ERARING CAN BE CLOSED ON SCHEDULE

July 2023

nexa ADVISORY

About Nexa

Nexa Advisory is a full-service advisory firm supporting clients through their clean energy transition.

Nexa Advisory was created in 2018 to be a trusted partner, delivering bespoke solutions to public and private clients, including renewable energy developers, investors and climate impact philanthropists, wanting to accelerate the clean energy transition. We have been shaping the energy industry for over 20 years. With a proven track record across policy creation, advocacy, political risk assessment and project delivery, we're holistic in our approach and deliver solutions with commercial intent.

Led by founder and CEO Stephanie Bashir, the Nexa Advisory team is a collaboration of passionate specialists who are committed to the successful transformation of Australia's energy markets, and realising the broad benefits it will bring. The team is focused on helping clients grasp the unpredicted opportunities the energy transformation will bring with trusted and innovative thinking and advice.

Acknowledgements

we would like to acknowledge our partner Endgame Economics for their contributions in providing the detailed analysis, modelling and charts for this project. Endgame Economics is an economics and mathematical consultancy that specialises in the energy sector. Endgame brings expertise in optimisation, quantitative analysis, and critical thinking to bear on complex problems.

Executive Summary

There is currently ongoing discussion about delaying the closure of Eraring coal-fired power station. While there is discussion there is no transparency about what it would take to close Eraring to the planned schedule.

The current slow pace of Australia's clean energy transition – generation, storage and transmission build and connection – may well necessitate delays to the closure of coal-fired power stations. This would shore up reliability in the near term, but would result in higher costs and emissions over the long term. The better approach would be to accelerate the rate at which we deploy new clean energy resources. This would negate or minimise the need to extend the lifespan of coal-fired power stations, and leave energy users and the nation much better off in coming years.

Given the risks associated with the slow pace of the transition in Australia, Nexa Advisory engaged Endgame Economics to provide evidence-based insights* into the likely impacts of delays to the transition and the closure of New South Wales' ageing coal-fired power stations, specifically Eraring and Vales Point.

* See Appendix 2 for detail

Summary of Findings

Several key findings emerged from the modelling and Nexa Advisory's research.

If we do not take action to accelerate the current build out rate of renewable generation, storage, and transmission we will continue to have **significant reliance on fossil fuel-fired electricity generation.** This would mean:

- **Risks to our power affordability, reliability and security** – Our ageing coal-fired power stations are unreliable and expensive.
- **Emissions targets will be missed** – Extending Eraring's closure date generates additional carbon dioxide equivalent emissions, totalling around 18.3 for a delay of 2 years, and 34.5 million tonnes for a delay of 4 years.
- **Our emissions budget will be exceeded** – The total cost of the emissions on our current slow pathway would be $160 billion, $31 billion more than a planned transition. Delaying Eraring's closure contributes $2.7 billion (2-year delay) and $5.2 billion (4-year delay) to these costs.
- **Consumer bills will increase** – On the current slow pathway, the typical consumer will pay between $4,500 and $6,000 more in total (dependent on state) over the next twenty years unless the energy transition is more effectively managed.
- **Renewable energy generation targets will be missed** – On our current pathway, around 60% of electricity in the NEM will be generated by large-scale renewables in 2030, making the Federal Government's 82% target difficult to achieve without a significant acceleration.
- **A domino effect** – Should the closure of Eraring be delayed because replacement renewable generation is not built in time, then it is likely the scheduled closures of other coal-fired power stations will also be missed, such as Vales Point and Yallourn.

The NSW Energy Minister Penny Sharpe has noted that "there is significant interest in investing in NSW's energy transition, both inside the REZ and outside the REZ, which signals that any risks around grid reliability can be resolved by accelerating the development of a clean, reliable, consumer-focused energy system".[2]

We strongly endorse the minister's view. Our analysis shows that there are more than sufficient renewable energy and storage projects in the pipeline ahead of the Eraring closure, with a total of 4.3 GW of committed and anticipated projects and a further 32 GW of proposed projects. Prioritising and accelerating the connections of these projects will provide investor certainty for financial close and facilitate timely commissioning.

Any reliability gaps identified by the Australian Energy Market Operator (AEMO) and AEMO Services are already being addressed.[3,4]

It is not too late to take the necessary actions to get back on track - if we act now and work fast, we can meet build targets and achieve the current schedule of coal-fired power station retirements.

1 Based on a price of AUD$150/$_{tCO2\text{-}e}$, referencing the EU price of EUR$90, which is a requirement in NSW benefit analyses

2 https://www.afr.com/policy/energy-and-climate/federal-scheme-to-unlock-10b-investment-in-firming-power-20230628-p5dk7g

3 https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/nem_esoo/2023/february-2023-update-to-the-2022-esoo.pdf?la=en

4 https://www.energy.nsw.gov.au/sites/default/files/2022-12/28October2022-Energy-Security-Target-Monitor-Report.pdf

Summary of recommendations

In our paper, we provide complementary actions and solution options to accelerate investments and ensure consumers in New South Wales (NSW) have a reliable, affordable, and clean source of electricity.

1. Lean into new capacity build

a. The Federal Government should continue to mobilise funding through the Capacity Investment Scheme (CIS) and/or the Clean Energy Finance Corporation (CEFC) to bring forward new dispatchable renewable generation (renewable generation plus batteries) in NSW, building on recent announcements.[5,6]

b. EnergyCo should be provided with additional resources, either directly or through expert support from the CEFC, to progress tenders at pace.

2. Bolster firming procurement in advance

a. The NSW Government, through EnergyCo should accelerate firming auctions to replace Eraring, and bring on additional "insurance" capacity earlier in the Renewable Energy Zones (REZ).

b. To improve the flow of committed projects, the NSW Government, through EnergyCo, could temporarily offer amended LTESA contracts or contracts for difference.

3. Explore Long Duration Storage

a. The NSW Government, through EnergyCo, should explore whether there is a role for the LTESA to underpin a portfolio approach in delivering hybrid storage with generation projects (rather than separate tenders for individual generation or storage projects).

b. The Federal and NSW governments should develop support for scalable long duration technologies, such as flow batteries and liquid air energy storage, leveraging ARENA and CEFC funding options.

4. Look beyond the REZ

a. The NSW Government, through EnergyCo, should actively facilitate new renewable generation and storage projects outside the declared REZ, to ensure that all new capacity is connected in a timely manner and to utilise existing capacity in the transmission system.

b. The Federal Government could explore underwriting Power Purchasing Agreements (PPAs) for new renewable generation (and storage) projects, which would ensure earlier financial close and a more rapid delivery of new firmed generation projects.

5 https://minister.dcceew.gov.au/bowen/media-releases/joint-media-release-capacity-investment-scheme-power-nsw-clean-cheap-reliable-energy

6 https://minister.dcceew.gov.au/bowen/media-releases/joint-media-release-100-million-investment-waratah-super-battery-deliver-more-reliable-cleaner-cheaper-energy-nsw

5. Enable critical transmission lines

a. The federal and NSW governments should advocate for new transmission lines to underpin the clean energy transition by designating it "nation-building" and expediting delivery of priority transmission, supported by appropriate compensation schemes for regional communities.

b. The Federal Government should make transmission contestability a pre-requisite for access to Rewiring the Nation funds.

c. The NSW Government should extend the competitive delivery of new transmission to all new transmission in NSW.

d. The NSW Government, through EnergyCo, should explore delivery of priority transmission projects that would support the connection of new firmed renewable generation and extend the "priority transmission" definition to all new transmission projects, including unsolicited projects, not those just those identified in the Integrated System Plans (ISP).

NSW already has in place all the legislative tools necessary to accelerate the delivery of REZ-related generation, storage, and transmission, and the delivery of non-REZ generation, storage and priority transmission lines.

Prioritising and accelerating the connections and statutory approvals, while maintaining rigor, for already committed and anticipated generation and storage projects would add a further 4.3 GW of firmed low carbon generation to the NSW power system. This would provide investor certainty for financial close and facilitate timely commissioning.

Beyond the Eraring Closure

While we have proposed some immediate actions above that would promote a transition to a low carbon power system, there are further approaches that need to be taken to ensure that the power system and market are ready and accommodating of subsequent coal-fired power stations closures, without resulting in reliability or price shocks.

The closures of Liddell and Eraring power stations provide lessons for future closures, such as Vales Point (currently scheduled for 2029).

Providing clarity to the market on when a coal-fired power station will cease operation provides developers and investors with the confidence to progress new renewable generation and storage projects.

There are a number of options for providing clarity in NSW and other jurisdictions:

1. A ministerial declaration on the dates for coal-fired power stations to cease operation would provide certainty for the owners and operators, AEMO as the power system and market operator, and developers of new generation and storage projects.

2. A legislated coal closure mechanism (national or state) would set the closure date for coal-fired power stations in legislation.[7] There would need to be a very limited degree of flexibility around the dates, with the owners and operators of the power stations required to define a window for closure, which would narrow as the date approaches. This mechanism would need to incorporate a penalty to ensure compliance with the closure date (e.g. funds in escrow[8,9]).

3. A strategic operating reserve needs to be developed. This would underwrite new firmed renewable generation through an auction, established under Capacity Investment Scheme. The auction would be held five years ahead of a scheduled closure. Once constructed and commissioned, the capacity would be in reserve (off market) such that in the event of an early closure (which is desirable) or a coal-fired unit failure near the end of its life, generation can rapidly be brought into the market. This would guarantee a smooth transition for any future coal closures and reduce price volatility, without distorting investment signals for other necessary firmed renewable energy investments. The reserves could also be available to ensure the NSW Energy Security Target is met.

Distributed Energy is a complimentary measure

Rooftop solar PV is an important complementary approach to meeting emission and renewable generation targets and reducing electricity prices for all customers. Rooftop solar PV in 2022 provided 5,878G Wh or 7.9% of generation in NSW in 2022, exceeding that of utility solar generation (6.7%) and not far behind wind generation (8.3%).[10] Yet because DER is owned and operated by the investor customers, who have their own motivations for its operation, household and small business DER cannot be depended on to respond in a system reliability event.

However, Commercial and Industrial (C&I) DER does and can play a significant role immediately. Commercial rooftop solar (systems >100kW) currently accounts for 4,150 MW in NSW or 43% of installed solar rooftop capacity.[11] While the market arrangements to provide flexibility and value for orchestrating these assets are currently in place through ancillary market services, demand response and tariffs, more work is needed to accelerate the participation of C&I in supporting the system. **The NSW Government could look at bolstering the C&I DER incentives to take advantage of this as a key resource.**

7 https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Environment_and_Communications/Coal_fired_power_stations/~/media/Committees/ec_ctte/Coal_fired_power_stations/Final%20Report/report.pdf

8 https://grattan.edu.au/wp-content/uploads/2019/10/922-Power-play.pdf

9 https://ccep.crawford.anu.edu.au/publication/ccep-working-paper/6775/brown-coal-exit-market-mechanism-regulated-closure-highly

10 OpenNem https://opennem.org.au/

11 APVI data: https://pv-map.apvi.org.au/postcode

Context - The clean energy transition is too slow

Australia is transitioning away from ageing fossil fuel power stations and shifting to cleaner and cheaper sources of energy generation, such as wind and solar, with associated storage.

There is broad recognition of both the urgent need to replace ageing coal-fired power stations, and the benefits of clean and low-cost renewable generation.

Australia's coal power stations are withdrawing from the system more quickly than anticipated, leaving a potential shortfall in generation unless we accelerate the rollout of replacement generation. In New South Wales, three coal-fired power stations are scheduled for closure over the next decade. The most cost-effective and environmentally responsible replacement for this generation capacity is renewable generation with integrated storage, to provide dispatchable 'firmed' electricity.

The scale of renewable power generation (of all types and size) that will need to be built is unprecedented. The transmission build that will be required to fully connect the new decentralised generation, rather than large and centralised fossil fuel power stations, is the equivalent of 25 per cent of today's entire grid. It will need to be built in less than 10 years.

The issues facing our energy transition are exacerbated by the global race to decarbonisation. New programs in the United States of America, European Union and Asia are accelerating the clean energy transition by providing clear financial incentives (e.g. the Inflation Reduction Act, USA; the Green Deal Industrial Plan, EU). These programs mean that Australia will need to move quickly to ensure it can attract funding, materials, and skilled people.

The Modelling

The modelling scenarios and inputs by Endgame Economics are based on AEMO's 2022 Integrated System Plan (ISP) Step-Change Scenario, including market, economic, political, and technical constraints, to determine the least-cost capacity mix for 2024 to 2043.

