Headwinds for the NEM transition

An alternative scenario to consider for Australia's National Electricity Market (NEM)

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"Pylon" – Linocut – 2024
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Baringa's Headwinds Scenario

Baringa's Headwinds Scenario research was conducted in our capacity as an independent markets and investment advisor within the National Electricity Market (NEM). Its purpose was to provide potentially useful information to all our existing subscribers of the quarterly Baringa Australia NEM Wholesale Market Electricity report. Our subscriber base includes a diverse range of market participants from across the Australian energy and banking sectors. Baringa itself has no policy goals in this regard.

Our NEM Reference Case market report provides a comprehensive overview of the Australian NEM, alongside our price projections and key insights

Our subscribers get the following benefits

Market-leading insight

- Summary of the key developments in the Australian power market, with a focus on the structure of the market, energy policy (particularly renewable energy policy) and the phase-out of coal
- Our key modelling assumptions and methodology
- Our projections for baseload power prices, renewable capture prices, green value and key market metrics out to 2055 for our Reference Case scenario, as well as our Low Case
- Analysis and insights from our modelling outputs
- Projections in a usable Excel format
- Up to five site-specific GWAs (onshore and offshore wind; utility-scale solar)

Based on the latest news and data

We update and publish our report on a quarterly basis, with a summary note on key changes in our modelling methodology, input assumptions and modelling outputs (with a focus on our power price projections).

In depth discussions

We offer an optional workshop with our team to discuss the market and our projections.

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Our Headwinds scenario explores some challenges to the NEM's energy transition that could stem from a change in government at the Federal level

Policy risk

Without bipartisan agreement on energy policy, political change in Australia could trigger a change of course and investment uncertainty. Headwinds explores:

- More extensive delays to transmission upgrades, and cancellation of the CIS
- A sustained pivot to nuclear
- Maintaining "baseload" coal power until nuclear is delivered

Investment risk

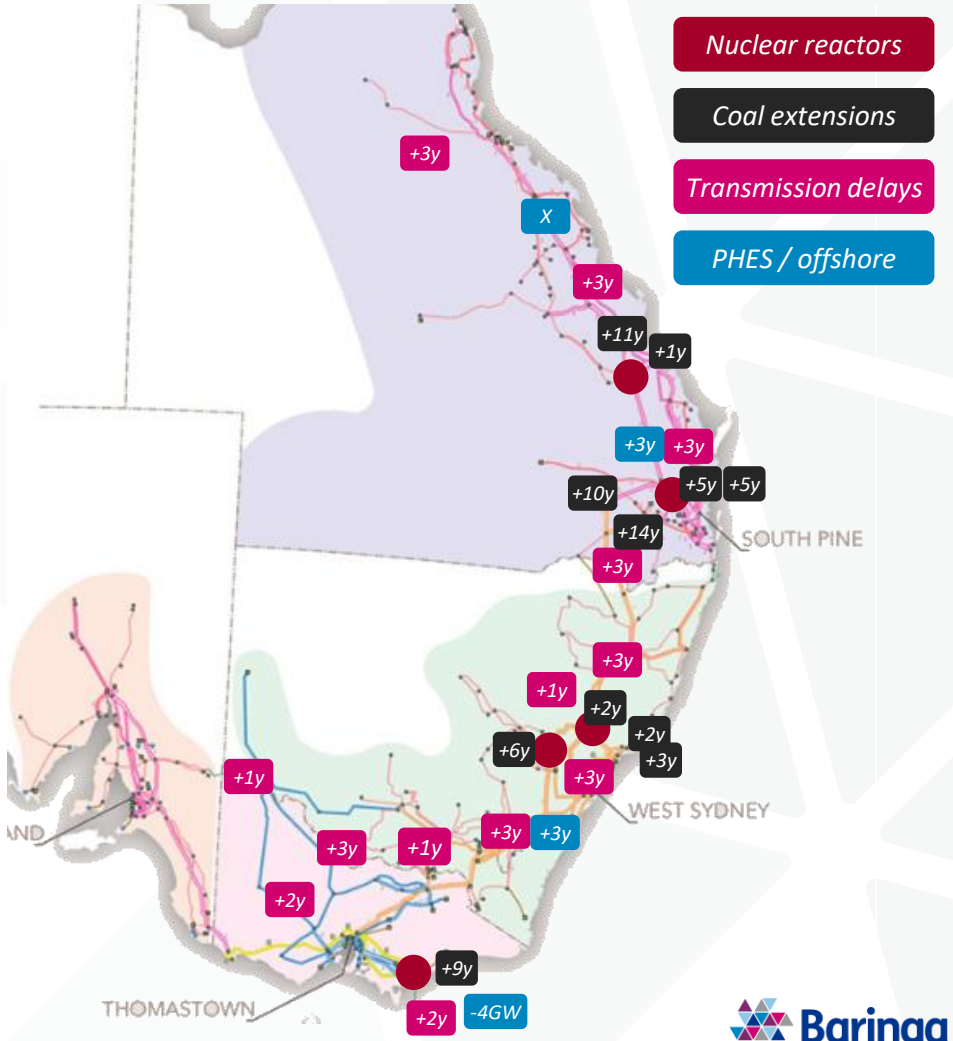
In Headwinds, policy uncertainty drives a lack of investment confidence, less investment in renewables, and higher hurdle rates required for FID.

