Topical Report #2

Australia's Progress to Net Zero by 2050

11 December 2025

NET ZERO AUSTRALIA

THE UNIVERSITY OF MELBOURNE
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CREATE CHANGE
PRINCETON UNIVERSITY
EVOLVED ENERGY RESEARCH

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The Net Zero Australia (NZAu) Project is a collaborative partnership between The University of Melbourne, The University of Queensland and Princeton University.

Please ensure that any use of the material in this report is acknowledged and cited as per the full reference above.

Disclaimer

The inherent and significant uncertainty in key modelling inputs and methods means there is also significant uncertainty in the associated assumptions, modelling and results. Any decisions or actions that you take should therefore be informed by your own independent advice and experts. All liability is excluded for any consequences of use or reliance on this publication (in part or in whole) and any information or material contained in it. Also, the authors of this report do not purport to represent Net Zero Australia Project Supporters and Advisory Group member positions or imply that they have agreed to our inputs, methodologies or results.

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3 Progress summary

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- 4.3 Enablers

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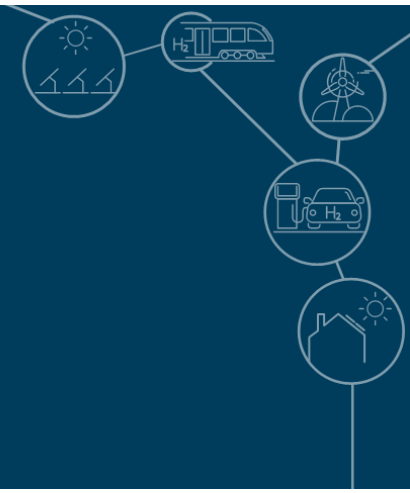
1 About the Net Zero Australia study



Net Zero Australia's areas of focus

Phase 2 of Net Zero Australia is completing deeper analysis of specific challenges and aims to make practical recommendations on decarbonisation while acknowledging environmental and social objectives.

1

A unified approach to decarbonisation

Informing nation-wide strategies for planning, governing, and implementing large-scale decarbonisation projects.

2

Biodiversity, land use and GHG management

Informing integrated approaches for balancing ecological preservation, agricultural productivity, and carbon management.

3

People, trust and the workforce

Informing measures that balance community benefits, workforce preparedness, and household engagement in the energy transition.

* The NZAu Project has consulted widely with our Advisory Group members and many other stakeholders but is independent of them all. NZAu does not purport to represent their positions or imply that they have agreed to our methods or results.

Project governance

Steering Committee

Responsible for the Project's strategy, scope and management.

Advisors and Supporters

Crucial input is being provided by diverse Advisors*, with generous support provided by several organisations. Gifts and grants ensure the Project's independence.

NZAu Team

Researchers and advisors across the Universities of Melbourne and Queensland, Princeton University, and Evolved Energy Research.

For more, visit our website:
www.netzeroaustralia.net

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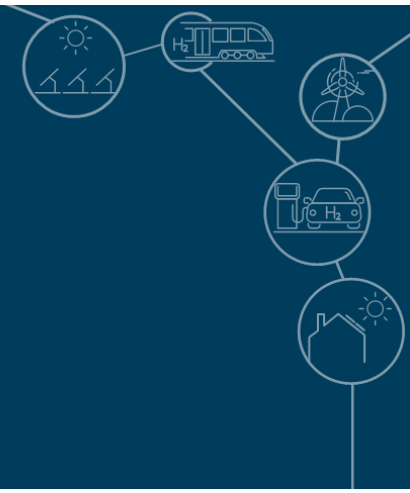
2 Progress Tracker Framework



Purpose and scope of this Progress Tracker

This second Topical Report uses publicly available data and Net Zero Australia modelling to complete a quantitative assessment of Australia's progress to achieving net zero by 2050. We focus on some of the most significant constraints.

REPORT PURPOSE

1. Provide an independent, quantitative perspective on Australia's progress to net zero emissions by 2050
2. Provide an evidence base on where to focus, helping inform policy development
3. Contextualise the scale of the task against historical progress