In addition, it was assumed that the new transmission lines in the 2022 ISP optimal development path were supported by the Rewiring the Nation program, and that coal-fired power stations closed as outlined in the 2022 ISP.

The modelling then explored our current transition approach by restricting the delivery of new renewable generation initially to 2.3 GW per year (as was delivered in 2022), growing to 3.8 GW per year by 2043. This scenario is described as "disorderly".

Further scenarios were developed by taking the "disorderly" scenario and also delaying the closure of all coal-fired power stations by two years ("disorderly coal 2y") and then four years ("disorderly coal 4y").

For details on the modelling see Appendix 1 [Endgame Economics paper, 2023]

In this paper we have defined the following terms used in the modelling as:

- Orderly to mean – a timely build out rate of renewable generation transmission and storage in line with the timing and investment outlined in the AEMO 2022 ISP Step Change Scenario
- Disorderly to mean – a slower build out rate of the renewable generation transmission and storage than is needed to meet the AEMO 2022 ISP Step Change scenario. This is the current situation, due to a range of issues, including but not limited to: the lengthy connection process, statutory approvals and transmission delays.

We are not on track

We are not building the renewable generation, storage, and transmission needed to replace the ageing coal-fired power stations fast enough. This is putting at risk electricity reliability and security in the National Electricity Market (NEM), and Australia's ability to meet emissions targets. It will also increase consumer electricity costs, in absolute terms and relative to what they would have been if we had achieved the transition more quickly.

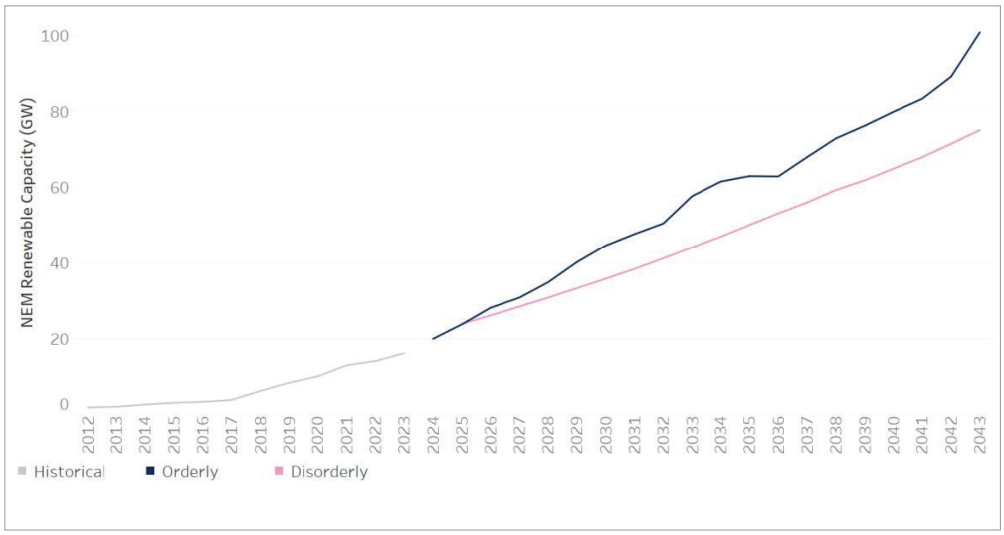


Figure 1: Required renewable generation (dark blue) in the NEM as recommended in the 2022 ISP Step Change scenario versus projected future delivery of renewable generation (pink) based on past delivery rates (grey) showing the significant and escalating shortfall in delivering renewable generation required [Endgame Economics, 2023]

While there is a great deal of positive investor sentiment about new renewable generation and storage in the NEM, as demonstrated by the NSW REZ, even expedited approaches to new transmission and firmed renewable generation are experiencing delays and cost increases.[12]

Unless we take action to quickly and efficiently expedite delivery of new generation, storage, and transmission, the current build out rate will lead to a shortfall in renewable generation capacity of 26 GW across the NEM by 2043.

To resolve any short-term reliability issues in NSW, the AEMO indicates that many of the developments that are already under consideration have the potential to significantly reduce the forecast reliability risk. This includes the renewable generation and long-duration storage to be developed under the NSW Roadmap by the end of 2029.

12 https://reneweconomy.com.au/nsw-renewable-zones-face-delays-and-cost-blowouts-as-questions-hang-over-eraring/

The reliability risk in NSW associated with the closure of Eraring power station in mid-2025 can be mitigated[13] by:

- the addition of necessary transmission, including the completion of the HumeLink and Hunter transmission projects
- a 380 MW tender for firming infrastructure
- a further 457 MW of anticipated battery developments,
- plus the current Retailer Reliability Obligation instruments that are in place

The urgent need for action has been recognised by the NSW Minister for Climate Change, Energy, the Environment and Heritage, who is actively exploring approaches to mitigate the need to delay the closure of Eraring power station. This is being progressed through the Expert Advisory Panel, led by Cameron O'Reilly.[14]

It is also pleasing to see the recent joint announcement by the NSW and federal energy ministers that they will progress a tender for an additional 550 MW of storage capacity under the Federal Capacity Investment Scheme,[15] and the announcement of $100 million of Clean Energy Finance Corporation funding for the 850 MW Waratah Super Battery[16] which will support 1400 MW of new dispatchable capacity in NSW (Eraring Power Station has a capacity of 2,880 MW).

These are important steps towards managing the closure of coal-fired power stations, and ensuring that Australia and NSW will have a coordinated and well-managed transition to low carbon power.

Implications are significant

The current slow rate of renewable generation build, plus delays in building the new transmission to connect it to the market, means we could be reliant on fossil fuel-fired power generation for longer than planned. Modelling by Endgame Economics highlights the significant implications of this.

Risks to the NEM's power reliability and security

Our coal-fired power stations are old, increasingly unreliable[17] and expensive. Even by achieving the power station closures as scheduled, the NEM, particularly in NSW and Queensland, will remain reliant on coal-fired generation into the future, backed up by increased use of flexible gas peaking plants because of coal plants' reliability issues.

New gas-fired power stations and pumped storage projects have been delayed significantly, presenting little hope of resolving the power reliability and security issues with a business-as-usual approach.

Should the rollout of renewable generation continue at the current slow pace, then it is likely the scheduled closure dates of other coal power stations will also be missed, such as Vales Point and Yallourn, exacerbating these issues.

13 https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/nem_esoo/2023/february-2023-update-to-the-2022-esoo.pdf

14 https://www.nsw.gov.au/media-releases/electricity-sector-check-up

15 https://minister.dcceew.gov.au/bowen/media-releases/joint-media-release-capacity-investment-scheme-power-nsw-clean-cheap-reliable-energy

16 https://minister.dcceew.gov.au/bowen/media-releases/joint-media-release-100-million-investment-waratah-super-battery-deliver-more-reliable-cleaner-cheaper-energy-nsw

17 https://reneweconomy.com.au/coal-plant-reliability-hits-a-new-low-as-unplanned-unit-outages-hit-a-new-high/

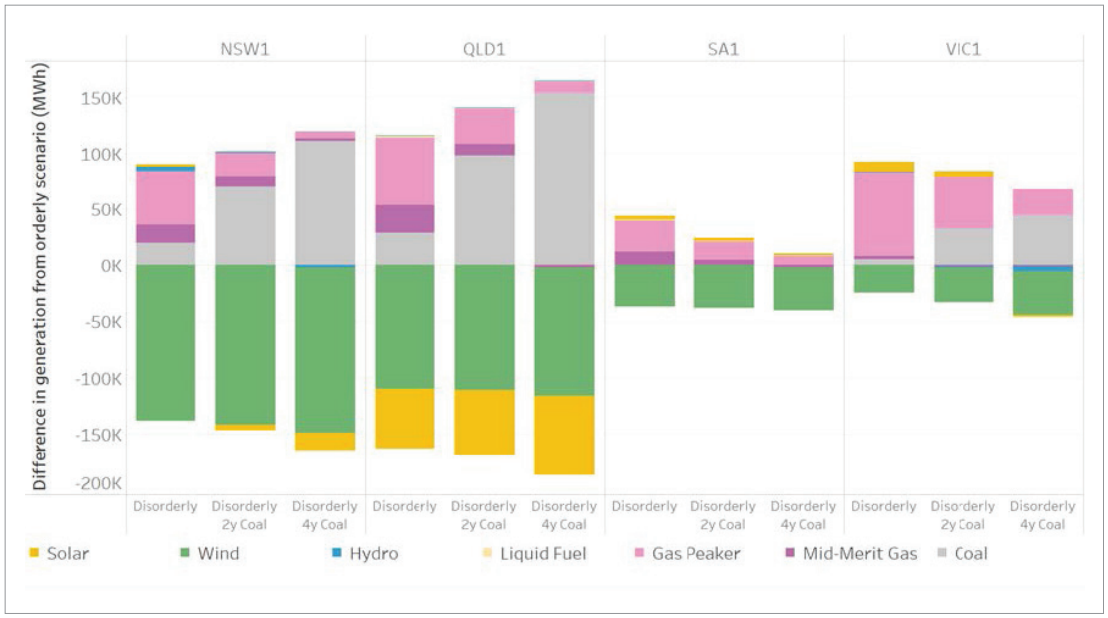


Figure 2: Continuing to transition at the current slow pace means that Australia will rely more on coal and gas, increasing emissions and pushing out clean generation such as wind and solar [Endgame Economics, 2023]

Emissions target and budget will be missed

Delaying the closure of our coal-fired power stations, such as Eraring and Vales Point, means that the NEM will be reliant on high carbon polluting generation, such as coal and gas, for longer. This undermines Australia's chances of meeting carbon emissions goals.

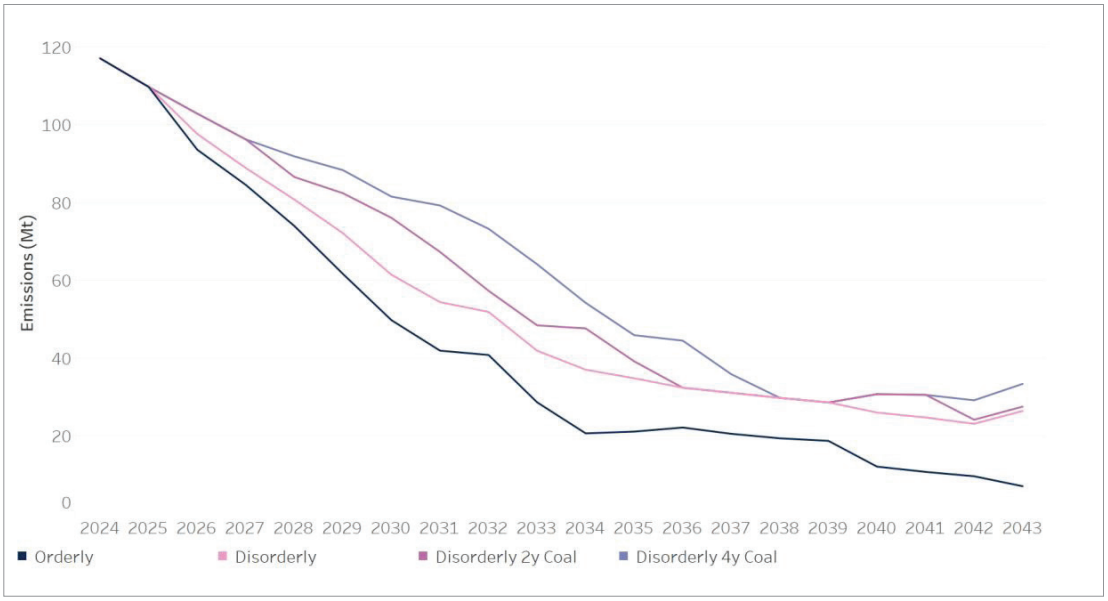


Figure 3: In a transition as outlined in the 2022 ISP, NEM carbon emissions steadily reduce to close to zero by 2043 (dark blue). On our current slow transition pathway, emissions also reduce over time, but more slowly, flattening out in 2042, and implying that net zero will not be achieved (pink). If the closure of coal power stations is delayed by 2 years (magenta) or 4 years (blue) then emission reductions occur more slowly and plateau in 2040, before increasing, resulting in net zero targets being missed [Endgame Economics, 2023]

If the transition continues on its current slow trajectory, Australia will exceed the carbon emissions 'budget' used in the AEMO 2022 Integrated System Plan in 2037. If all coal-fired power station closures are delayed by two years, the carbon budget will be breached in 2034.

