Australian Government
Department of Climate Change, Energy, the Environment and Water
Office of Energy Economics

Energy transition – What we've learned so far

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Overview

Australia's energy system	Energy underpins Australia's economy as a major energy exporter The global net zero transition is underway, influencing Australia's energy markets
Australia's transition to renewable electricity	Australia's energy system is already undergoing rapid change The Australian Government has taken significant action to accelerate the energy transition Australia's energy mix will continue to transform Electricity grids will need to balance more variable inputs as renewables increase Reliance on GPG is expected to drive prices
Next steps in the energy transition	Improving energy performance can deliver a faster and cheaper energy transition The role of gas in our energy systems will evolve through the transition New technologies will support decarbonisation of hard-to-abate sectors

Australia’s energy system

Energy underpins Australia's economy

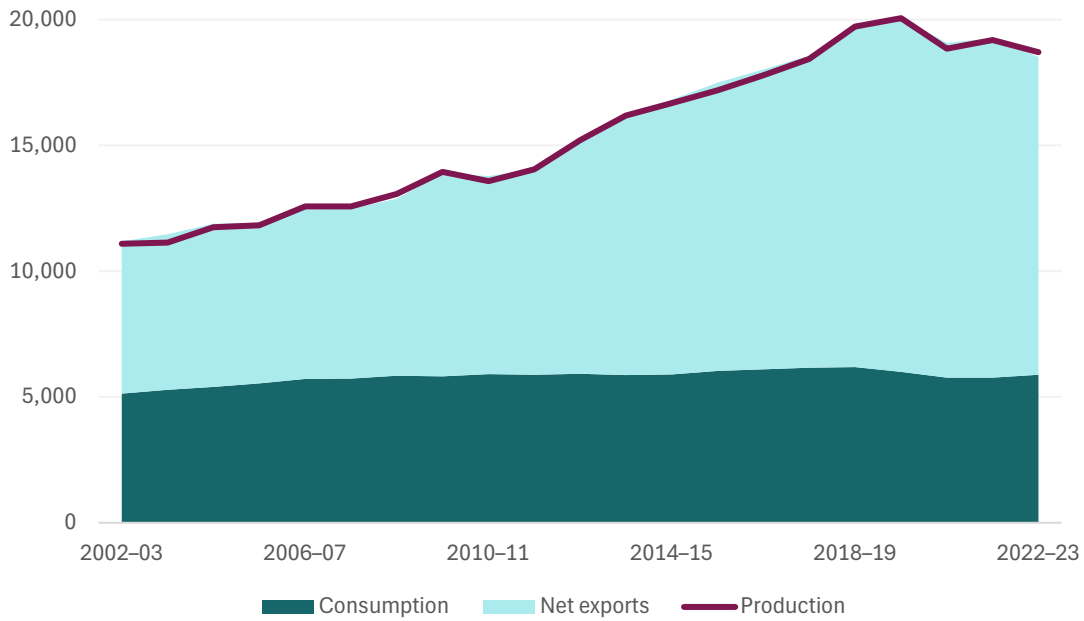
Australia is a major global energy exporter – as the world's 2nd largest exporter of both coal and LNG in recent years

The sector accounts for

- around **10%** of Australia's labour productivity growth since 2000
- around **5%** of Australia's national income over the last decade
- around **one third** of Australia's export revenue
- **91%** of Australia's net emissions

Source: Geoscience Australia (2024); Australian Bureau of Statistics, Department of Industry, Science and Resources; Department of Climate Change, Energy, the Environment and Water