Delivery risk

Australia has seen delays to transmission upgrades, which in turn has delayed new renewables builds in these regions of the NEM. Headwinds explores:

- Continued delays to transmission projects, with federal policy settings less supportive
- Increased outage rates for ageing coal generators
- Delays to committed renewable projects
- Cancellation of most of the Victorian offshore wind program
- Slower and lower hydrogen demand

Selected changes to Baringa's Reference Case (Q2 2024)*



* Transmission projects not shown on the map are delayed three years compared to our Q2 2024 NEM Reference Case assumptions

Nuclear will be challenging to deploy in Australia, with delivery likely to take at least 20 years. Our Headwinds scenario deploys nuclear from 2045

Coalition nuclear plans

- The Coalition have outlined plans to build nuclear generation on seven sites around Australia (if they form Government):
  - Five large scale facilities in Queensland, NSW and Victoria
  - Two SMRs in South Australia and Western Australia
- We consider that the most likely outcome of a 'nuclear pivot' would be the initiation of policy and planning, which could take many years. For our Headwinds scenario, we explore where the nuclear pivot in federal policy does eventually deliver nuclear power generation in the NEM.
- We build 1.45GW units similar to APR-1400s at each proposed large-scale site, with 7.25GW deploying between 2045-50. We model these as large-scale PWR plants but note that modelling as SMRs would unlikely change the conclusions.

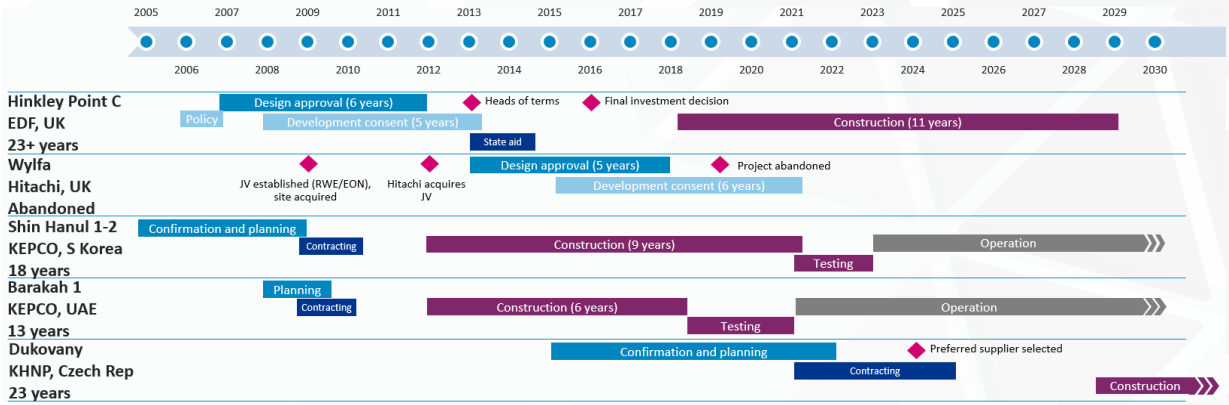
Nuclear costs

- Nuclear is expensive, with the CSIRO Gencost report estimating capital costs would decline to around $8,700/kW, with the first reactors costing more.
- There is a significant potential that costs could exceed this, for example:
  - Europe's two most recent reactors, Olkiluoto 3 in Finland and Flamanville 3 in France, cost A$11,000-13,000/kW excluding financing, with the French Court of Audit concluding total costs including financing, taxes and levies were 50% higher.
  - EDF's latest Hinkley Point C estimates are c. A$24,000-$28,000/kW in today's money, more than twice original estimates.
  - Estimated costs for Dukovany, in final contracting in the Czech Republic, are just over A$12,000/kW.
- Hinkley C is contracted at a strike price of A$250/MWh in today's money. CSIRO Gencost estimates LCOEs between $150-250/MWh even with the lower capex.