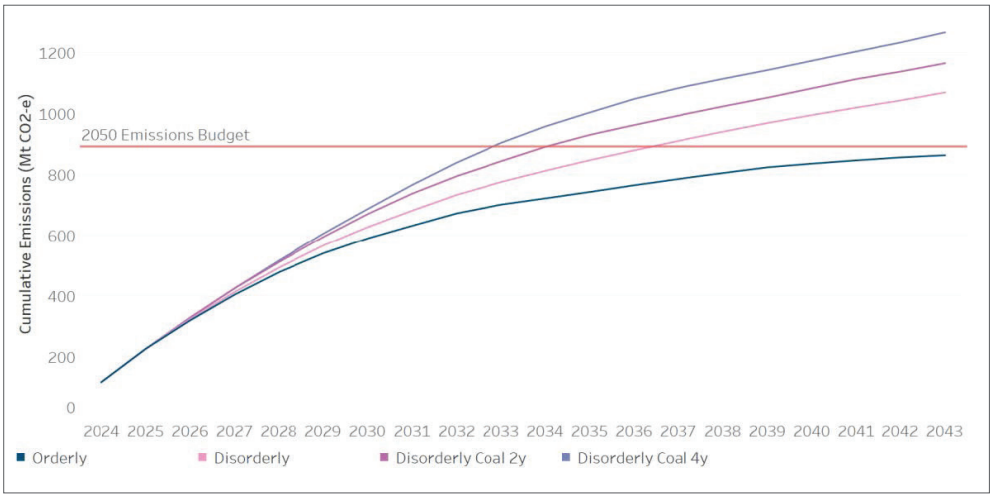


Figure 4: In a transition based on the 2022 ISP, Australia stays within the carbon budget necessary to achieve net zero by 2050 (dark blue). With our current slow transition, Australia will exceed its carbon budget in 2037 (pink) making it unlikely that net zero would be achieved. If the closure of coal power stations is delayed by 2 years (magenta) or 4 years (blue) then Australia will exceed its carbon budget in 2034 and 2033 respectively, resulting in net zero targets being missed [Endgame Economics, 2023]

The modelling indicates that extending Eraring's closure date by two and four years generates around 18.3 million and 34.5 million tonnes of carbon dioxide equivalent ($Mt_{CO2\text{-}e}$) respectively.

While Australia does not have a carbon price, the NSW Government has legislated that all investments in the state must take into consideration a carbon price when undertaking a cost-benefit analysis. The price to be used is that defined in the European Union Emissions Trading System,[18] with a current average of EU$90 per tonne of CO_2 equivalent carbon ($t_{CO2\text{-}e}$) in 2023, equating to approximately AU$150 per $t_{CO2\text{-}e}$.

If we continue on our current slow transition pathway, the cost of the extra emissions produced would be $160 billion by 2043. This is $31 billion more than the emissions cost for a transition based on the 2022 ISP. Delaying the closure of Eraring would add a further $2.7 billion over two years and $5.2 billion over four years to the increased emissions cost of the slow transition.

Consumer bills will increase

If we do not take action to get back on track with our energy transition, consumers in all the mainland states will pay more for electricity than they otherwise would in an accelerated transition achieving the goals outlined in the 2022 ISP. Consumers in NSW will be paying an additional $769 and consumers in Queensland an additional $1110 by 2043.

	2027	2031	2035	2039	2043
NSW	106.3	352.0	441.5	340.6	768.6
SA	109.3	343.9	394.4	201.2	587.1
VIC	90.5	334.3	348.2	157.4	639.0
QLD	65.0	221.8	388.9	242.0	1109.5

Table 1: Additional costs to consumers on our current slow transition pathway

In total, the typical consumer will pay between $4500 and $6,000 more cumulatively (dependent on state) over the next twenty years, than they otherwise would have if the transition been more effectively managed.

18 https://www.treasury.nsw.gov.au/sites/default/files/2023-03/20230302-technical-note-to-tpg23-08_carbon-value-to-use-for-cost-benefit-analysis.pdf

Figure 5: Comparative cost per consumer of a transition based on the 2022 ISP (dark blue) and continuing our slow transition (pink), showing the increased costs of our current slow transition [Endgame Economics, 2023]

Renewable energy generation targets will be missed

Should the transition continue on the current pathway of lagging behind the required build rate for firmed renewable generation and transmission, Australia will be highly unlikely to meet the Federal Government's 82% Renewable Energy Target in 2030. On our current slow pathway, only slightly more than 60% of electricity in the NEM will be generated by large-scale renewables in 2030. Even on the ideal pathway, the 82% target can only be met in 2030 by including rooftop solar photovoltaic (PV).

Further, delaying the closure of Eraring power station may trigger delays in the closure of other coal-fired power stations to address short-term concerns related to reliability. Continuing reliance on coal generation beyond anticipated closure dates will reduce the confidence of potential investors in the new firmed renewable generation that is needed to deliver a clean energy future.[19]

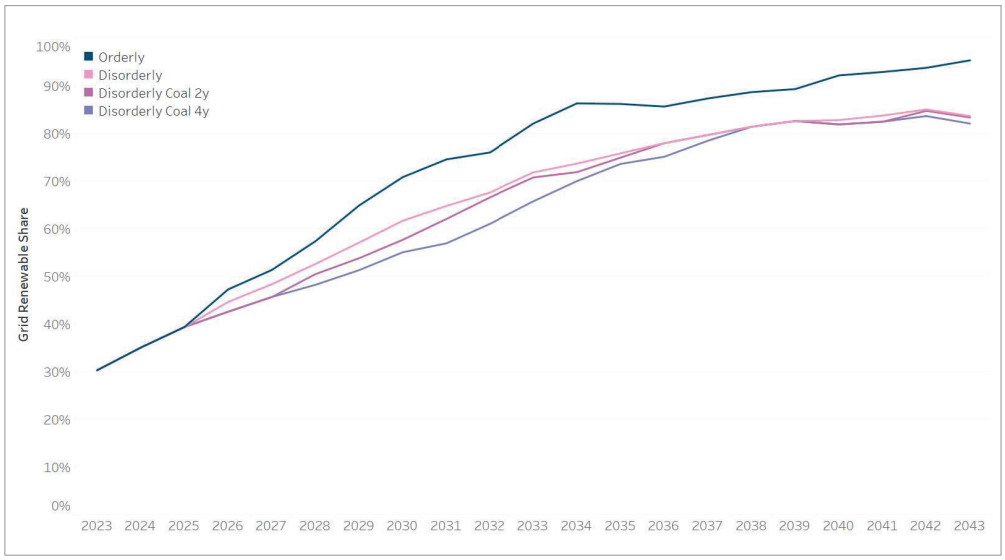


Figure 6: Renewable generation share (ignoring the contribution from rooftop solar PV) showing the target for meeting 82 % renewable generation by 2030. On our current trajectory (pink) 82 % renewable generation would not be achieved until 2038-39. Delaying the closure of coal power stations by 2 years (magenta) or 4 years (blue) similarly delays the achievement of the target [Endgame Economics, 2023]

19 https://www.afr.com/companies/energy/taylor-moves-to-delay-the-exit-of-coal-from-grid-20220407-p5abjc

Transmission the missing link

Australia needs to build 10,000km of transmission, equal to 25 per cent of today's entire transmission grid, in less than 10 years. Even if we could generate enough renewable energy, we do not have the transmission infrastructure required to convey it to consumers.

The scale of build required risks supply chain and procurement bottlenecks for the regulated monopoly networks. Transgrid must compete on the international stage for highly specialised assets, and skilled labour such as project management of large infrastructure projects.

Transmission is not being approved and built fast enough and this is then slowing down the renewable generation and storage build needed.

As part of this, lengthy and uncertain approvals process do nothing to ensure social licence from and compensation of host communities.

Recent work by Nexa Advisory[20] demonstrates that Australia's regulated monopoly Transmission Network Service Providers (TNSP) are small in comparison to the established international companies already operating in Australia. These international entities have asset bases equivalent to the entire transmission asset base of the NEM ($22 billion), earning a revenue equivalent to the largest TNSP in the NEM, Transgrid.

Transgrid indicates that over $14 billion of investment is needed in 2,500 km of new transmission in NSW, while needing a further $16 billion a year to operate this expanded system.[21] Transgrid has also repeatedly sought regulatory changes, because they are unable to finance the required new transmission without damaging their credit rating.[22,23]

Opening up the transmission market in NSW to competition, as the NSW Government has done already for the delivery of the REZ transmission would:

- encourage innovation in both technical approach and delivery, promoting long-term efficiency and reducing energy costs to customers
- attract international private finance and capital quickly and efficiently, potentially alleviating financing constraints in the delivery of transmission by regulated PTNSPs
- achieve greater efficiency in the construction, operation and maintenance of transmission assets

Additionally, continuing to restrict the delivery of new transmission to the regulated monopoly TNSP will cost customers in the NEM $13 billion more than seeking to deliver new transmission competitively.[24]

20 https://nexaadvisory.com.au/site/wp-content/uploads/2023/06/Nexa-Advisory_Transmission-Contestability-in-Australia-Research-Report-June-2023.pdf

21 https://www.transgrid.com.au/media/avyondr4/system-security-roadmap-2023.pdf

22 https://www.aemc.gov.au/rule-changes/participant-derogation-financeability-isp-projects-transgrid

23 https://www.aemc.gov.au/sites/default/files/2023-07/ENA%20rule%20change%20request%20-%209%20June%202023.pdf

24 https://nexaadvisory.com.au/site/wp-content/uploads/2023/06/Nexa-Advisory_Transmission-Contestability-in-Australia-Research-Report-June-2023.pdf

We need actions to accelerate and get on track

It is not too late to take the necessary actions to get back on track - if we act now and work fast, we can meet build targets and achieve the current schedule of coal-fired power station retirements.

Taking the right actions now would see the timely build of sufficient renewable generation and storage, and its connection to the wider system by new transmission. Modelling estimates that 4 GW of dispatchable renewable energy capacity must be added each year across the NEM, ahead of the closure of coal-fired power stations. This would be ~2.3 GW of capacity in NSW alone. By 2043, the amount of renewable capacity in the NEM is modelled to be 26 GW higher in the scenario based on the 2022 ISP, rather than on our current slow trajectory (Figure 1).

A clear and certain approach to accelerating the transition is critical to ensure that private capital and investment is available to build the new generation, transmission and storage.

Recommendations to bring forward investment in NSW

The NSW energy minister is actively exploring approaches to mitigate the need to delay the closure of Eraring power station. We provide these potential complementary actions and options to be considered as part of the broader review that seeks to ensure consumers in NSW have a reliable, affordable, and clean source of electricity.

Lean into new capacity build

The Federal Government should continue to mobilise funding through the Capacity Investment Scheme (CIS) and/or the Clean Energy Finance Corporation (CEFC) to bring forward new dispatchable renewable generation (renewable generation plus storage) in NSW, building on recent announcements. This, in concert with the continuing actions of the NSW government through the NSW Energy Infrastructure Act and EnergyCo to bring forward renewable generation and storage, would be a robust response to managing these closures in NSW.

The federal and NSW governments should continue to work together to leverage the funding through the CIS and the CEFC to underpin the delivery of new renewable generation and storage capacity in NSW.

Bolster firming procurement in advance

The NSW Energy Infrastructure Act provides incentives for the delivery of new renewable generation, firming and long duration storage through the LTESAs.

However, currently a firming LTESA can only be sought when a future breach of the security requirements has been identified in the annual Energy Security Target Monitor. While the response to firming tenders has been robust, firming, such as batteries, may not be delivered in time if the only trigger is the identification of a future breach of reliability standards.

There may be benefits to procuring firming through the LTESA mechanism ahead of identified breaches, as this would provide cost-effective “insurance” against an unexpected earlier loss of capacity, such as the earlier-than-announced closure of a coal-fired power station. It would also be more efficient than urgently trying to secure firming.

Additionally, securing firming early provides a strong signal to investors of the need and desirability of new battery projects.

The NSW Government, through EnergyCo should accelerate firming auctions to replace Eraring, and bring on additional "insurance" capacity earlier in the Renewable Energy Zones (REZ).

The design of the LTESA contracts could also be amended as a tool to speed up the buildout of RE in the State.

The LTESA contracts are currently designed to act as 'insurance' products by providing minimum cash flows for projects if their revenues decline when electricity prices are low. Whilst this is useful to address the concerns of banks, equity financiers retain higher levels of risk.

There is a strong pipeline of projects in NSW. To improve the flow of committed projects, the NSW Government could amend its LTESA contracts to ensure they address the level of excessive risk for equity investors. Those amendments could be in place for a limited time only (say 2-4 years) while NSW builds a buffer of generation and storage capacity ahead of Eraring's (and other thermal plants') closure.