Australian energy balance

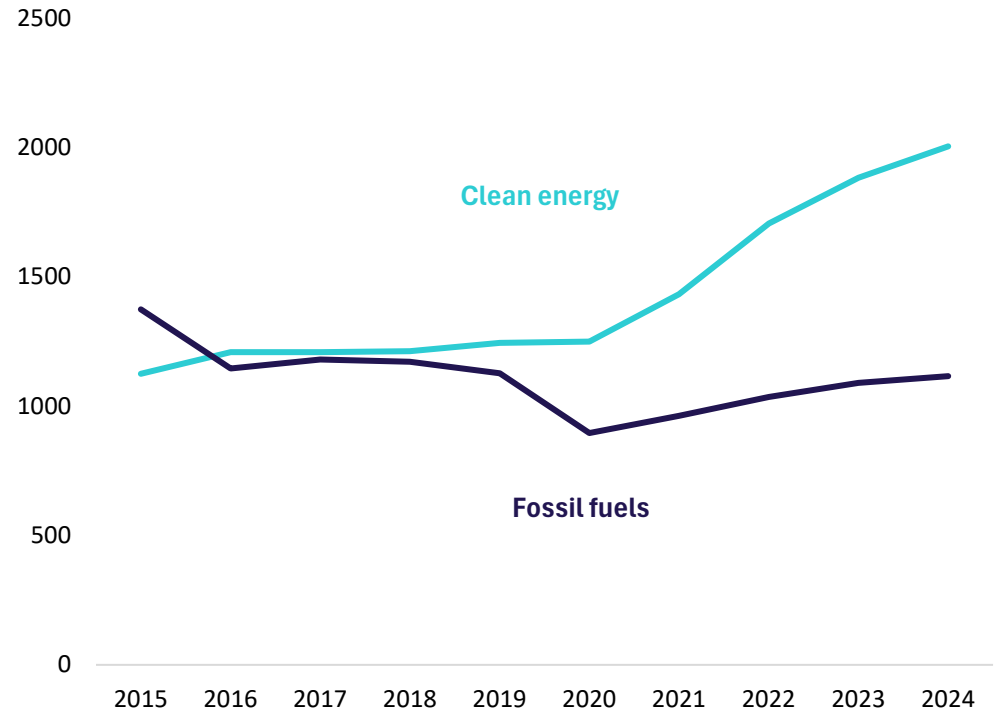


Source: DCCEEW (2024) Australian Energy Statistics

Global energy systems are changing

Global capital is shifting towards clean energy

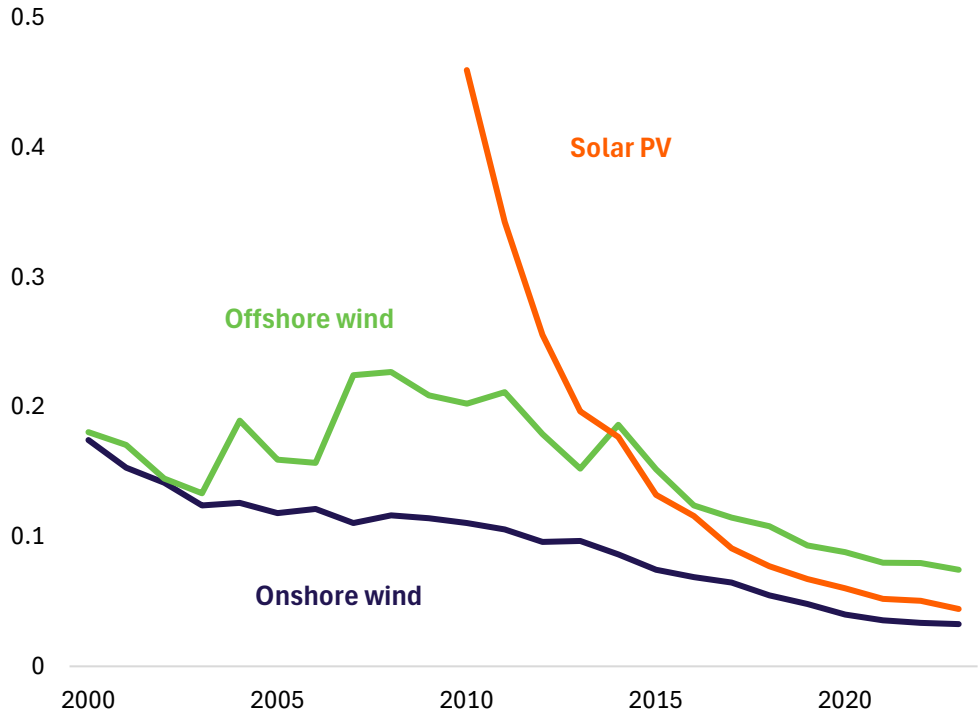
Global investment in clean energy and fossil fuels, US$ billion



Source: World Energy Investment 2024, International Energy Agency
Data is expressed in constant 2023 US$, MER

Rapid technology cost declines have improved the economics of renewables

Global levelised cost of energy for renewables, $/kWh



Source: OurWorldinData.com analysis of IRENA (2024).
Data is expressed in constant 2023 US$.

Global developments influence Australia's energy markets

Australia's energy sector is export-oriented

- **Global fossil-fuel demand set to decline over the medium-to-long term**

  Global demand for coal is expected to peak within a decade.

- **142 countries have committed to net zero by 2050** including most of our key trading partners.

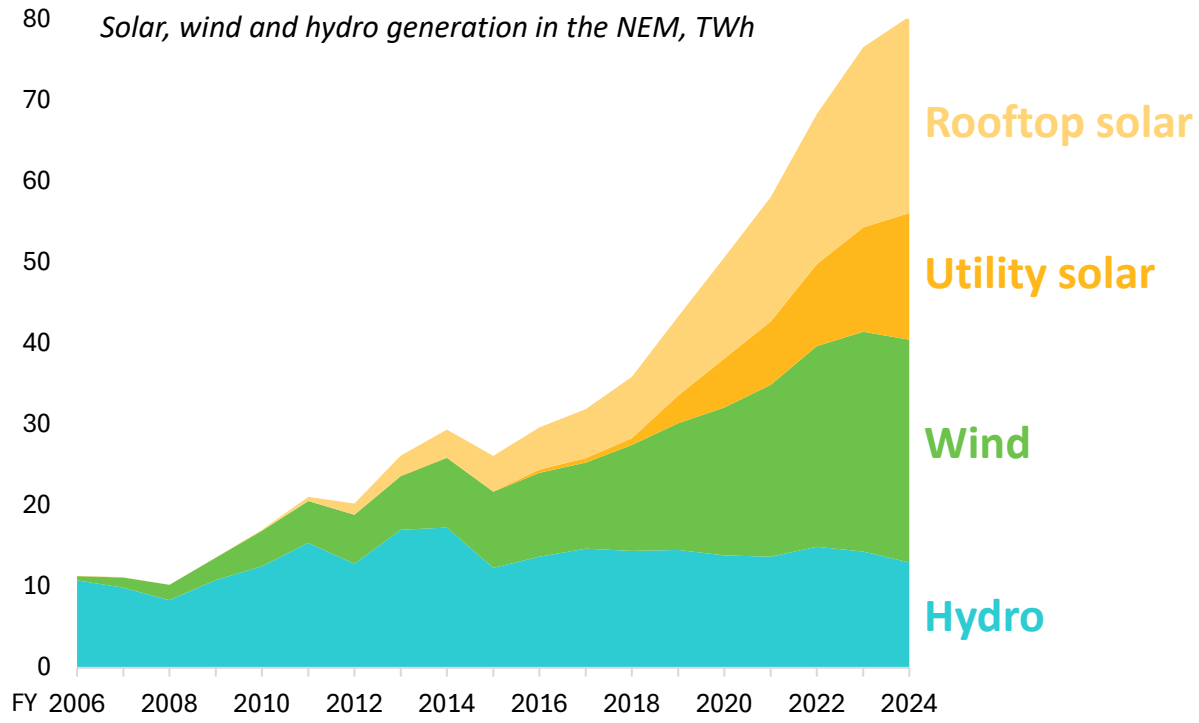
Domestic markets are exposed to global price shocks