Nuclear is unlikely to take less than 20 years to deliver

- The Coalition has indicated they would target first nuclear power by 2037.
- International examples indicate that between policy, planning, construction and testing, nuclear programmes tend to take 15-25 years. One exception to this is the UAE, however the UAE has very different planning and contracting rules to Australia.
- The Australian experience is more likely to mirror timescales from Europe or the US. With no prior nuclear power industry, Australia is unlikely to improve on these timescales.
- For Headwinds, we have assumed an ambitious timescale with nuclear policy and planning to commence in 2025, with the first unit beginning operations 20 years later.

Example international project timelines



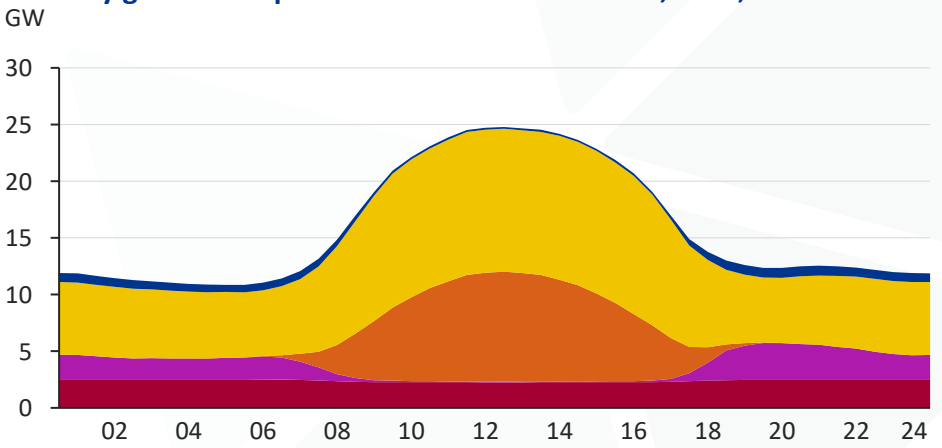
Nuclear is technically flexible but often operates near-baseload. It is likely to cause some additional solar curtailment, but 7 GW will not cause issues for the NEM

Nuclear flexibility

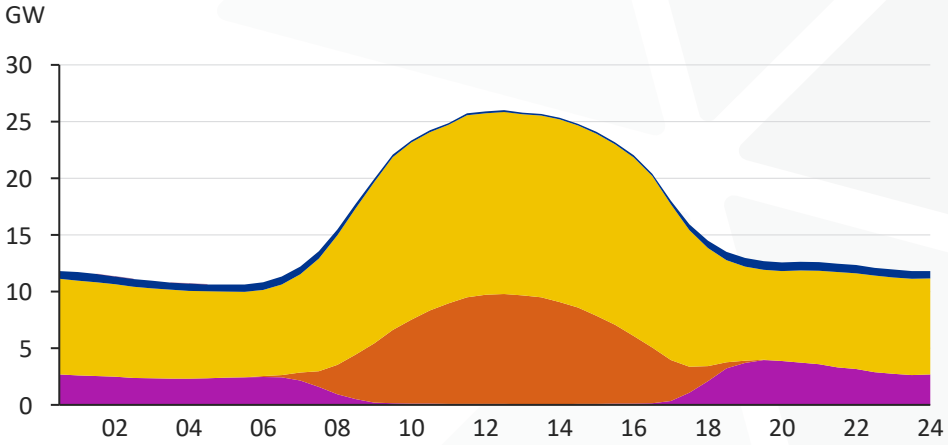
- Nuclear power has been touted as a 'baseload' power source for Australia, but constant output does not provide flexibility needed in a renewable-heavy power system, particularly around rooftop solar.
- Nuclear reactors are technically very flexible:
  - High ramp rates, and low minimum stable levels.
  - E.g. KEPCO's APR1400 quotes operation at 50%1, while Westinghouse's AP1000 specifications include ramping down to 15% output2.
- However, this flexibility is often not achieved in practice:
  - Safety restrictions encourage steady state operation to safely handle reactor contingencies.
  - Fuel costs are typically based on set refuelling cycles, without fuel cost savings from ramping down, and so other generators typically ramp down first.
- For Headwinds, we have taken a middle-of-the-road approach and allow ramping down to 70% of output.
- Headwinds explores the impact of five x 1.45GW reactors. They reduce solar generation in the middle of the day, but even if nuclear was completely inflexible, the Coal and Nuclear Variability chart shows that five reactors generate less than the minimum stable levels of current coal plant.