☑ IN SCOPE

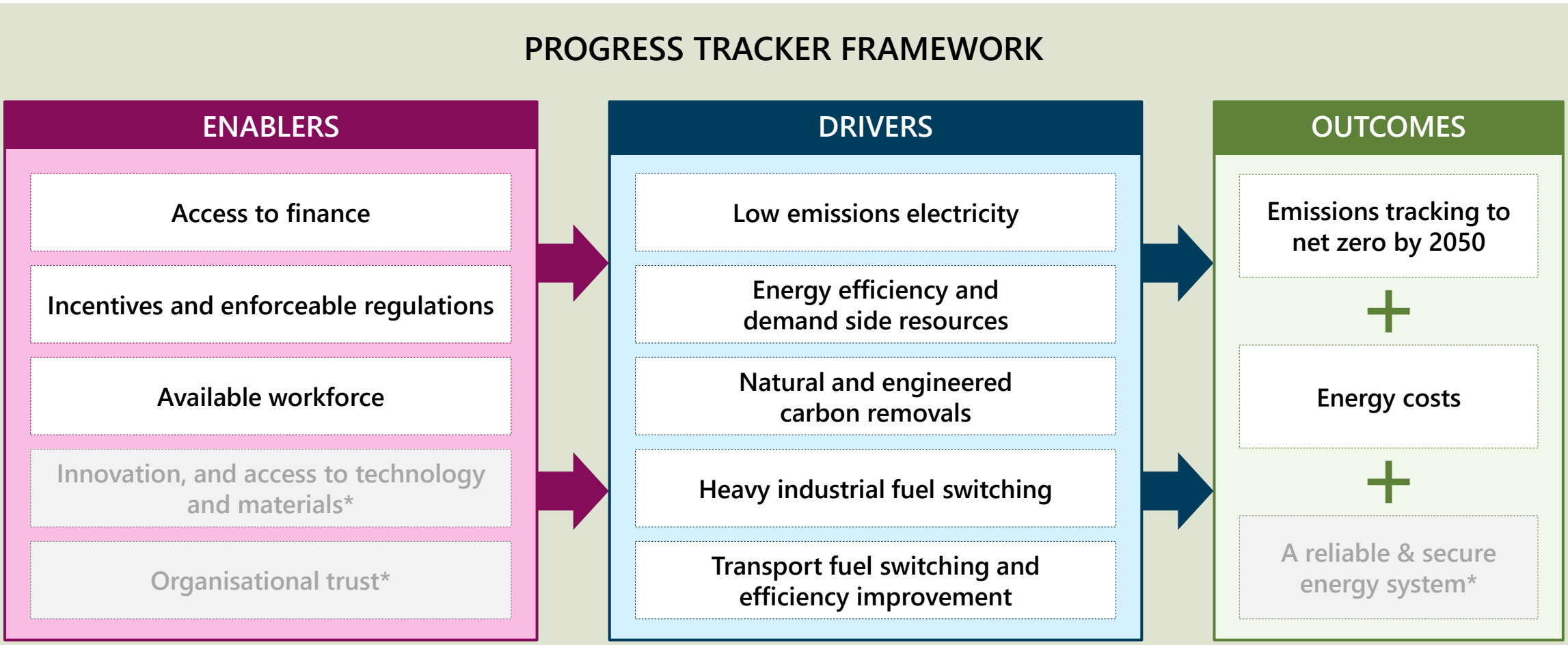
- Benchmarking historic progress against both legislative targets and modelled results
- Highlighting trends using historic data
- Base analyses on high quality, independent data

☒ OUT OF SCOPE

- Qualitative reporting
- Financial assessment of what's required to get on track
- Tracking broader climate goals – e.g. 1.5°C alignment
- Assessment of energy system security and reliability, as it will be a focus of future work

Alignment with the CCA: We acknowledge the Climate Change Authority's annual advice on progress towards emissions reduction targets, international developments, climate-related risks and climate policies. Our report does not seek to duplicate this effort and instead complements it by focusing on metrics with independent benchmarks from the NZAu Project, and other reputable sources.

We class metrics as enablers, drivers, and outcomes of decarbonisation.



*Note: boxes in grey are not tracked in this iteration of the Progress Tracker.

We track the biggest constraints to achieving net zero by 2050, benchmarked against legislation and NZAu modelling.

CRITERIA FOR INCLUSION

To be included, a metric must:

1. have **reasonable data availability** from a credible source; and
2. either be:
   i. a **significant driver of abatement** according to multiple sources; OR
   ii. a **critical enabler** of decarbonisation; OR
   iii. a **required reporting measure.**

ASSESSMENT FRAMEWORK

On track	Projections of current trends **deliver to within 20%** of the investment (units, capital or capacity), abatement, or costs estimated from either i) legislation or ii) the higher of the NZAu Project's Net Zero 2050 Scenario[1], AEMO's 2024 Integrated System Plan or the Australian Government's 2025 Net Zero Plan.
At risk	Projections of current trends deliver to **within 20%-50%** of the estimated investment, abatement or costs by 2050.
Off track	Projections of current trends deliver **outside 50%** of the estimated investment, abatement or costs by 2050.

1. You can access our previous independent modelling report on our website: https://www.netzeroaustralia.net.au/publications/

We track progress with metrics across 10 sub-categories within this Report.