Wood Mackenzie, 2025, *Global thermal coal 10-year investment horizon outlook 2024*, Nov 2024

Australia’s push towards renewable electricity

Australia's energy system is already undergoing rapid change

Australia has seen a rapid growth in renewables



Source: AEMO ISP 2024

Consumer investment is leading the way

One third of Australian homes now have rooftop solar - more than **seven times** the level in 2014

More Australian homes have solar panels than backyard swimming pools – at 4 million to 3 million

Australia's EV fleet has also grown rapidly– with an **850-fold** increase from 300 cars in 2011 to over 250,000 by 2024

EVs now represent approximately 1.5% of the total light vehicle fleet in Australia and **9.5% of new car sales**

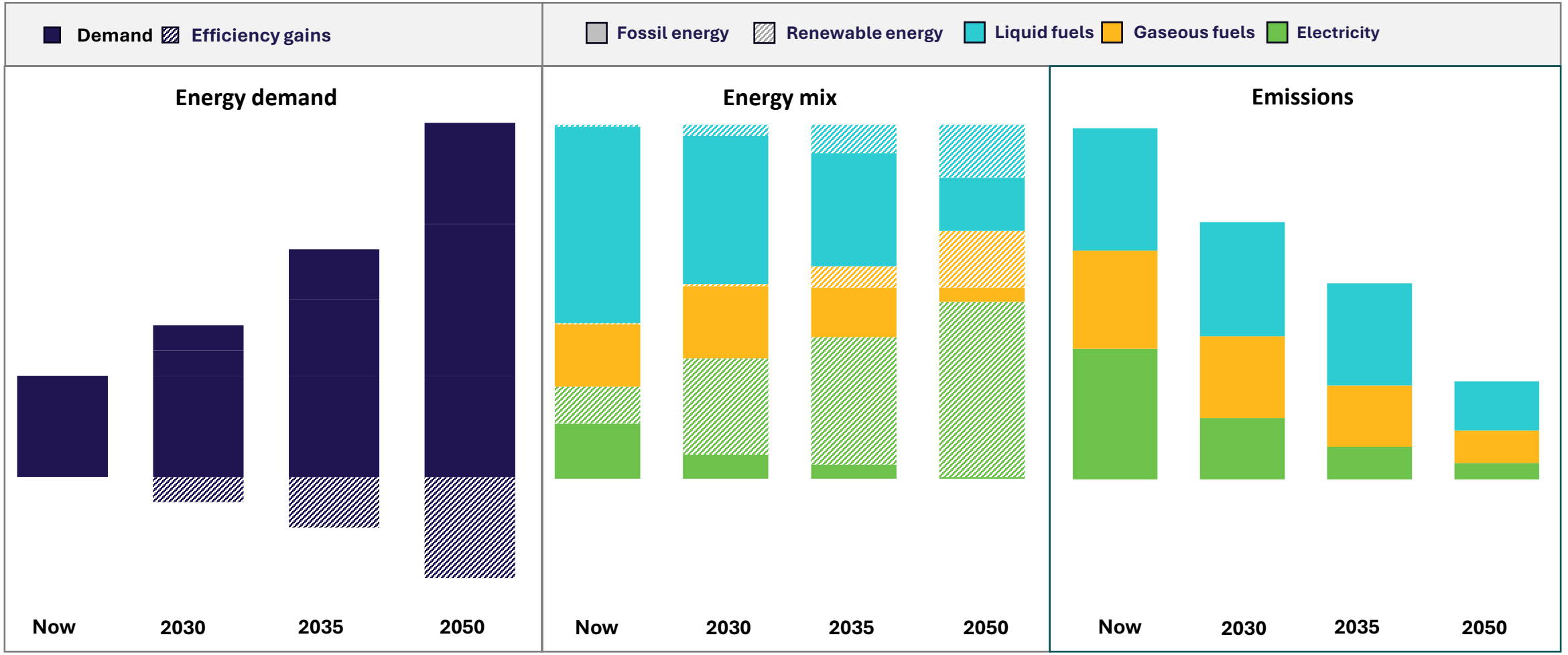
Sources: ECMC (2024), CER Roadmap;
Roy Morgan (2023) & DCCEEW (2024)
Electric Vehicle Council (2024), State of Electric Vehicles 2024