Impact in the NEM

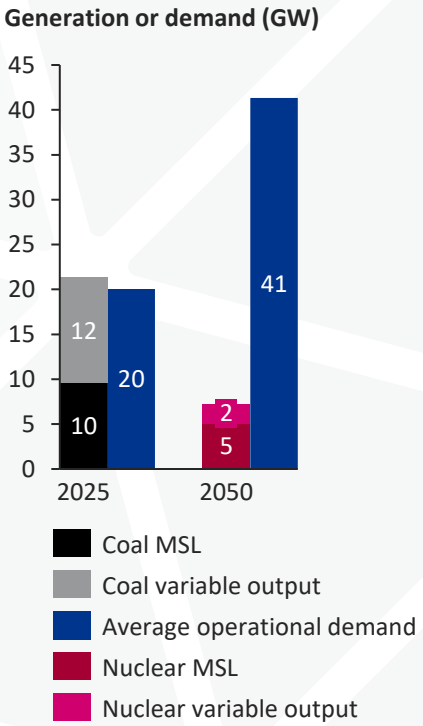
Intraday generation pattern – Headwind Scenario, NSW, 2050



Intraday generation pattern – Baringa Reference Case, NSW, 2050



Coal and nuclear variability



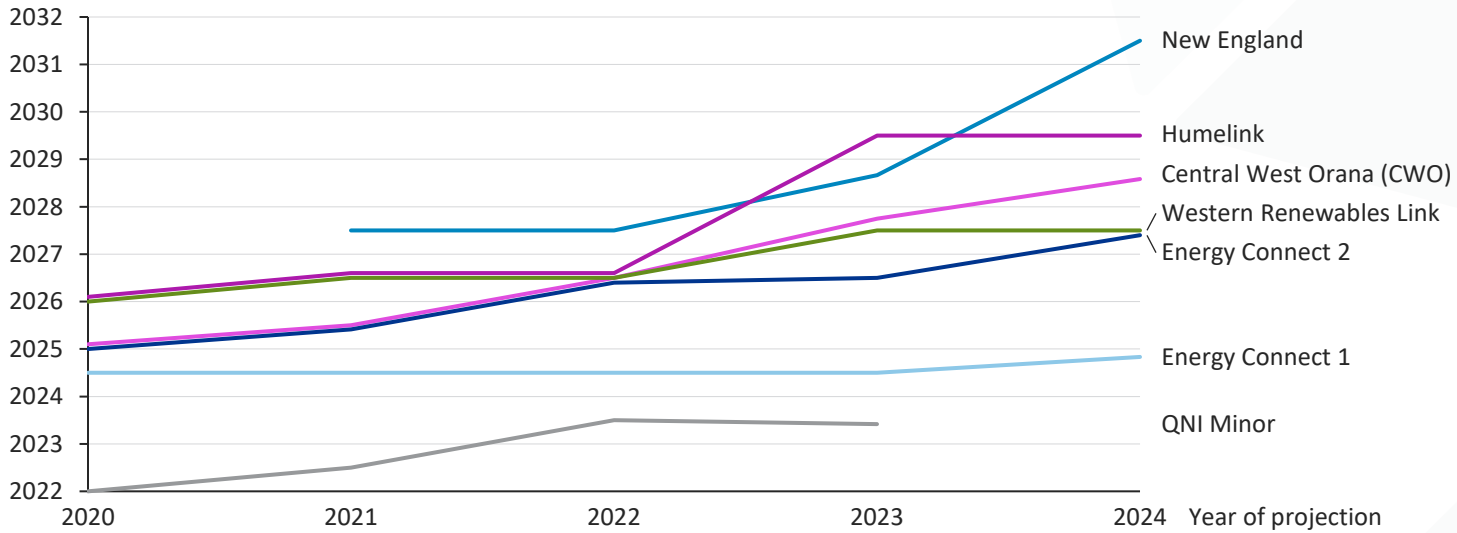
1. IAEA APR1400, Section 2.6. 2. Westinghouse AP1000 Overview