We note that there is bi-partisan support for the LTESA framework in NSW and this recommendation is not suggesting a re-write of the LTESA contracts, rather an add-on or amendment to the template LTESA contract to temporarily improve the risk profile for equity investors.

Whilst it may be more difficult politically, another alternative could be for the NSW and/ or Commonwealth governments to consider offering proven and effective mechanisms such as the more traditional and understood contracts for difference used in the ACT and Victoria.

To improve the flow of committed projects, the NSW Government, through EnergyCo, could temporarily offer amended LTESA contracts or contracts for difference.

Explore Long Duration Storage

Established electricity storage technologies with a discharge duration of eight hours or longer are limited. While very large batteries are an option for long duration storage, the only established such technology is pumped hydro-electricity. However, suitable geographic locations are few and community concerns about environmental damage may make securing sites difficult.

Additionally, holding back capacity from the market, to always ensure that a specified storage capacity can be delivered on the limited occasions it is required, will result in very high costs for availability.

One option is to adopt a portfolio approach to long duration storage, which includes a hybrid of renewable generation and batteries.

Further, the federal and NSW governments should work together to explore the development of scalable long duration electricity storage such as flow batteries and/or liquid air energy storage technologies. This is because larger and larger lithium-ion batteries are not best suited to long duration storage approaches and are not the most efficient use of fast response lithium-ion battery applications. Commencing this work now will ensure that long-duration storage technologies are ready to be deployed when needed.

The NSW Government, through EnergyCo, to explore whether there is a role for the LTESA to underpin a portfolio approach to delivering hybrid storage with generation projects (rather than separate tenders for individual generation or storage projects).

The federal and NSW governments to immediately commence exploring support for scalable long duration technologies, such as flow batteries and thermal energy storage, leveraging ARENA and CEFC funding options.

Look beyond the REZ

The immediate priority in NSW has been to focus on the declared REZs. However, there are likely to be high value, high-capacity projects outside of REZs that can be prioritised to deliver diversified sources of capacity and storage.

The NSW Electricity Infrastructure Investment Act 2020[25] specifies the capacity of generation to be added inside and outside the REZ. It suggests that 1 GW is needed outside in the REZ by 2029. However, the capacity outlined in the legislation is the minimum requirement and there is scope to seek additional investment.

There are a number of generation and storage projects that have been proposed by developers but not progressed due to the focus on investment in the REZs. Limiting the delivery of new projects to the REZs hampers the ability of the NSW government to address security concerns, particularly where there may be residual transmission capacity that can support new generation connections outside the REZs. Encouraging new developments beyond the REZs would attract investment where it is needed and allow the transition to progress at a faster pace.

25 https://legislation.nsw.gov.au/view/html/inforce/current/act-2020-044. Clause 44.3

	Solar PV	Wind Onshore	Wind Offshore	Batteries	Other Storage	Total
Committed	980	396	0	300	0	1,676
Anticipated	205	617	0	1,769	0	2,591
Total Committed & Anticipated	1,185	1,013	0	2,069	0	4,267
Proposed	4,417	14,835	9494	3,421	200	32,367^

Table 2: Committed and anticipated Renewable generation and storage waiting to connect outside the REZ in NSW (MW). ^The 32.4 GW of proposed generation and storage includes 1.5 GW of generation inside the Central West-Orana REZ[26]

Analysis of the renewable generation and storage projects waiting to connect outside the REZ in NSW shows that there is 1.7 GW of committed projects and 2.6 GW of anticipated projects, providing a total of 4.3 GW of new renewable generation and storage. However, these projects are still working through connection arrangements to secure agreements. Expediting the connections and statutory approvals for projects determined as high value for NSW energy transition and reliability measures, would result in earlier commissioning of these projects. While we welcome the May 2023 announcement from the Energy and Climate Change Ministerial Council – Energy Ministers Sub-Group to provide support to AEMO to deploy additional resources to support NEM projects that are targeting connection for the 2023-24 summer,[27] we believe more can be done. Transgrid is a critical partner with AEMO in delivering new connections in NSW; providing resources to expedite the connections process would result in additional renewable generation and storage projects coming online earlier. It would also provide confidence to investors that projects can progress rapidly.

Additionally, underwriting Power Purchasing Agreements (PPAs) for new renewable generation (and storage) projects would support a more rapid financial close on new developments, supporting earlier delivery of new firmed generation.

The NSW Government, through EnergyCo, should actively facilitate new renewable generation and storage projects outside the declared REZ, to ensure that all new capacity is connected in a timely manner and to utilise existing capacity in the transmission system. This will minimise the risk of reliance on REZs as the sole source of new generation investment.

The Federal Government could also explore underwriting Power Purchasing Agreements (PPAs) and or CIS for new renewable generation (and battery) projects, which would ensure earlier financial close and a more rapid delivery of new firmed generation projects.

26 https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/generation_information/2023/generating-unit-expected-closure-year.xlsx?la=en

27 https://www.energy.gov.au/sites/default/files/2023-05/EMSG1%20final%20communique%2019%20May%202023_0.docx

Enable critical transmission lines

While EnergyCo has been focusing on the delivery of the transmission in the REZ, delivering other priority transmission projects outside of these REZ, including the interconnectors identified in the 2022 ISP, will further support the connection of new firmed renewable generation.

The NSW Electricity Infrastructure Investment Act 2020[28] supports the delivery of priority transmission lines identified in the ISP, but this should be extended to non-ISP identified transmission lines.

Where transmission capacity may be limiting new projects outside the REZs, it may be possible to identify a limited number of relatively minor priority transmission augmentations that would efficiently facilitate a large opportunity for new firmed renewable generation. By signalling the need for both generation and storage in these non-REZ locations, investors would be able to proceed with developments.

Innovative technologies can be used to maximise the available capacity of existing transmission lines (e.g. active network management via power flow controller technologies) and have already been used in NSW.[29]

Developing social licence for new transmission is important and delivering the benefits of access to clean, low-cost firmed generation is critical. New transmission lines are essential nation-building infrastructure that underpin the security of electricity supply, while driving economic prosperity and reducing energy bills.

Extending the contestable delivery of new transmission lines in the REZ to all new transmission lines in NSW will introduce the competition that will accelerate delivery, enhance supply chain and procurement leverage, and innovation, and reduce costs for consumers.

The federal and NSW governments should advocate for new transmission lines to underpin the clean energy transition by designating it "nation-building" and expediting delivery of priority transmission, supported by appropriate compensation schemes for regional communities.

The Federal Government should make transmission contestability a pre-requisite for access to Rewiring the Nation funds.

The NSW Government should extend the competitive delivery of new transmission to all new transmission in NSW.

The NSW Government, through EnergyCo, to explore delivery of priority transmission projects that would support the connection of new firmed renewable generation and extend the "priority transmission" definition to all new transmission projects, including unsolicited projects, not just those identified in the ISP.

28 https://legislation.nsw.gov.au/view/html/inforce/current/act-2020-044. Clauses 32 & 34

29 https://www.energymagazine.com.au/transgrid-delivers-45m-vni-upgrade-unlocking-170mw/

Beyond the Eraring Closure

While we have proposed some immediate actions above that would promote a transition to a low carbon power system, there are further approaches that need to be taken to ensure that the power system and market are ready and accommodating of coal-fired power stations closures, without resulting in reliability or price shocks.

The closures of Liddell and Eraring power stations provide lessons for future closures, such as Vales Point.

Providing clarity to the market on when a coal-fired power station will cease operation provides developers and investors with the confidence to progress new renewable generation and storage projects.

There are a number of options for providing clarity in NSW and other jurisdictions:

1. A ministerial declaration on the dates for coal-fired power stations to cease operation would provide certainty for the owners and operators, AEMO as the power system and market operator, and developers of new generation and storage projects.

2. A legislated closure mechanism (national or state) would set the closure date for coal-fired power stations in legislation.[30] There would need to be a very limited degree of flexibility around the dates, with the owners and operators of the power stations required to define a window for closure, which would narrow as the date approaches. This mechanism would need to incorporate a penalty to ensure compliance with the closure date (e.g. funds in escrow[31,32]).

3. The development of a strategic operating reserve, where new firmed renewable generation is underwritten through an auction under the established Capacity Investment Scheme. The auction would be held five years ahead of a coal closure. Once constructed and commissioned, the capacity would be in reserve (off market) such that in the event of an early closure (which is desirable) or if a coal-fired unit fails near the end of its life, generation can rapidly be brought into the market. This would guarantee a smooth transition for future closures and reduce price volatility, without distorting investment signals for other necessary firmed renewable energy investments. The reserves could also be available to ensure the NSW Energy Security Target is met.

30 https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Environment_and_Communications/Coal_fired_power_stations/~/media/Committees/ec_ctte/Coal_fired_power_stations/Final%20Report/report.pdf

31 https://grattan.edu.au/wp-content/uploads/2019/10/922-Power-play.pdf

32 https://ccep.crawford.anu.edu.au/publication/ccep-working-paper/6775/brown-coal-exit-market-mechanism-regulated-closure-highly

Note on the role of DER

Distributed Energy Resources (DER), such as household rooftop solar PV and batteries, and community batteries, do have an important proven role in supporting emissions reductions. They will lower costs for all consumers and ensure we reach the target of 82% of all electricity generation by renewables in 2030.

Rooftop solar PV is an important complementary approach to meeting emission and renewable generation targets and reducing electricity prices for all customers. Rooftop solar PV in 2022 provided 5,878GWh or 7.9% of generation in NSW in 2022 exceeding that of utility solar generation (6.7%) and not far behind wind generation (8.3%).[33] Yet because DER is owned and operated by the investor customers, who have their own motivations for its operation, household and small business DER cannot under current market arrangements count towards meeting reliability standards.

However, Commercial and Industrial (C&I) DER does and can play a significant role immediately. Commercial rooftop solar (systems >100kW) currently accounts for 4,150 MW in NSW or 43% of installed solar rooftop capacity.[34] While the market arrangements to provide flexibility and value for orchestrating these assets are currently in place through ancillary market services, demand response and tariffs, more work is needed to accelerate the participation of C&I in supporting the system. The NSW Government could look at bolstering the C&I DER incentives to take advantage of this as a key resource.

The 2022 AEMO Integrated System Plan (ISP) step-change scenario, which was the basis for the modelling in this paper, does include DER.

Note on reliability standards

The AEMC Reliability Panel sets both the Reliability Standard of 0.002% of Unserved Energy (USE, meaning 0.002% of electricity demand in a state (region) cannot be met by generation, which is equivalent to an average household having a power cut for 10-11 minutes in one year[35]) and the more conservative Interim Reliability Measure of 0.0006 % USE.

The annual AEMO Electricity Statement of Opportunities (ESOO) assesses the ability of each state and the NEM to meet the standards in the coming five years. Additionally, AEMO Services assess the ability of NSW to meet the standards in the annual Energy Security Target Monitor (ESTM), who advise the NSW minister, in conjunction with the biennial Infrastructure Investment Objectives (IIO) report, on capacity and transmission lines needed to deliver electricity reliably.

However, in a recent review the AEMC Reliability Panel identified that the current standards may not be fit-for-purpose for a renewable energy power system and that work is underway on considering new metrics:[36]

"A single 'expected value unserved energy' metric provides insufficient information on the distribution of USE in a high VRE power system and may not effectively reflect changes in the NEM's reliability risk profile by 2028… The Panel considers that there is likely to be a material benefit from amending the form of the reliability standard following 1 July 2028."

As experience in operating a high renewable generation system, with inverter support, reliability standards will inevitably adapt and may be less conservative.

33 OpenNem https://opennem.org.au/

34 APVI data: https://pv-map.apvi.org.au/postcode

35 https://reneweconomy.com.au/this-is-no-time-for-energy-ministers-to-panic-over-reliability-standards-37320/

36 https://www.aemc.gov.au/sites/default/files/2022-09/2022%20RSS%20Review%20Final%20Report%20%281%29.pdf

www.nexaadvisory.com.au
info@nexaadvisory.com.au

nexa
ADVISORY

Modelling the impact of a disorderly transition

Date: 20 July 2023

1. Introduction

1.1. Scope of engagement

Endgame has been engaged by Nexa Advisory to highlight the need for the National Electricity Market's (NEM) transition to net-zero emissions to occur in an orderly manner. We do so by modelling the consumer cost and emission impacts of the transition under various orderly and disorderly scenarios.

1.2. Key takeaways

Conditions for an orderly transition

- If an orderly transision is to occur, the roll out of renewable build needs to be sufficient and timely. Transmission and storage investment is also required to transfer VRE generation between regions and during periods of low VRE availability, and to provide a more resilient energy system.