Australia's energy mix will continue to transform

Energy demand will continue to grow

Electrification will see a switch to electricity use

These changes will drive a decline in emissions



Charts set out an indicative pathway only and do not represent modelled outputs

The Australian Government has taken significant action to accelerate the energy transition

43% emissions reduction by 2030 target

Significantly driven by clean electricity transition, including **82% renewable electricity target by 2030**

Government underwriting utility-scale renewables and battery-firming investment

- Capacity Investment Scheme (CIS) - 32GW of new generation and clean dispatchable capacity.

Markets for large-scale renewables generation and industrial energy efficiency and emissions reduction

- Large-scale Renewable Energy Target (LRET) and large-scale generation certificates (LGCs).
- Safeguard Mechanism and ACCUs.

Investing in new electricity transmission and distribution lines

- Rewiring the Nation

Subsidising home solar and batteries

- Small-scale Renewable Energy Scheme (SRES).
- Coming home battery subsidy.

Improving governance, coordination and strategy

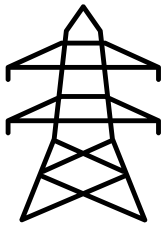
- Renewable Energy Transformation Agreements (RETAs) between the Commonwealth and states and territories.
- Consumer Energy Resources (CER) Roadmap to unlock CER at scale across Australia.
- National Energy Performance Strategy - Long-term framework to manage energy demand and improve energy performance.

Challenges for the rapid expansion of renewable electricity

1 – Tripling the build rate of renewable generation & storage

Double this rate again for a Green Energy Exports (GEE) future by 2050.

2 – Expanding transmission lines

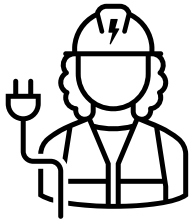


8,000-10,000 km of new transmission lines are required in the **NEM** by 2050.

Significant grid-connected energy export requires up to **26,000 km** of new transmission.

WA needs up to **7,000 km.**

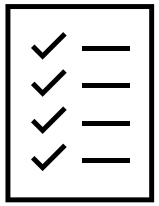
3 – Many more workers & skills needed



Need 32-47% more employees by 2050 **(rising to approximately 2.05-2.28 million people).**

There are pre-existing and forecasted future skilled labour shortages across critical occupations.[1]

4 – Streamlining approvals and social licence



Average total time for a large renewable project is still **41 months for solar** and **53 for wind**.[2]

Approved new capacity reached a record high in 2024 after declining from 2019 to 2023.

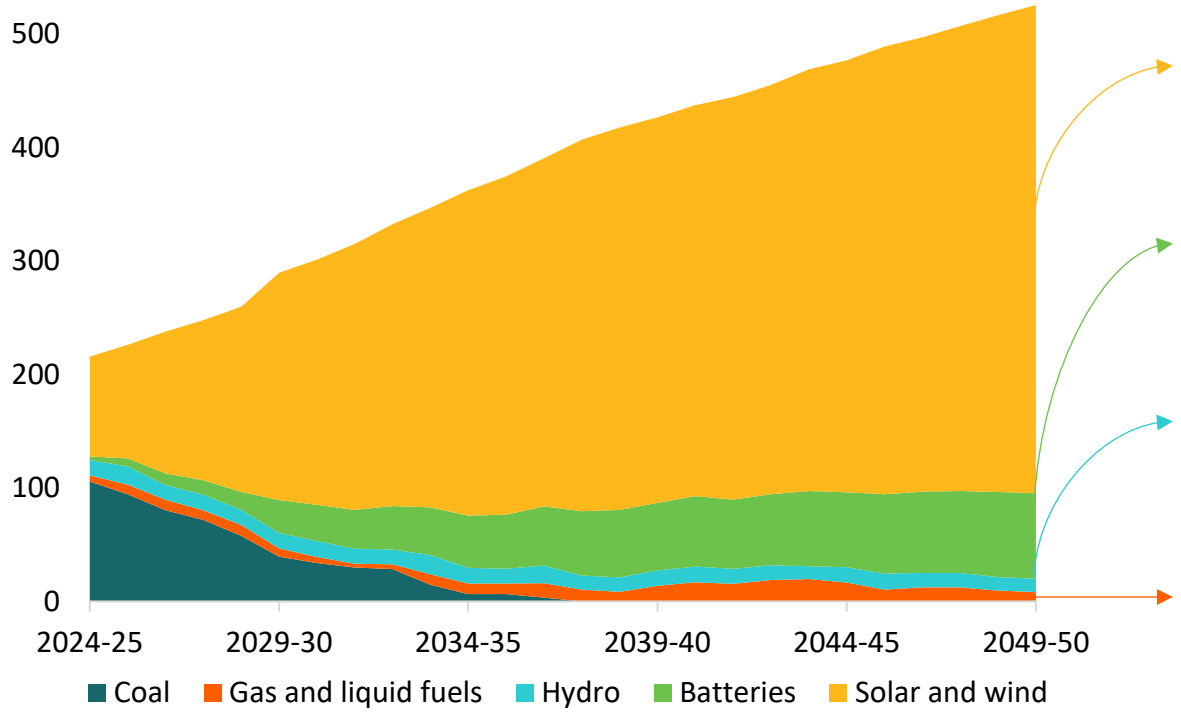
Increased information and engagement requirements, as well as locational challenges have been driving longer approval times. [3]

