more volatile weather caused by climate change will be a driver of energy demand in of itself.

Total grid demand in the National Energy Market was 188 TWh in 2023 and is the baseline we will be comparing to. AEMO is forecasting underlying demand to double by the 2040s in their central case with a large part of the increase in demand serviced by rooftop solar.



Electric vehicles

Electric vehicles made up 7.3% of all 2023 new car sales in Australia. Globally one in five new car sales were electric in 2023 and in China it was one in three. The Australian Bureau of Statistics conducts five yearly surveys on vehicle usage. The last survey was conducted in 2020 with some of the data presented below.

Type of vehicle	km travelled (millions)	Megalitres of fuel	Litres per 100 km	% of total fuel

Passenger vehicles	162,983	18,094	11.1	55%
Motorcycles	1,683	102	6.1	0%
Light commercial	52,229	6,678	12.8	20%
Rigid trucks	10,976	3,138	28.6	10%
Articulated trucks	8,181	4,342	53.1	13%
Non-freight truck	321	75	23.2	0%
Buses	2,126	591	27.8	2%
Total/Average	**238,499**	**33,019**	**13.8**	**100%**

Electrifying the entire vehicle fleet would present an opportunity to displace 33,000 megalitres of fossil fuel. To provide an estimate of how much additional grid demand that would result from this adoption, we have created a hypothetical scenario where all passenger and light commercial vehicles are displaced by the most popular electric vehicle in Australia, the Tesla Model Y. Tesla does not officially disclose battery capacity but quick googling reveals that the long range Model Y has a battery capacity of 81 kWh and a range of 533 km. This would imply that the model Y achieves about 6.5km/kWh of battery charge or 15 kWh per 100 km. To cover the 162,983 million kilometres this would require an additional 25 TWh of grid demand. Should the range be overstated by 20% (that is, real world efficiency doesn't quite match the theory of standardised mileage tests) the required energy usage to electrify the entire passenger fleet would be 30 TWh or 16% of current grid demand.

The electricity usage assumptions would be higher for commercial vans/trucks and buses. Assuming all the other categories of vehicles (excluding motorcycles) would require twice the energy per kilometre of a passenger electric vehicle this would be another 30 TWh of grid demand for vans, trucks and buses which would take total grid demand to electrify vehicle transport to around 30% of current grid demand.

Thus, while electric vehicles wont "blow up the grid" as some commentators suggest, they will result in a meaningful boost to electricity usage over a 10-20 year.

Electrification of heating and cooling

Heat pumps and induction cooktops are significantly more efficient that their gas counterparts. The coefficient of performance (COP) is a measure of the ratio between the energy output to the energy input of a heating or cooling unit. For a heat pump the COP is usually around 4. There are some models such as the Sanden heat pump system that can go up to 6. A gas boiler has a coefficient of performance of 0.9-1.0. For our assumptions we will assume a COP of 1 for a gas boiler. On average electrification of household appliances will require 4 times less energy compared to their gas equivalent. The efficiency of an induction cooktop has a similar COP to a heat pump but requires significantly less cooking time.

The main drawback of a heat pump or induction cooktop is that the upfront cost which is significantly higher than the equivalent gas system. However, the operating costs of a heat pump are next to nothing with a higher COP and "free" electricity from a rooftop solar system. The counterfactual operating cost of a gas system is high. It is currently a no brainer to electrify your heating/cooling/cooking requirements if building a new home or if you plan to live in your house for an extended period of time.

Based on the 2023 AEMO Gas Statement of Opportunities current household gas consumption is 175 PJ per annum. If all of gas demand at the residential level were to be electrified this would be equivalent to 48.6 TWh of electricity (for the non-engineers, this is based on a conversion factor of 3.6 MJ to MWh). With the higher COP of heat pumps and induction cooktops the load would be reduced to 12 TWh (assuming a COP of 4). This is 6-7% of current operational demand.