Prices increase if we build insufficient renewables and transmission

- Long-term consumer costs are lowest when the transition occurs in an orderly manner.
- Wholesale electricity prices and in turn consumer costs rise when the transition is disorderly.
- These price increases will likely induce coal life extensions both for price and reliability.

Emissions increase in this disorderly world particularly if coal closures are delayed

- A disorderly transition will also contribute to much higher emissions than an orderly transition. Emissions rise even further if coal closures are delayed. These all result in Australia not meeting its 2030 targets.
- The NEM fails to meet its cumulative emissions target of 890.7 Mt CO2-e and Australia may be unable to reach net-zero emissions by 2050 unless the transition follows an orderly trajectory.
- Eraring generates around 18.3 million and 34.5 million tonnes of additional carbon if its closure date is extended by two and four years respectively.

How are we currently tracking?

- Historical and committed renewable generation entry suggests Australia is closer aligned with a disorderly transition than an orderly transition.

Government action

- Current government plans may be insufficient due to issues such as supply chain constraints.
- Given this, governments may need to act to to develop plans that address these issues and promote the build out of sufficient and timely renewable, storage and transmission.
- Costs are likely to be lower if these supply chain constraints are addressed soon.

What does this mean for Eraring, Yallourn and other future closures?

- If sufficient renewable energy capacity does not enter the system, we increase the risk that there will be an insufficient amount of generation built to to replace Eraring before its scheduled closure date.
- Additional transmission infrastructure enables renewable assets to connect to retire coal plant in a timely manner. Least cost capacity expansion modelling demonstrates that the required renewable mix is primarily wind since solar is reliant on relatively expensive storage to meet evening peak demand and overnight periods.
- Noting that in the last five years Eraring has contributed around 21 per cent of generation in meeting annual NSW demand, plans must be developed to deliver commensurate renewable energy construction and operational commencement within the next 2 years, particularly in NSW. The modelled orderly scenario includes approximately 4 GW of new, primarily wind, renewable energy capacity per year.

1.3. Context

The National Electricity Market (NEM) is currently experiencing fundamental changes to its generation mix and operational patterns driven by Australia's commitment to reach net-zero emissions by 2050. As part of this transition, the NEM is shifting away from the existing thermal fleet towards renewables and storage facilities.

The transition towards clean energy, however, is a unique and significant challenge and may have important ramifications for Australia if not done in an orderly manner.

We identify two key requirements of an orderly transition. Firstly, there needs to be sufficient renewables, transmission and storage to operate the system and meet energy demand into the future; the latter two here are required to transfer variable renewable energy (VRE) generation between regions and during periods of low VRE availability, prevent curtailment and to provide a more resilient energy system. Secondly, the roll out of these projects needs to be timely and completed ahead of coal closures, both planned and unplanned.

If these requirements are not met and the transition instead becomes disorderly with either or both insufficient and untimely new build, the resilience of the system may be compromised, wholesale prices may become more volatile and higher costs will be passed onto consumers.

Governments may also decide to respond to the challenges of a disorderly transition by intervening to delay coal closures. This, however, would have a significant impact on emissions and Australia would likely be unable to meet its climate commitments.

As it currently stands, the transition is most likely following a disorderly trajectory. Although some federal and state governments have set ambitious targets for reducing emissions, the

current plans to deliver on these targets may be insufficient due various constraints. Increased competition for raw materials and labour, exacerbated by heightened international policy support (eg, US Inflation Reduction Act and REPowerEU), is adding pressure to global supply chains that were already disrupted by the COVID-19 pandemic. Compounding this are challenges around grid-integration, securing finance, land acquisition, obtaining social license and addressing community engagement concerns.

Given this, if renewable, storage and transmission build out is due to be delivered in a timely and sufficient manner, federal and state governments may be required to develop plans that address these challenges. This, in turn, will facilitate an orderly transition with lower prices, lower emissions, and increased resilience.

This report details our modelled consumer cost and emission impacts of the transition under various orderly and disorderly scenarios.

2. Model description

We firstly prepared a long-term planning model where the least-cost capacity mix was determined from FYE 2024 to 2043 subject to market, economic, policy and technical constraints. Input assumptions largely reflected AEMO's final 2022 ISP Step Change scenario which was found to be the scenario that is most likely to eventuate through stakeholder review. Transmission projects were assumed to be delivered according to the ISP's optimal development path accelerated by the Rewiring the Nation program. To define the level of VRE and demand at each time interval, we used a POE10 rolling reference year approach for the planning model and AEMO's POE50 2019 reference year data for the dispatch model. Other key assumptions were:

- There is enough long-duration dispatchable supply to meet demand throughout any VRE droughts.
- Gas and coal fuel prices are capped to $12/GJ and $125/t respecively up to FYE 2024. From here onwards, they reflect the 2023 draft IASR diverse step change scenario.
- Thermal and hydro plants bid strategically based on historical bidding behaviour.
- Storage facilities seek to recover the opportunity cost of their cycling.

The capacity mix determined by the planning model reflects the scenario where the transition occurs in an orderly manner (referred to as 'Orderly'). We then adjusted this modelled capacity mix to develop the following disorderly scenarios:

- A disorderly transition scenario (referred to as 'Disorderly'), where VRE build[1] is delayed. In FYE 2026, we restrict annual construction of VRE build to 2.3 GW. We then eased this restriction by 100 MW each year so that VRE build is limited to 3.8 GW by FYE 2043[2]. We also did not allow an investment response here meaning that additional thermal generation or storage cannot be built to cover any shortfalls.
- The above disorderly transition scenario (referred to as 'Disorderly 2y Coal') but where all coal closures are delayed by two years, and

[1] That is not already committed.
[2] This reduced VRE rollout is a proxy for several possible causes for delay including delayed transmission build.

- The above disorderly transition scenario (referred to as 'Disorderly 4y Coal') but where all coal closures are delayed by four years.

We then prepared a short-term dispatch model to examine price and generation outcomes subject to these scenarios.

One of the reasons why we only modelled two and four year extensions to coal closures is because the coal plants would exceed their technical lives and would no longer be economically viable if we extended them further.

3. Modelled results

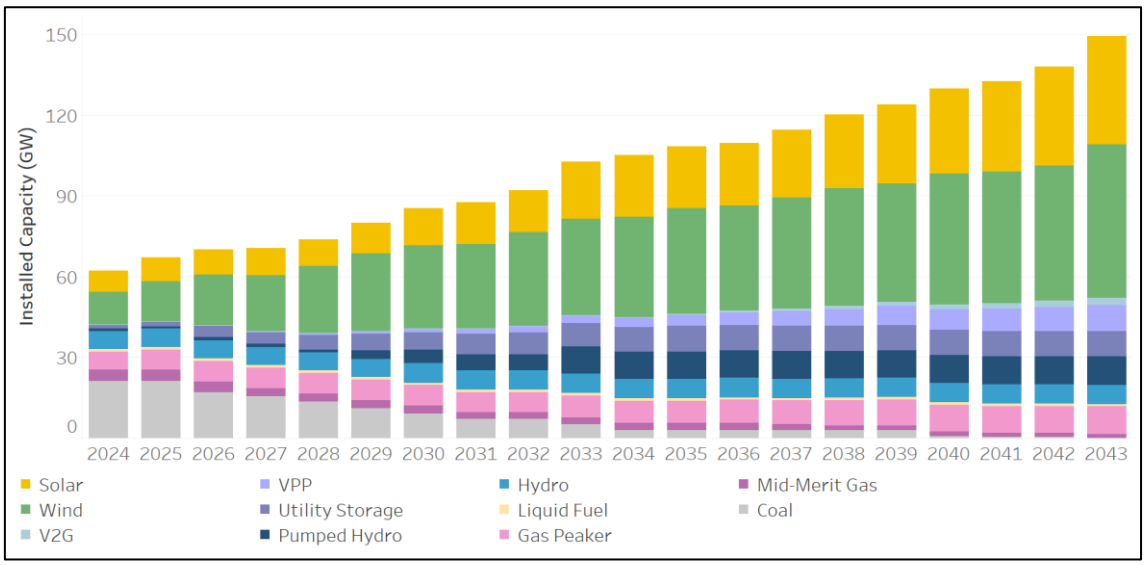
3.1. Capacity and generation

We firstly show the capacity and generation results for all orderly and disorderly scenarios.

Capacity

Figure 1 below shows the capacity mix under the orderly transition scenario. Steady reductions to coal capacity are projected from 21 GW in FYE 2024 until the entire coal fleet has retired by FYE 2040. In contrast, the capacity of VRE increases from around 20 GW to 88 GW by FYE 2043 as does storage (utility-scale and pumped hydro) from 2 GW to 20 GW and distributed storage (virtual power plants and electric vehicles) from 0 GW to 12 GW. Aggregate gas capacity remains around 11 to 12 GW throughout the transition with gas providing important support to the system in periods of protracted low VRE generation.

Figure 1 - Modelled installed capacity for the NEM by FYE for orderly scenario

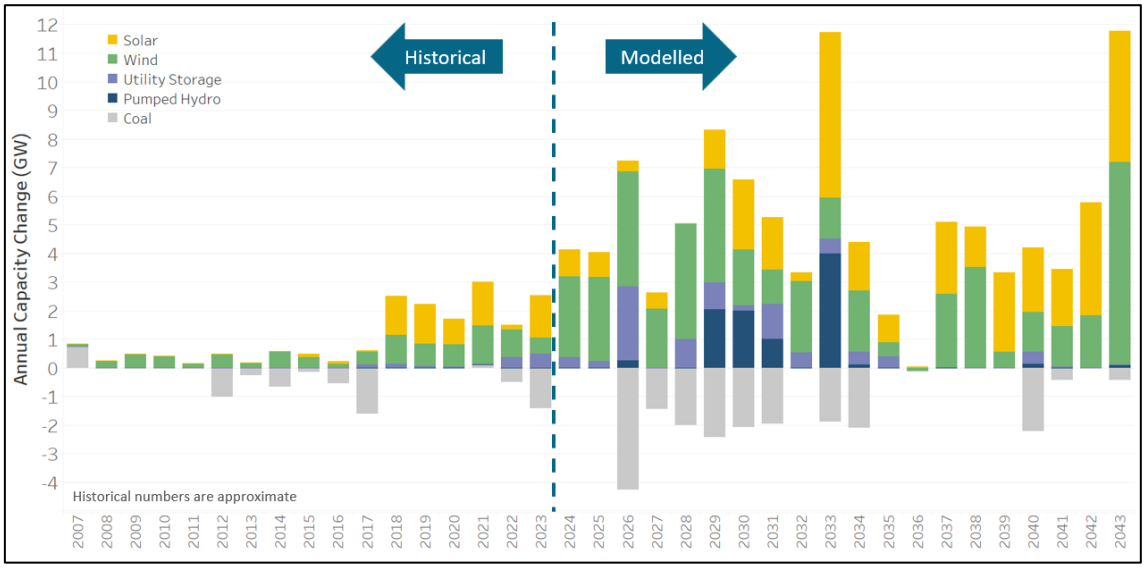


From Endgame Economics March 2023 Price Projection

Figure 2 below shows NEM-wide capacity changes for VRE, storage and coal for the orderly case. Historical and modelled values are shown to the left and right of the blue dotted line respectively. The chart highlights how demanding the transition will be since the rate and scale of required VRE build into the future significantly outweighs what has been achieved in

the past. This emphasises the need for governments to act now and develop plans that promote and accelerate the entry of this build rather than allowing it to be delayed.