Note: Refers to AEMO Draft ISP 2024 Step Change scenario and on-grid supply unless otherwise referenced. Sources: 1. Jobs and Skills Australia (JSA), 2023, *The Clean Energy Generation,* Report; 2. Lachlan Clapin, Thomas Longden, 2024, Waiting to generate: An analysis of onshore wind and solar PV project development lead-times in Australia, Energy Economics, Volume 131, 2 February 2024; 3. Rystad Energy, 2022, expert witness statement to ACCC.

Electricity grids will need to balance more variable inputs as renewables increase

Electricity generation from renewable sources is expected to increase substantially

Annual electricity generation in the NEM to 2050, TWh



Source: ISP, AEMO 2024. Generation mix in the NEM, Step Change scenario

Low emissions firming is depleted during drought

By 2050, Australia's electricity grids will be dominated by **variable renewable electricity**, replacing **coal fired generation**

Batteries can currently only store a few hours of energy, making them too expensive for longer periods. Though technology is still developing.

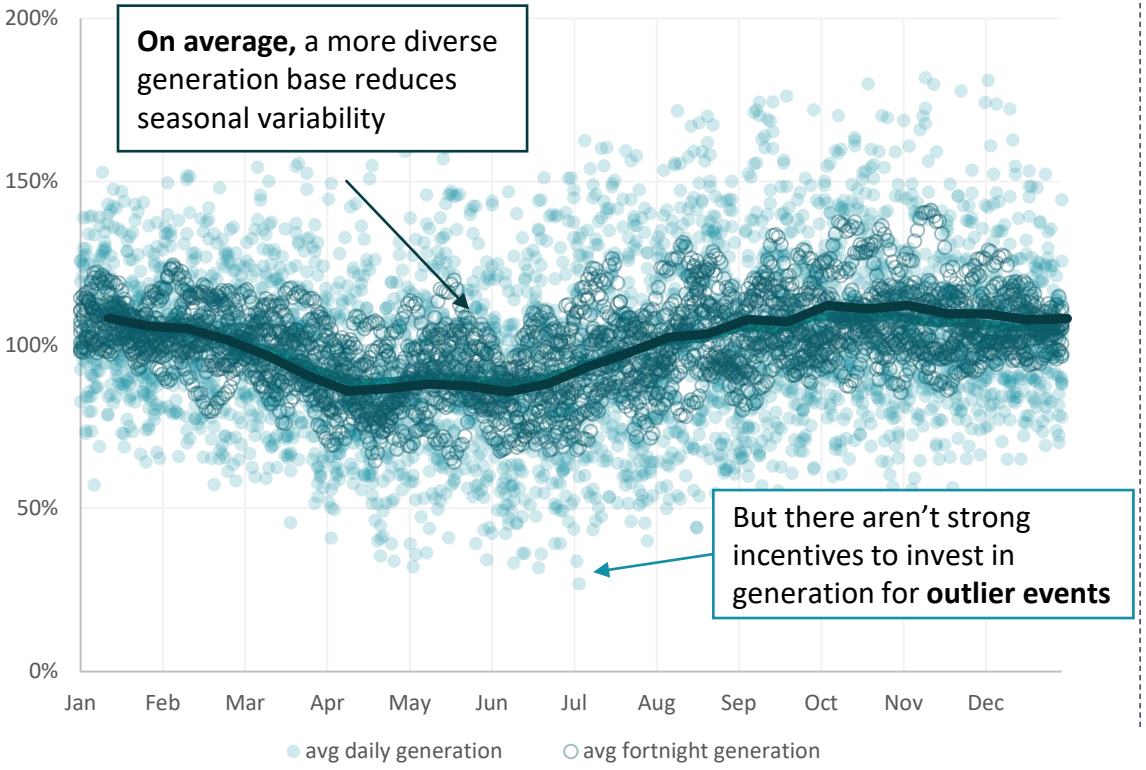
Pumped hydro is not scalable and can still deplete over extended droughts

GPG can dispatch a large amount for four weeks straight and is currently the most affordable solution for deep firming. This will make up the last percentage of generation in the grid.