Australia needs more transmission, but recent projects have been significantly delayed

Transmission delays in the NEM

- The growth of renewables is driving major transmission projects around the NEM, with Renewable Energy Zone (REZ) construction as well as Energy Connect, VNI West and the Queensland SuperGrid likely to lead to a step change in the ability to move energy around the NEM.
- Historically, transmission projects have seen significant delays, with delivery being well after the initial timelines proposed. The chart below shows how the expected delivery dates of some key projects around the NEM have changed over the last four years.
- Uncertainty in transmission timing drives risks for generation projects, either directly via connection, or through risks to MLFs and curtailment, and in turn drives policy risk, for instance as to whether NSW can meet its roadmap renewable generation targets.
- Headwinds assumes continued delays to delivery, as shown to the right.

Projected delivery date



Note: delivery dates of some projects (CWO, Energy Connect, Humelink) have been adjusted by one month for clarity where lines would otherwise obscure each other

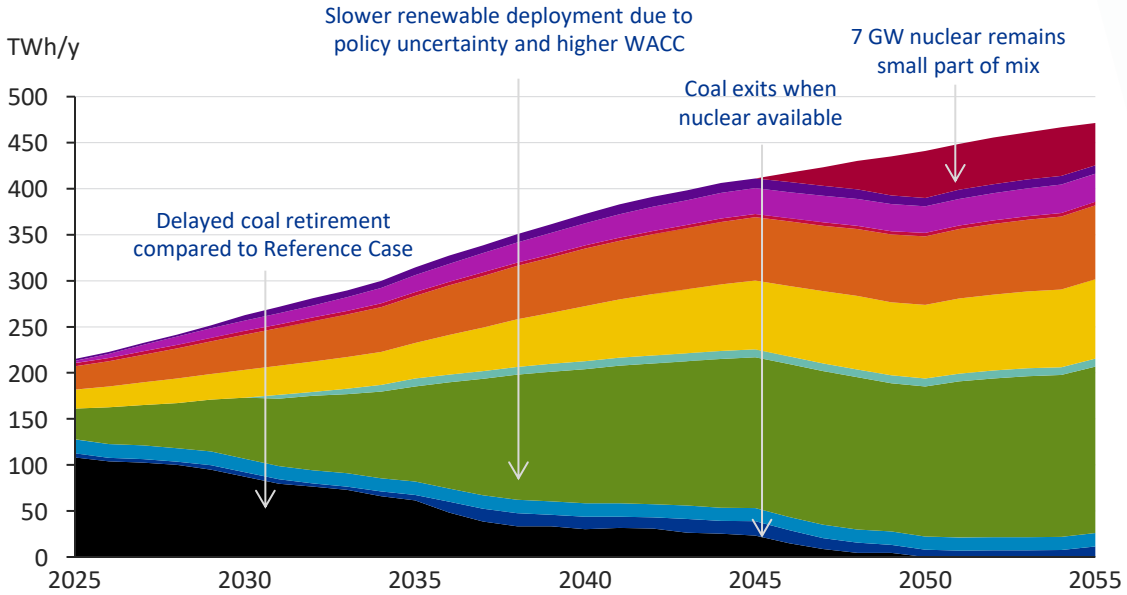
Headwinds transmission assumptions

Project	Headwinds	Delay vs Q2 RC (y)
Project Energy Connect	Dec 2025 (stage 1) Jul 2028 (stage 2)	+1
Western Renewables Link	Jul 2029	+2
CWO REZ	Aug 2029	+1
Sydney Ring	Dec 2031	+3
HumeLink	Jul 2032	+3
Marinus Link	Dec 2032 (stage 1) Not built (stage 2)	+2
New England REZ	Jul 2034	+3
VNI West	Jul 2034	+3
Copperstring	Jul 2034	+3
QLD Supergrid South	Sep 2034	+3
Borumba hydro	Sep 2034-35	+3
QLD Supergrid North	Jul 2035-36	+3
QNI Connect	Jul 2036	+3