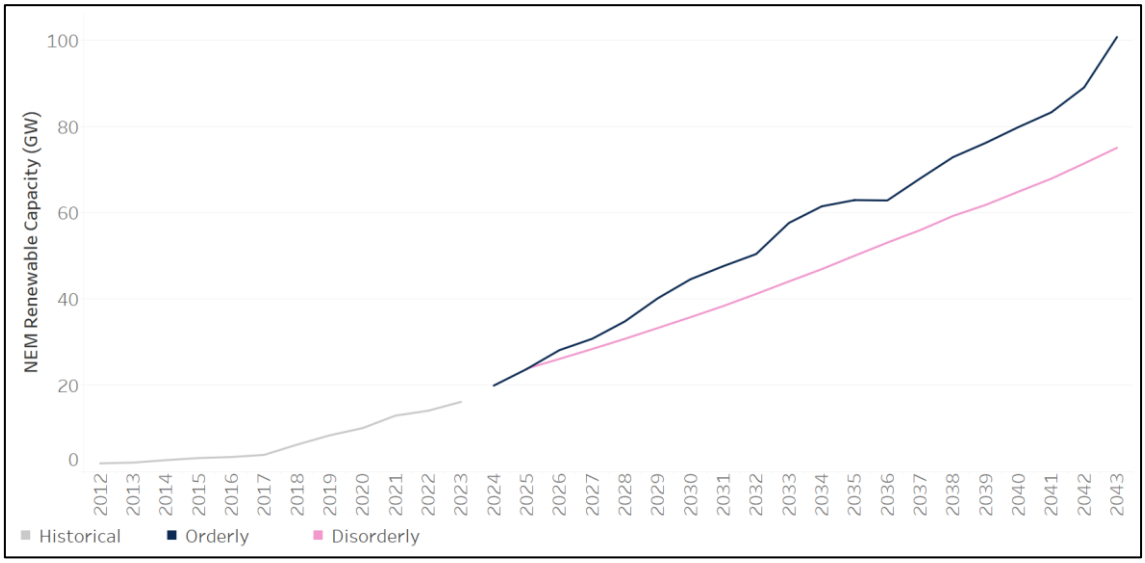
Figure 2 – Historical & modelled NEM-wide capacity change by FYE for orderly scenario



From Endgame Economics March 2023 Price Projection

A similar capacity mix is reflected in the disorderly scenario but with restrictions to VRE build and delays on coal retirement – see scenario descriptions outlined above in section 2. We show a comparison of the modelled installed VRE capacity for the NEM by scenario below.

Figure 3 – Historical & modelled installed VRE capacity for the NEM by FYE and scenario



From Endgame Economics March 2023 Price Projection

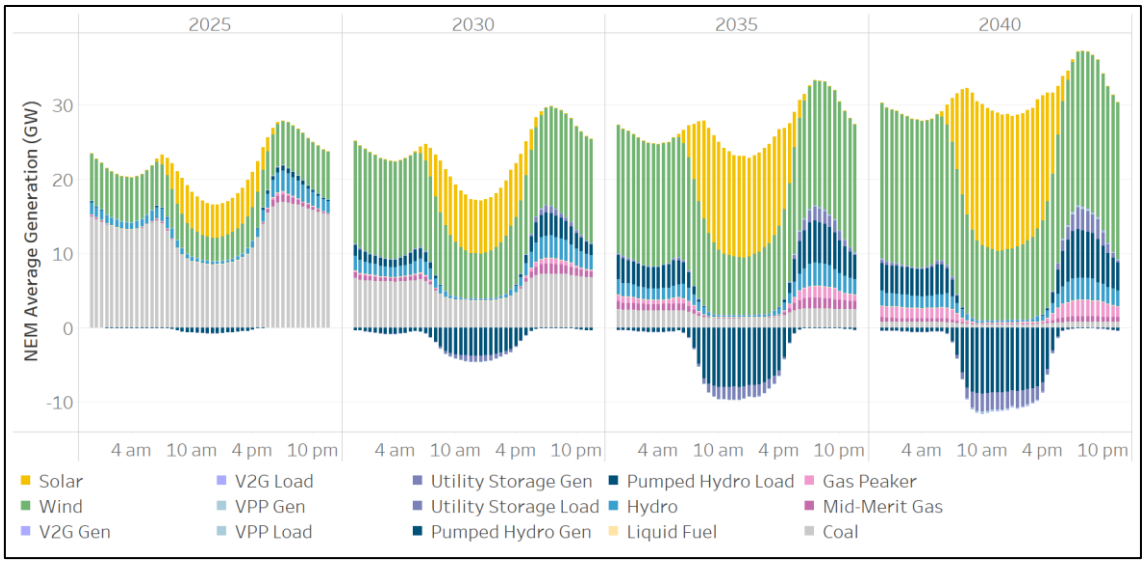
Given the current build out rate, the transition is set to follow the disorderly path. If this continues, it can lead to a difference in VRE capacity from the orderly scenario of 26 GW by

2043. However, if we act now, we can work to close this gap and move closer to the orderly trajectory.

Generation

Figure 4 shows the time-of-day generation mix for the orderly scenario. Prior to FYE 2030, coal dominates the mix (around 17 GW at peak demand and 8.5 GW at minimum demand on average modelled in FYE 2025). Coal generation then declines steadily and flattens out across the day from FYE 2025 onwards. Gas generation is projected to increase over the modelling horizon especially during peak and overnight periods (around 2 to 3 GW on average modelled in for FYE 2035 and FYE 2040 upwards from a maximum of around 1 GW in FYE 2025) to complement VRE once coal retires. Both wind and solar become increasingly dominant with support from storage assets.

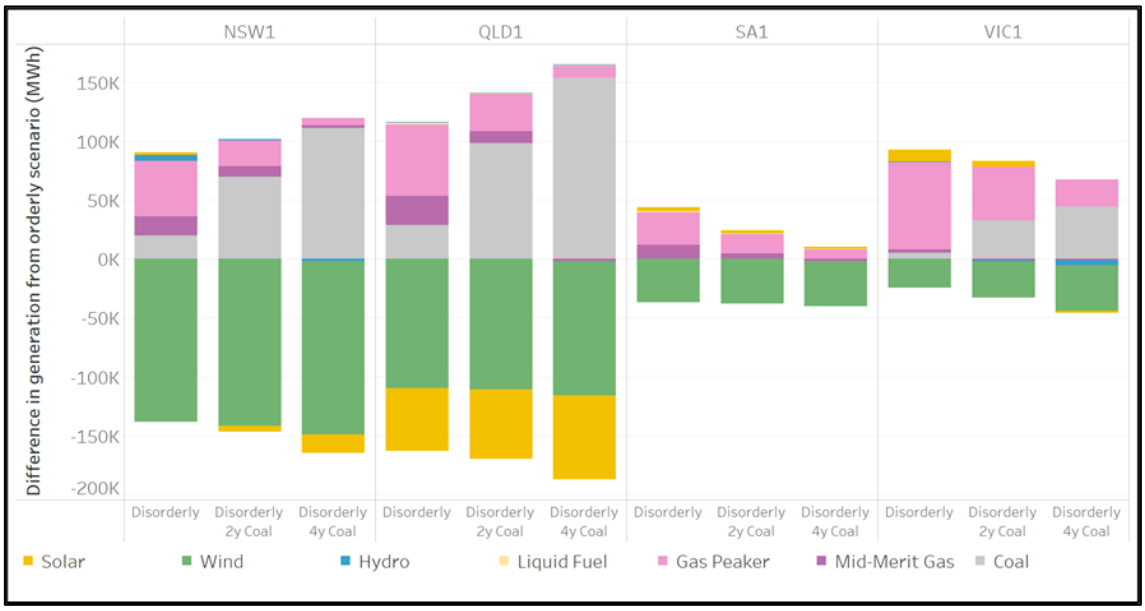
Figure 4 – Modelled time-of-day generation in the NEM by FYE for orderly scenario



From Endgame Economics March 2023 Price Projection

Figure 5 shows the difference in generation between the disorderly and orderly scenario excluding storage facilities. A positive bar corresponds to an increase in generation in the disorderly scenarios compared to the orderly scenario and vice versa for a negative bar. There are two main observations here. Firstly, there is significantly more thermal generation and significantly less VRE generation under the disorderly scenarios. These differences are particularly stark for NSW and QLD given the substantial size of their existing coal fleets and of the modelled VRE investment required to cover the shortfall in generation once these coal fleets retire. Secondly, when renewable build and coal exits are delayed, coal displaces gas since it has a lower short-run marginal cost and is also dispatchable.

Figure 5 – Generation difference between orderly and disorderly scenarios by region (21 year modelling horizon)



From Endgame Economics March 2023 Price Projection

3.2. Prices and consumer costs

Below, we outline the price and consumer cost modelling results with a focus on the orderly versus the disorderly scenario.

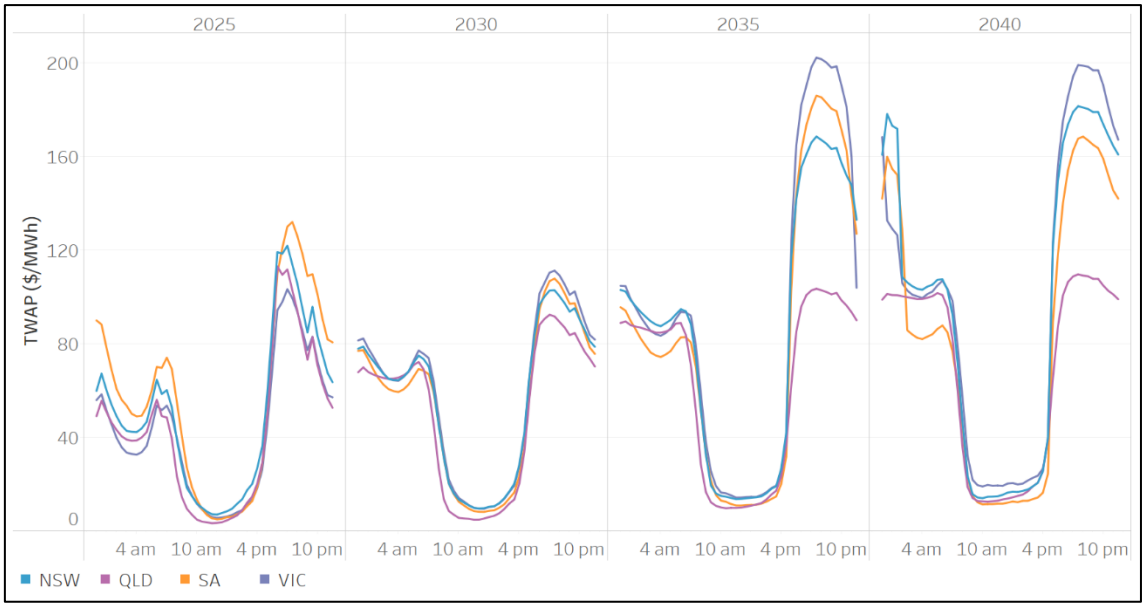
Prices

The changing generation mix shown in Figure 4 leads to an increasingly peaky daily wholesale price shape– see Figure 6. As VRE penetration increases and coal plants retire, prices are often set:

- By VRE at its $0/MWh short-run marginal cost[3],
- By gas or storage during peak periods, or
- During scarcity events at or close to the value of lost load.

[3] Without varying LGC assumptions.

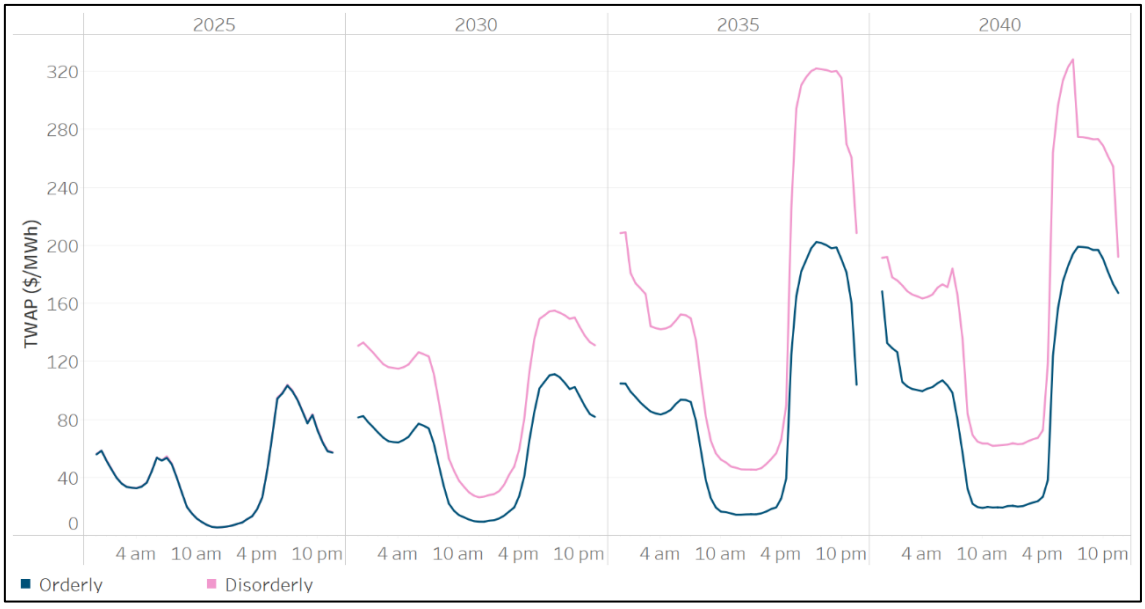
Figure 6 - Modelled time-of-day wholesale electricity prices by FYE for orderly scenario



From Endgame Economics March 2023 Price Projection

Figure 7 shows that the peaky daily wholesale price shape is particularly pronounced in the disorderly scenario given prices are not set as much by low marginal cost VRE.