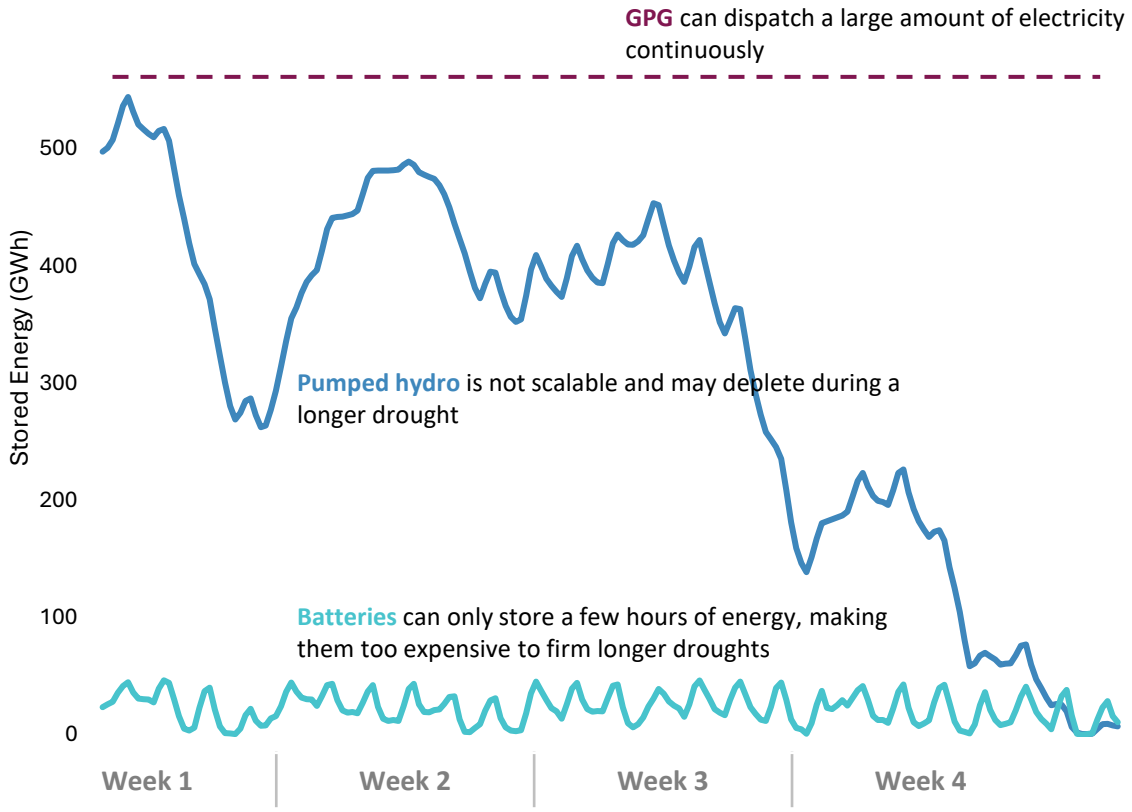
Market signals driving investments that smooth out the more predictable fluctuations in renewable output

Daily and seasonal price fluctuations provide an incentive to invest in wind generation to complement solar

*Projected **solar and wind** generation over 10 different years of weather, per cent of annual average*



But in extended renewables droughts, gas-powered generation is currently the most cost-effective form of firming



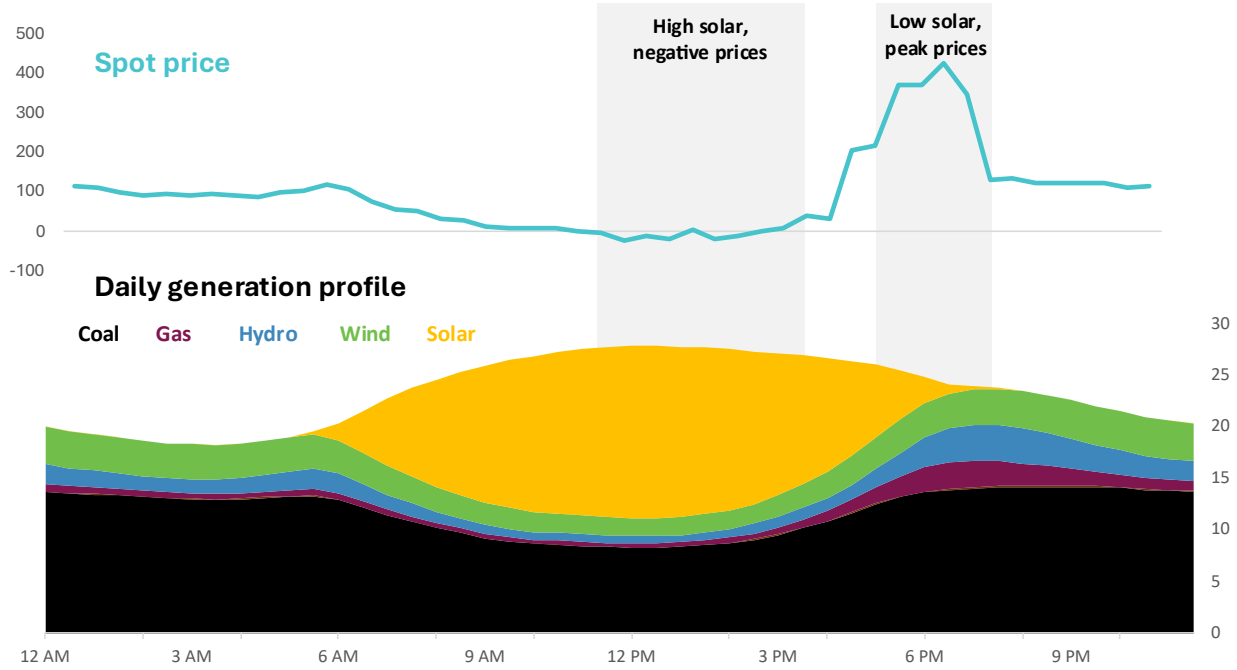
Source: DCCEEW modelling, 2024

Peak demand with low renewables supply to drive prices

In daily demand peaks, GPG sets prices as the supplier of last resort.