Utility scale storage

Storage is key to achieving a grid with higher levels of renewable energy supply. It allows for the mismatch between intermittent renewable energy and consumer load to be matched. For coal plants to close, it will require building a significant amount of dispatchable capacity. AEMO is forecasting that 33 GW / 514 GWh of storage capacity will be required by 2035. Short duration storage of less than 4 hours is forecast to be 10 GW/20-40GWh. This will be served by batteries which have a round trip efficiency of about 85%. The round trip efficiency losses mean a battery is a net user of electricity from the grid. Assuming the AEMO short duration forecast is met, there would be an annual draw from the grid of 1-2 TWh (assuming one cycle per day) from round trip efficiency losses or 0.5-1.0% of existing operational demand of the grid.

Rooftop solar

As of the end of February 2024 there is 22.6 GW of rooftop solar installed across 3.745 million sites. Based on the last census, there are 9.275 million households in Australia of which 70% are detached dwellings or 6.5 million households. It is likely that 80% of households will eventually have solar, which means there is potentially another 1.3 million households to install solar systems. If the trend of larger system sizes continues there is potentially another 15-20 GW of potential rooftop solar or 25-35 TWh per annum of additional solar generation (negative demand).

Data centres

Over the last decade data storage has migrated from onsite company owned facilities and to remote locations on the cloud. This has led to the steady growth of data centre demand. More recently this has accelerated with streaming, gaming, and AI/machine learning requirements becoming more relevant to a variety of different facets in our society. The main operators in Australia are AirTrunk, NextDC, Equinix, Canberra Data Centres, and Macquarie Telecom. Data centres are essentially a property play with landlords selling a margin over electricity to operate and cool the data centre. Data centres are capital-intensive, volume-based businesses and require sophisticated cooling, security, and energy backup systems for clients to access data any time.

Currently, there are 307 data centres in Australia. According to IBIS World, the revenue has grown by 5.6% to $5.2 billion over the last 5 years and is forecast to expend by 8% in the next 5 years to $7.7 billion. There is around 900 MW of data centre capacity with 1.5 GW of potential data centre capacity in the pipeline. Utilisation rates vary among data centre providers but based on NextDC public disclosures their centres are running at 80-90% utilisation rates. Assuming 80% utilisation of the existing capacity, and making the very simplified assumption that the servers are running 24/7, this would equate to an electrical load of 17 TWh per annum on existing data centres increasing to 30 TWh in the next 5-10 years as capacity increases to 2.5+ GW. This could add 8-10% of additional grid demand.

Hydrogen

Hydrogen is a transportable and storable alternative fuel source to fossil fuels, which produces no carbon emissions when used. It is a platform to allow the global trade of clean energy and a path forward for emissions reduction in hard-to-abate sectors such as steelmaking, mining, chemicals, cement, aviation, shipping, and heavy road transport.

If/when Australia's Hydrogen industry gains traction, Green Hydrogen is likely to be a significant portion of energy demand. Therefore, the growth of the Hydrogen industry may become a significant driver of increased NEM load. Nevertheless, there are significant uncertainties surrounding Hydrogen's future. The AEMO recognises this, and have created three Hydrogen forecasts within the Integrated System Plan's 'Green Energy Exports', 'Step Change' and 'Progressive Change' scenarios:

2040 Hydrogen related electricity consumption (TWh)

	Green Energy Exports ('Hydrogen Superpower')	Step Change	Progressive Change
Domestic	50	28	15
Export	183	7	0
Total	233	35	15

In a 'progressive change' scenario, at 15TWh, the AEMO are predicting hydrogen production will consume the same amount of electricity as 3 million average Australian households in a year (or just over that of the State of Victoria). This is not insignificant, let alone a 'Step Change' or 'Green Energy Exports' scenario demanding a load of 2.3x or 15.5x the 'Progressive Change' scenario respectively.

Conclusion

It is conceivable we could have an additional 50-100 TWh of underlying demand from electric vehicles and datacentres over the next 20 years and increase grid demand to 250-300 TWh. Getting to 400 TWh would seem like a stretch but plausible if there was a hydrogen industry in Australia. The rooftop solar boom will continue and operational demand will grow at a slower rate than underlying demand.

Of course, this analysis really only assumes one new industry – Hydrogen. But if we're really to become an 'energy superpower' it means that we must have the lowest cost energy (comparative advantage) and so this begs the question what else could we do – which we'll explore in future articles.