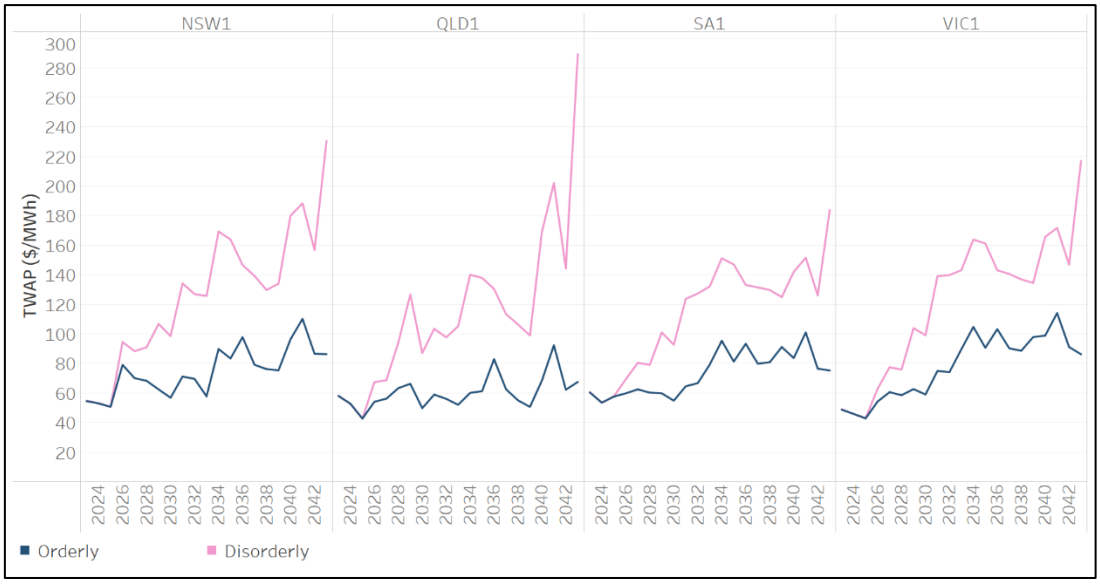
Figure 7 - Modelled time-of-day wholesale electricity prices for VIC by scenario and FYE



From Endgame Economics March 2023 Price Projection

The overall changing generation mix is also projected to contribute to an uplift in wholesale prices over time. On top of this, prices will elevate even further unless we put plans in place to expedite the renewable build out rate urgently as shown in the disorderly scenario in Figure 8.

Figure 8 - Modelled annual wholesale electricity prices by region, scenario and FYE

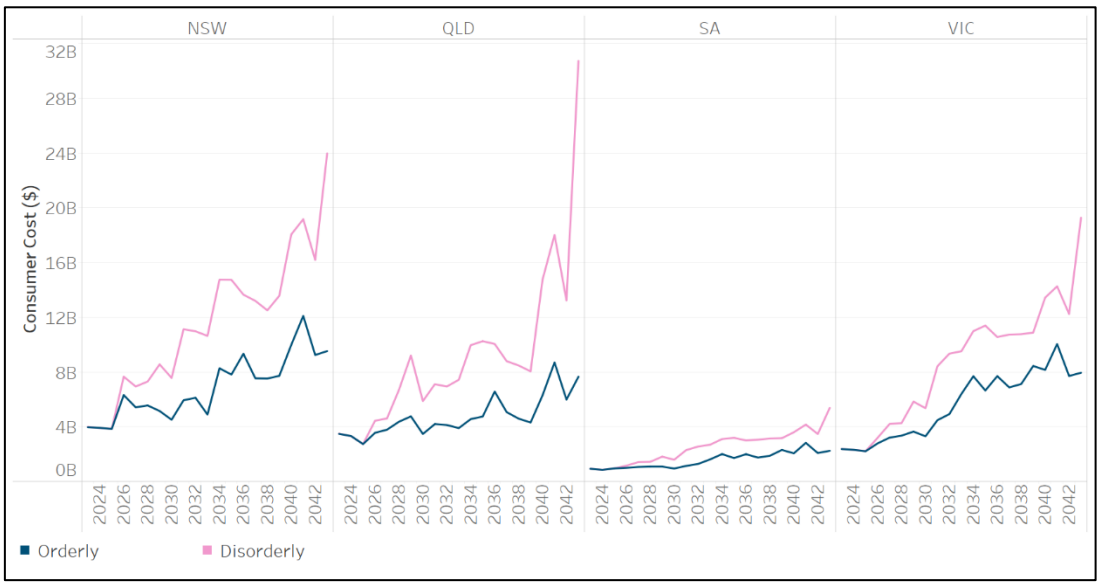


From Endgame Economics March 2023 Price Projection

Consumer costs

Figure 9 shows the wholesale energy component of the annual aggregate consumer costs for each region and scenario calculated as the load weighted average price multiplied by demand for each region. Overall, consumer costs rise in line with the wholesale prices shown in Figure 8. Although consumer costs are projected to rise in both scenarios, they are considerably higher in the disorderly case when action is not taken to deliver sufficient and timely renewable build. Consumer costs are also driven by demand and are therefore highest for NSW, followed by QLD and then VIC.

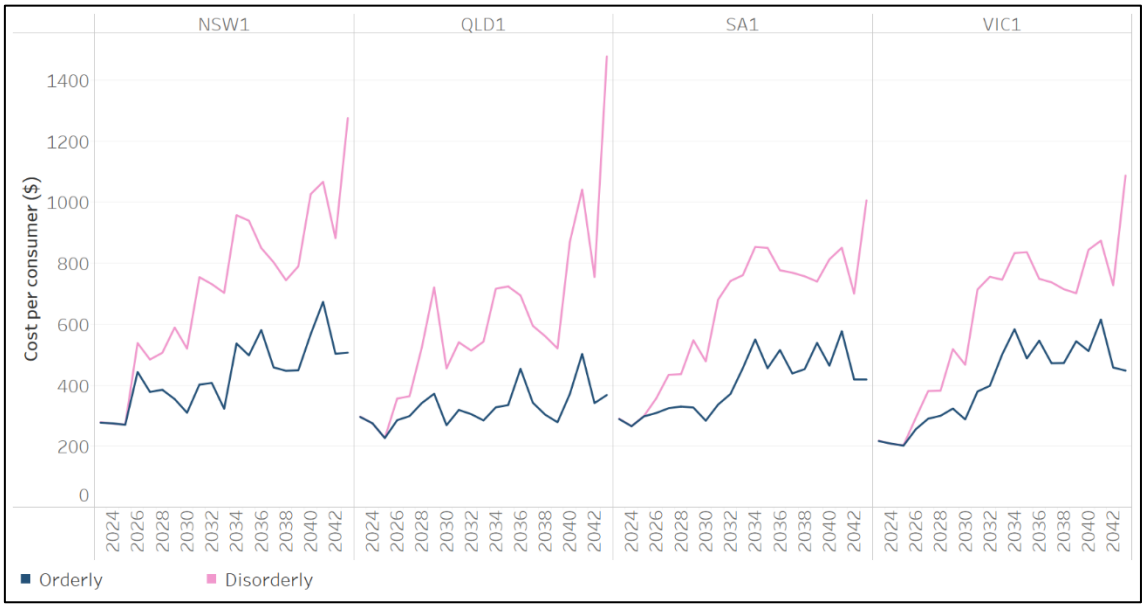
Figure 9 – Modelled aggregate consumer costs by region, scenario and FYE



From Endgame Economics March 2023 Price Projection

Wholesale energy costs per residential consumer are shown below in Figure 10, calculated as the load-weighted average price multiplied by the annual residential consumption[4] for each region. These costs follow a similar trajectory to those shown above in Figure 9 and again demonstrates that a disorderly transition leads to a sharp uplift in consumer costs.

Figure 10 – Modelled wholesale energy cost per consumer, by region, scenario and FYE



From Endgame Economics March 2023 Price Projection

As it currently stands, the build out rate for renewables is likely too slow and so consumer costs are set to follow a trajectory much more similar to the disorderly scenario assuming no delays to coal closure relative to the orderly scenario. We summarise the implications of this for consumers below:

Table 1 – Annual additional wholesale energy cost per consumer in the disorderly scenario compared to the orderly scenario by region and FYE

	2027	2031	2035	2039	2043
NSW	106.3	352.0	441.5	340.6	768.6
SA	109.3	343.9	394.4	201.2	587.1
VIC	90.5	334.3	348.2	157.4	639.0
QLD	65.0	221.8	388.9	242.0	1,109.5

This means that if we continue on such a trajectory, the typical consumer will pay $769 more in NSW, $587 more in SA, $639 more in VIC and $1,110 more in QLD in the year FYE 2043 than they otherwise would if an orderly trajectory were followed.

[4] Sourced from DMO for NSW (Essential Energy), QLD (Energex) and SA (SAPN) and VDO for VIC.

Table 2 – Cumulative additional wholesale energy cost per consumer in the disorderly scenario compared to the orderly scenario every four years from FYE 2023 per region

	After 4 years	After 8 years	After 12 years	After 16 years	After 20 years
NSW	202.5	1,120.4	2,686.2	3,936.8	5,936.6
SA	159.9	1,025.0	2,397.5	3,494.5	4,985.1
VIC	129.6	920.3	2,120.7	2,988.1	4,486.8
QLD	136.6	1,075.4	2,319.4	3,311.0	5,871.1

This means that if a disorderly trajectory eventuates, the typical consumer will pay $5,937 more in NSW, $4,985 more in SA, $4,487 more in VIC and $5,871in QLD after twenty years from now (ie, by the year FYE 2043) than they otherwise would if an orderly trajectory instead eventuated. In light of this, if governments were to mitigate this price risk and subsequently close this gap in costs for consumers, they may try to alleviate constraints on renewable generation build out.

3.3. Emissions impact

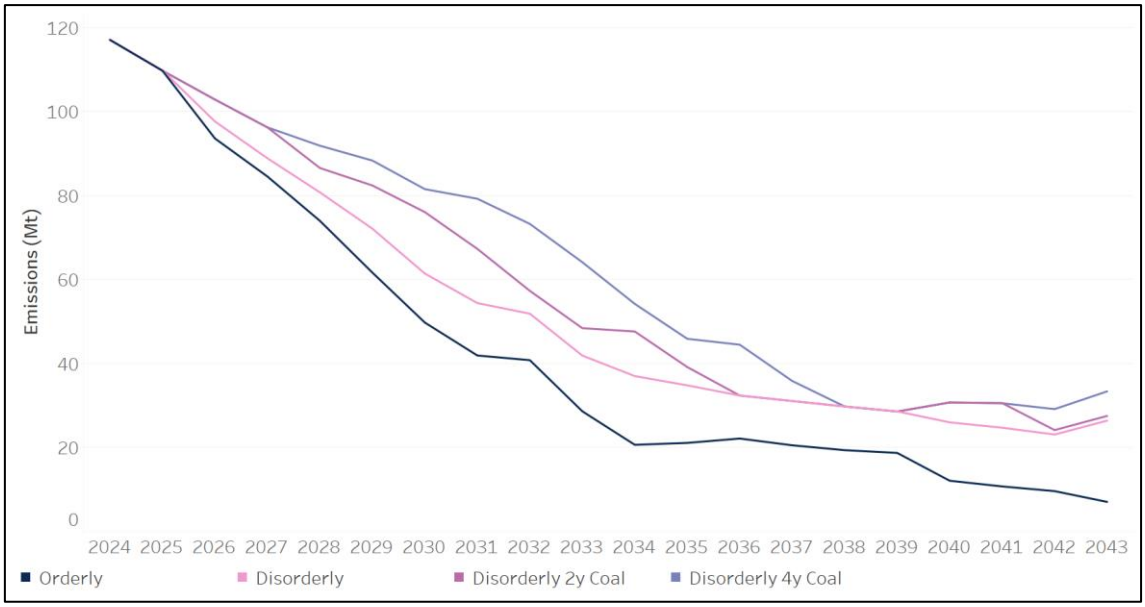
We lastly show the modelling results for emissions for all orderly and disorderly scenarios.

Emissions

Emission levels also vary significantly depending on the speed of renewable rollout and vary even greater if coal closures are delayed - see Figure 11 below. Emissions are lowest in the orderly scenario when sufficient VRE and transmission build are delivered in time to meet increased demand and replace coal. Emissions increase significantly in the disorderly scenario and even further when more emissions-intensive generators[5] are relied upon to meet demand.