Batteries are starting to replace gas here.

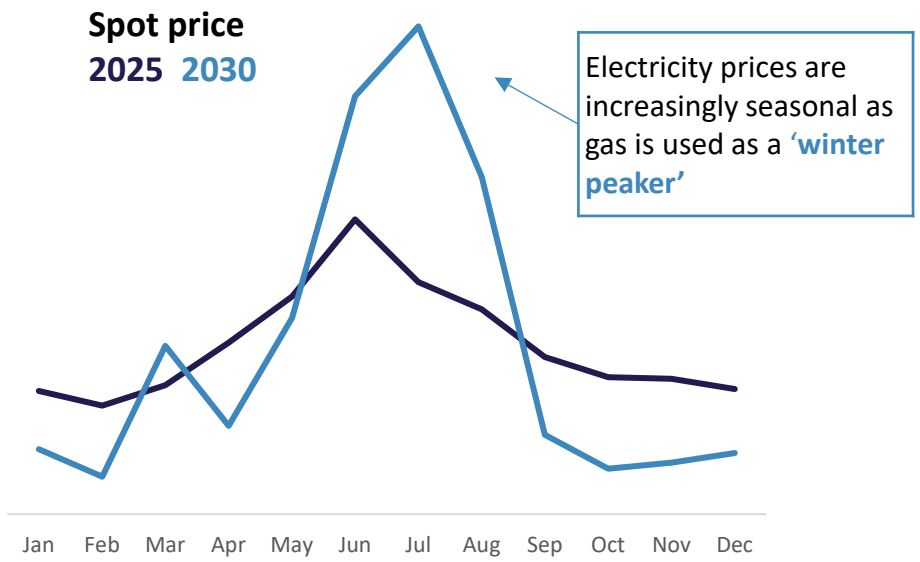
Daily generation profile (GW, RHS) and spot price (AU/MWh, LHS) in the NEM, 28-day average



Source: Open Electricity. 28day average for 24 October to 21 November

Prices are to become increasingly seasonal as winter reliance on GPG increases.

Also, during renewables droughts, gas is used through the day – not just as a daily peaker.



Next steps in the energy transition

Improving energy performance can deliver a faster and cheaper energy transition

Energy efficiency:
using less energy to do the same task. For example, insulation of buildings or using more efficient appliances.

Fuel switching, especially electrification:
cleaner or more cost-effective energy sources. For example – the use of EVs or electrification of gas heating.

Demand flexibility:
shifting when we use energy to make the most of abundant renewable supply. For example, charging devices during the middle of the day when solar output is high.

Better energy performance makes it easier to decarbonise the energy system.

- Need less (clean) energy and less infrastructure to meet our needs.
- Lowers the cost of the transition and the cost of energy for consumers.

Energy performance improvements can provide several benefits

Between 2011 to 2022, minimum standards and transparency on energy efficiency saved Australians **$12-18 billion in energy costs**.

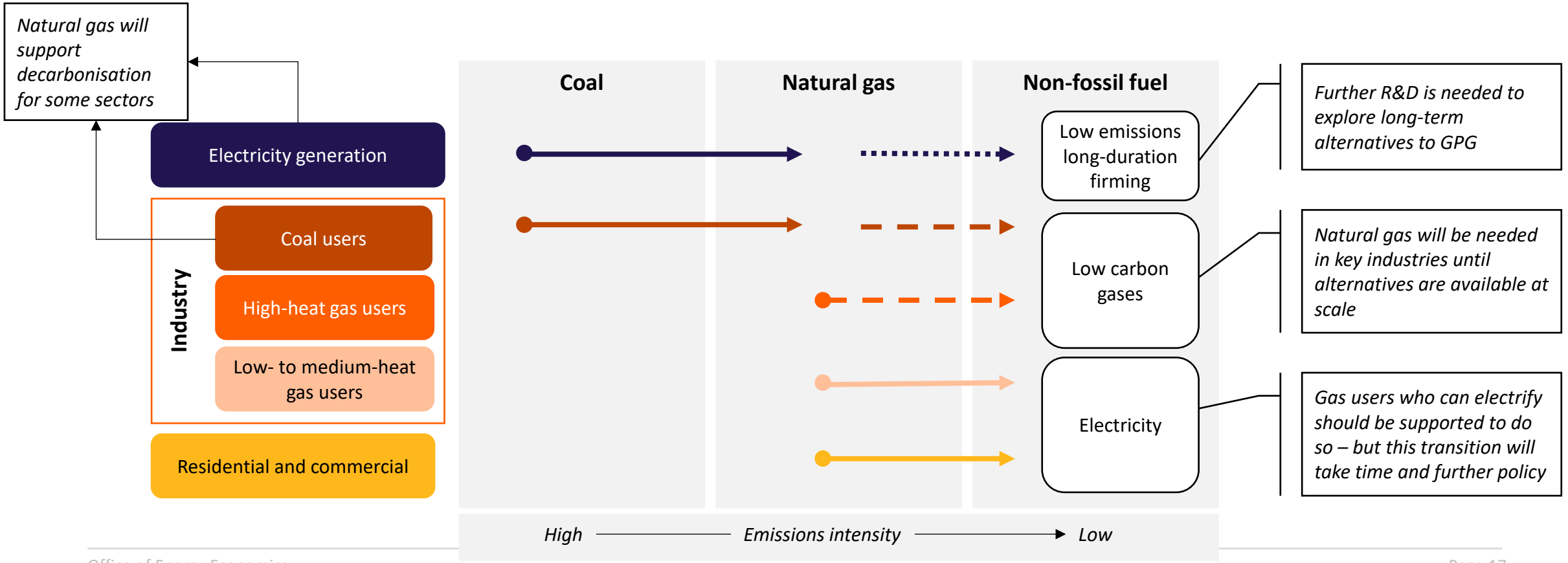
Estimates that flexible demand could generate up to **$18 billion in cost savings** for consumers by 2040.