Our Headwinds scenario sees coal extended to 'maintain baseload' until nuclear is operational, and coupled with policy uncertainty leads to less renewables on the grid

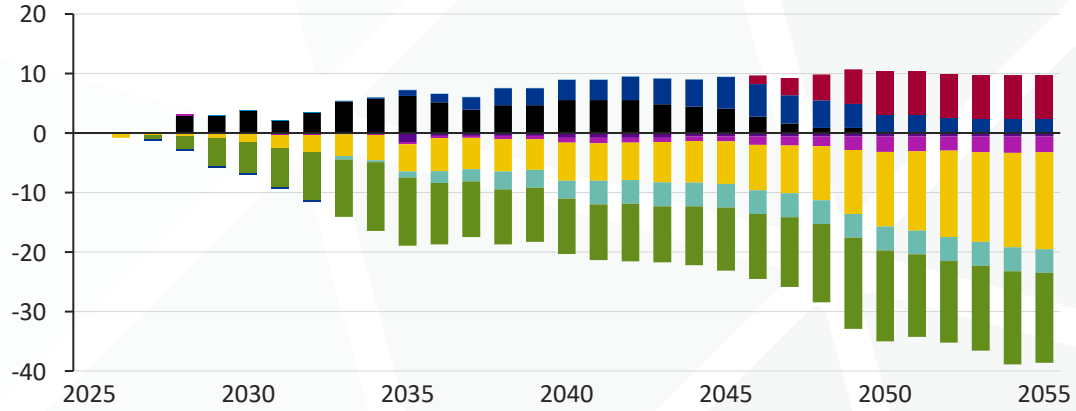
Generation mix (NEM, TWh/y)

- Headwinds sees coal kept open until nuclear is delivered from 2045, with 51% more coal generation than our Reference Case (over FY25 to FY50).
- Renewable deployment dominates new capacity, with renewable entry only slowing down where nuclear ramps up quickly. Higher investment costs drive higher prices across the horizon. Delayed hydrogen demand means overall capacity and generation is lower in Headwinds than in our Reference Case.
- With five 1.45GW reactors, nuclear in Headwinds remains a small part of the electricity mix compared to coal today. While costs remain uncertain, this level of nuclear would likely require significant public funding on top of market prices.

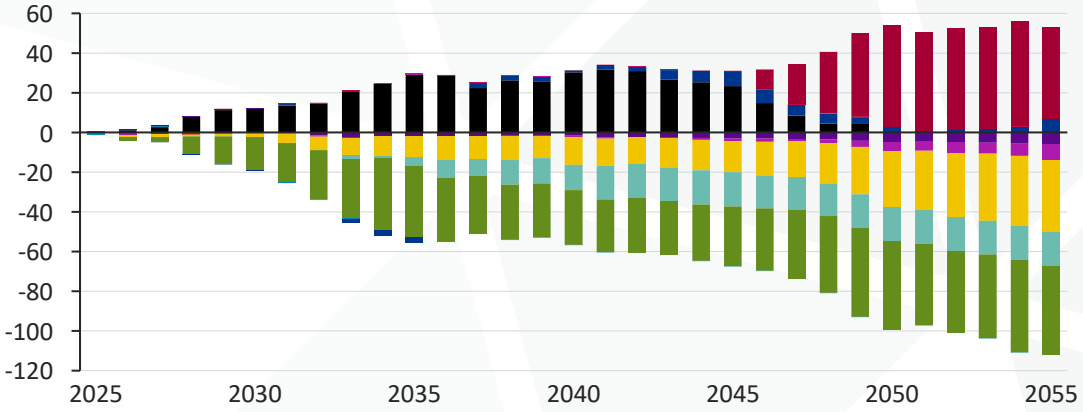


Capacity and Generation mix – Headwinds vs. Q2 2023

Capacity change Headwinds vs Baringa's Reference Case (FY-end, NEM, GW)



Generation change Headwinds vs Baringa's Reference Case (NEM, TWh/y)



Coal | Gas | Hydro | Wind | Offshore Wind | Solar | Solar Rooftop | Battery Storage | Pumped Storage | Nuclear

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