[5] Mid-merit gas, gas peaking and coal generators typically have a CO2-e emissions intensity of at least 400kg/MWh, 500kg/MWh and 800kg/MWh as generated respectively.

Figure 11 – Modelled annual emissions in the NEM by scenario and FYE

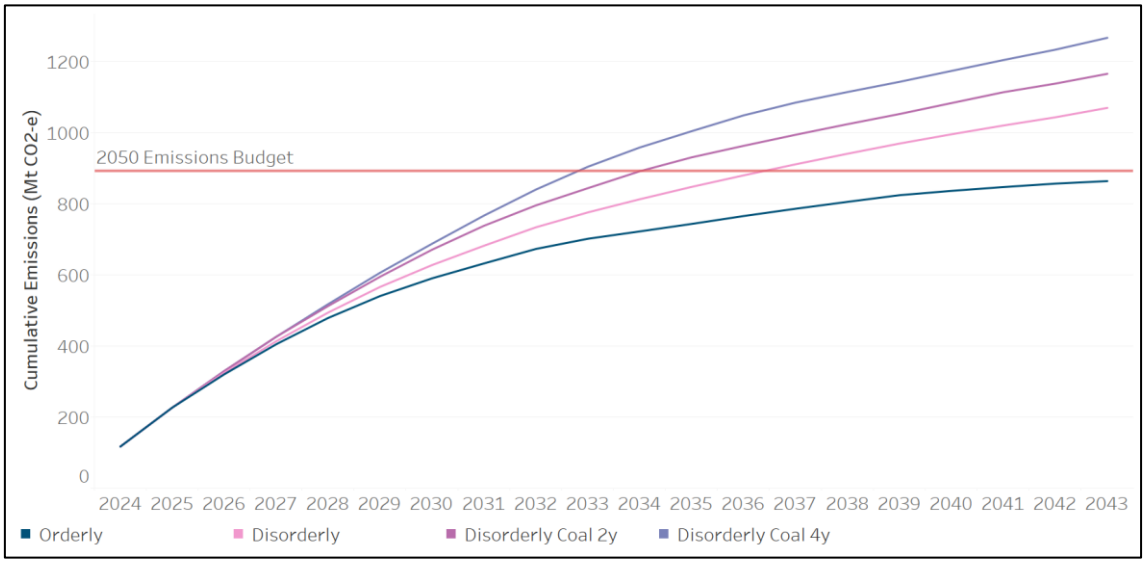


From Endgame Economics March 2023 Price Projection

Figure 12 below shows that unless the transition follows an orderly trajectory, the NEM fails to meet its cumulative emissions target of 890.7 Mt CO2-e[6]. This target is breached by:

- 2037 under the disorderly transiton scenario,
- 2034 under the discorderly scenario where coal closures are delayed by two years, and
- 2033 under the disorderly scenario where coal closures are delayed by four years.

Figure 12 – Modelled cumulative emissions in the NEM by scenario and FYE



From Endgame Economics March 2023 Price Projection

[6] The 2022 ISP's step change modelled cumulative carbon budget.

Historical and committed renewable generation entry suggests Australia is closer aligned with a disorderly transition than an orderly transition. This suggests that the NEM is likely to breach the 2050 emissions budget by 2037. However, if governments are able to relieve constraints on renewable energy build out then the emissions budget may still be able to be met.

Emissions cost

To put this further into perspective, assuming a carbon price of $50/t the cumulative total cost of these emissions until FYE 2043 amounts to:

- $43.18bn under the orderly scenario,
- $53.47bn under the disorderly scenario,
- $58.26bn under the disorderly scenario when coal closures are delayed by two years, and
- $63.32bn under the disorderly scenario when coal closures are delayed by four years.

The difference in these cumulative emission costs under each disorderly scenario compared to the orderly scenario until FYE 2043 is then:

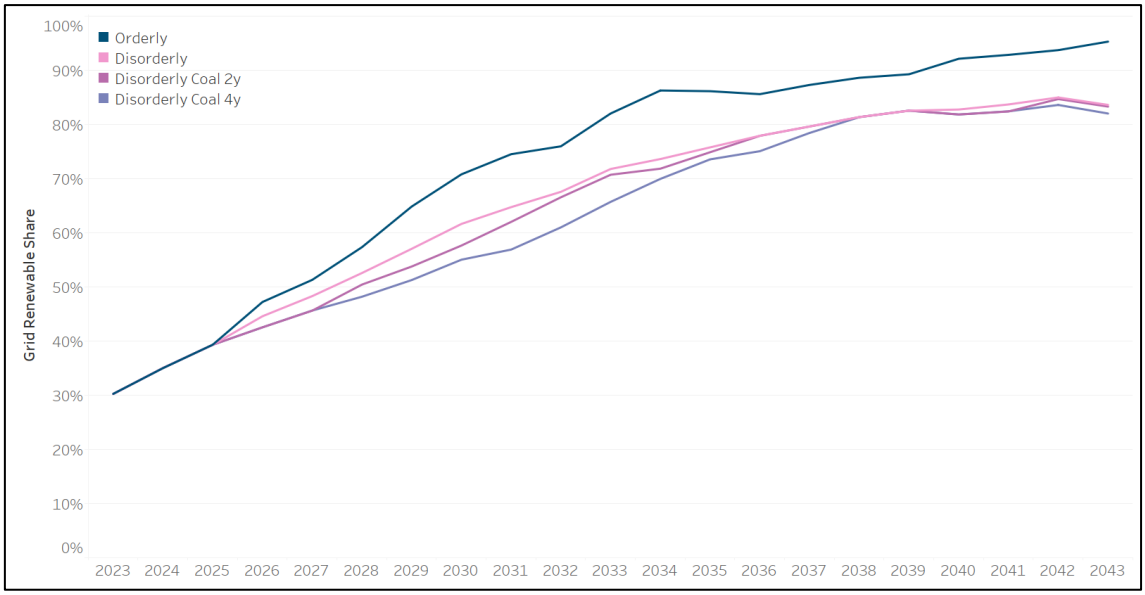
- $10.25bn under the disorderly scenario,
- $15.05bn under the disorderly scenario when coal closures are delayed by two years, and
- $20.1bn under the disorderly scenario when coal closures are delayed by four years.

NEM Renewable Targets

Figure 13 shows the NEM renewable energy share by scenario. The orderly scenario approximates the path required to deliver the 82 per cent renewable energy target by 2030. The chart highlights that the system will fail to meet this target unless enough renewable energy generation and transmission is built to reduce ongoing usage of emissions-intensive generators such as coal.

Please note while interpreting this chart that the orderly scenario reflects the ISP step change scenario. The 82% target is slightly higher than the orderly scenario and includes rooftop PV unlike this chart. This therefore demonstrates that the disorderly and coal extension scenarios are significantly lower than the 82% target.

Figure 13 – Modelled NEM-wide renewable energy share by scenario (excl. rooftop PV)



From Endgame Economics March 2023 Price Projection

Eraring focus

Below we highlight Eraring's contribution to emissions by FYE. Figure 14 shows the cumulative emissions for the NEM and the cumulative emissions as a result of extending Eraring from 2025. The chart indicates that extending Eraring's closure date by two and four years generates around 18.3 million and 34.5 million tonnes respectively[7] and highlights the contribution of these delays to cumulative NEM-wide emissions. To put this into perspective assuming that carbon is priced at $50/t, this translates to roughly $0.915 billion and $1.726 billion respectively – see Figure 15. Figure 16 lastly shows the contribution of Eraring to NEM-wide emissions and indicates that with each additional year of delay causes significant increases in emissions. Similarly, delays to Eraring's closure date would push the NEM further towards exceeding the 2050 emissions budget. If governments would like to ensure a timely and orderly closure of Eraring, then they must ensure that sufficient renewables and storage is built in a timely manner.

[7] This analysis relied on our 'Disorderly coal 4y' modelled results. The results for 'Disorderly coal 2y' produced comparable results for FYE26 and FYE27.

Figure 14 - Modelled NEM-wide and Eraring (from 2025) cumulative emissions by scenario and FYE

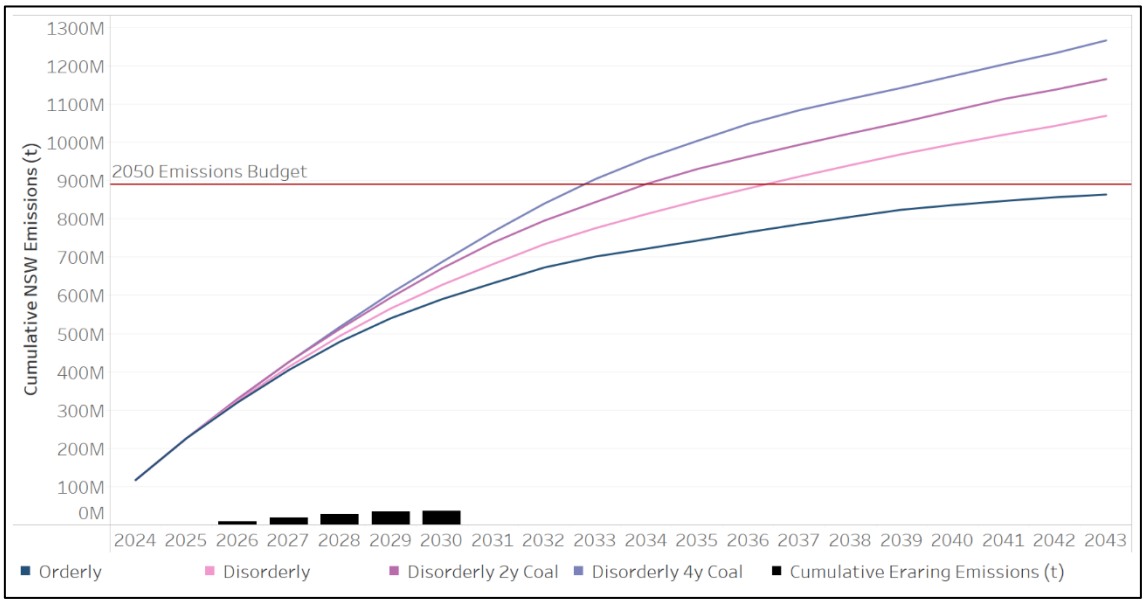


Figure 15 – Modelled implied emission cost generated by Eraring by FYE

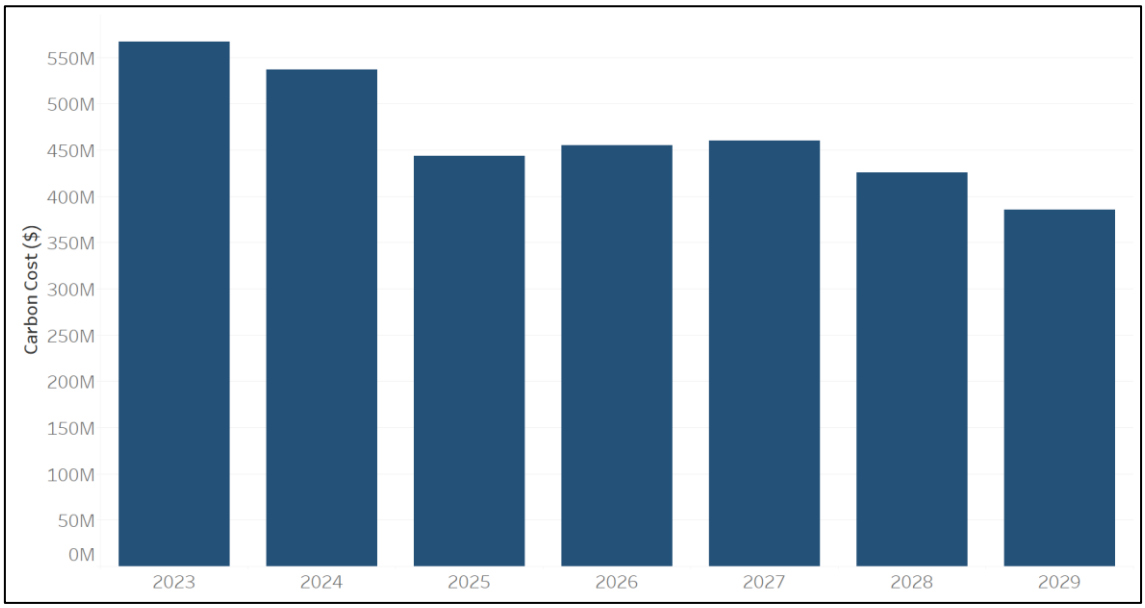


Figure 16 - Modelled NEM-wide and Eraring emissions by scenario and FYE