Around **20% of global emissions** reduction by 2030 will be achieved by electrification.

The role of gas in our energy system will evolve through the transition

The transition away from natural gas will be complex – varying across sectors and over time

Decarbonisation pathways for coal and natural gas users



New technologies will support decarbonisation of hard-to-abate sectors

For energy users that can't electrify, other low carbon alternatives will support decarbonisation.

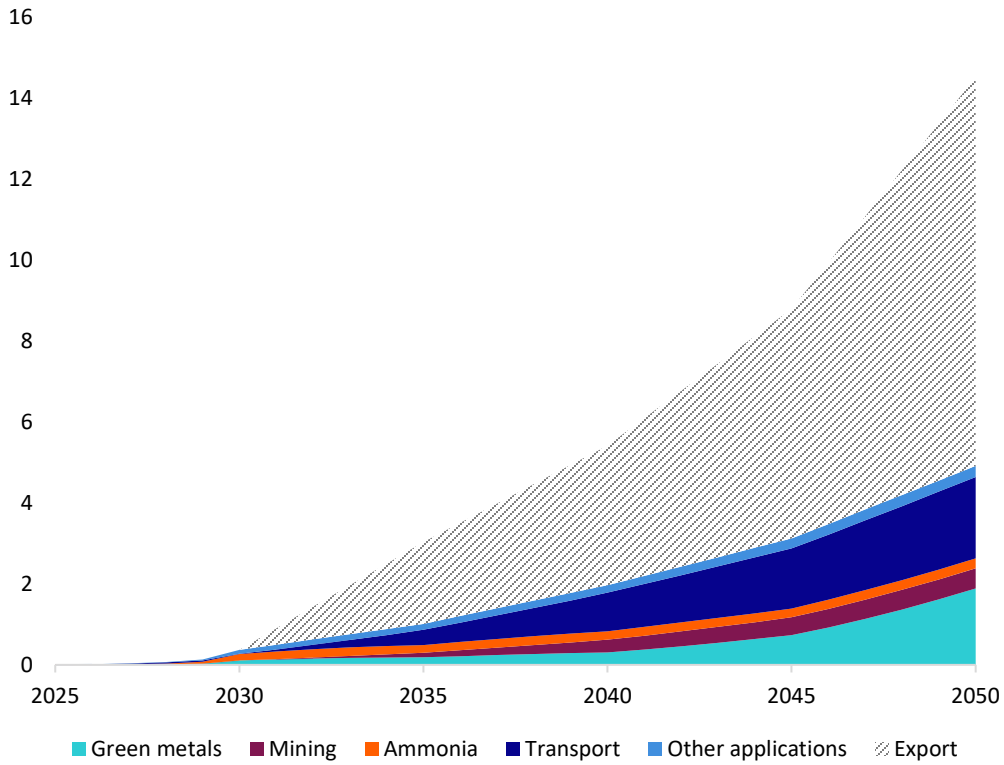
- Hydrogen offers opportunities for new industries and export markets but needs new infrastructure and time to scale.
- Biomethane can be integrated into existing networks and is a mature technology that can be deployed in the near term.
- Low carbon liquid fuels can support decarbonisation of transport, agriculture and other sectors that cannot electrify but needs further support to establish a market.

Work is underway to support low carbon gases.

- The Safeguard Mechanism provides incentive for Australia's largest industrial facilities to reduce emissions.
- A combination of supply-side support, demand-side measures and research, development and deployment (RD&D) may be needed to grow these industries.

Hydrogen will support domestic decarbonisation, but only from the mid-2030s

Hydrogen demand to 2050 in the 'Domestic Transformation' scenario, Mt



Assumes Central scenario in the National Hydrogen Strategy 2024
Source: DCCEEW, internal modelling to support the Electricity and Energy Sector Plan

Conclusion

The transition to clean energy away from fossil fuels has major economic impacts for Australia.
This transition is already well underway and has been supported by all levels of government.
Whilst there are challenges to address, there are also opportunities as an energy exporter to capitalise on the global shift to clean energy.
Work is still needed to ensure the energy transition continues to deliver affordable, clean, reliable and secure energy supply.

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