Category	Sub-category	Metric	Unit
Outcomes	**Emissions**	Historic domestic greenhouse gas emissions, by sector	Mt CO_2e p.a.
	Energy costs	Historic annual energy costs, by end use sector	Real $2024-25
Drivers	**Low emissions electricity**	Historic and projected electricity generation by fuel type	% GWh p.a.
		Electricity generation, storage and transmission build rates, by technology	Various
		Utility solar and onshore wind project development times, by stage	Months; Months/MW
	Energy efficiency and demand side resources	Installed capacity of rooftop solar and household batteries	MW; MWh p.a.
	Natural and engineered carbon removals	Land sector sequestration by subsector; sequestration from reforestation	Mt CO_2e p.a.
		Projected Australian engineered CO_2 storage capacity by project	Mt CO_2e p.a.
	Heavy industrial fuel switching	Industrial sector energy consumption by fuel source	% TWh p.a.
	Transport fuel switching	Emissions intensity by light duty vehicle class, new sales	g CO_2e/km
		Uptake of hybrid and electricity light duty vehicles	% new sales
Enablers	**Access to finance**	Estimated cumulative and annual capital investment in onshore wind and utility scale solar generation projects, by NEM state, historic vs modelled	2025 AUD p.a.
	Incentives and enforceable regulations	Difference in 2035 modelled emissions between Net Zero 2050 and Current Policies Scenarios	Mt CO2e p.a.
	Available workforce	Historic employment per industry over the last 25 years relative to modelled employment	‘000s jobs

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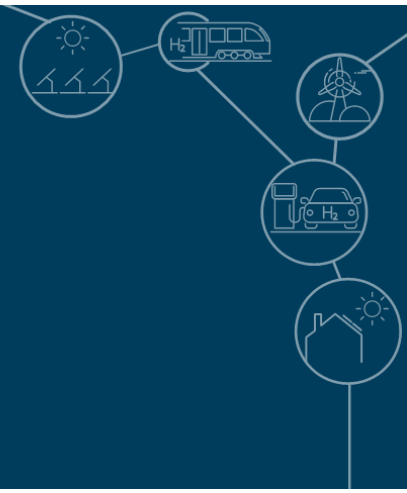
3 Progress summary



Summary of progress

Progress to net zero by 2050 is varied, with bright spots in behind the meter resources and storage, and challenges with deployment of large-scale generation and carbon removals.

Outcomes

Emissions

AR — Historic domestic greenhouse gas emissions, by sector.

Energy costs

AR — Average annual energy costs by end use sector.

System security & reliability

NS — Time per year that the reliability standard is not met.

Drivers

Low emissions electricity

AR — Renewable proportion of electricity generation.

AR — Average annual new onshore wind and utility solar capacity additions.

On — Average annual new battery capacity additions and storage duration.

Off — Historic and projected future installed capacity of gas fired generation.

On — Historic and projected future installed transmission capacity and length.

AR — Utility solar and onshore wind project development times.

Natural & engineered carbon removals

AR — Projected Australian engineered CO_2 storage capacity.

Off — Projected Australian land sector abatement.

Heavy industrial fuel switching

AR — Electrification and renewable fuel uptake in the industrial sector.

Transport fuel switching & efficiency

AR — Emissions intensity of light duty vehicle fleet.

On — Uptake of hybrid and electric vehicles.

Energy efficiency & demand side resources

On — Installed capacity of rooftop solar and small-scale batteries.

NS — Average NatHERS / NABERS ratings for existing building stock.

Enablers

Access to finance

AR — Capital investment in renewable generation projects.

Incentives and enforceable regulations

AR — Emissions abatement expected from Current Policies, by sector.

Available workforce

On — Historic employment per industry years relative to modelled employment.

Organisational trust

NS — Social acceptance of energy infrastructure.

On On track AR At risk Off Off track NS Not in scope for this report.

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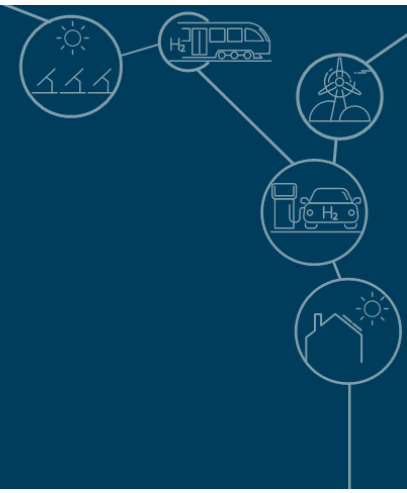
4 Australia's progress by metric



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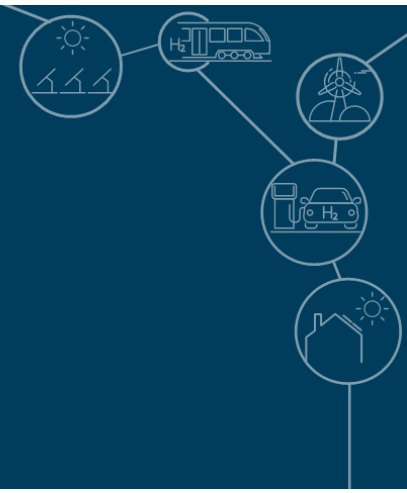
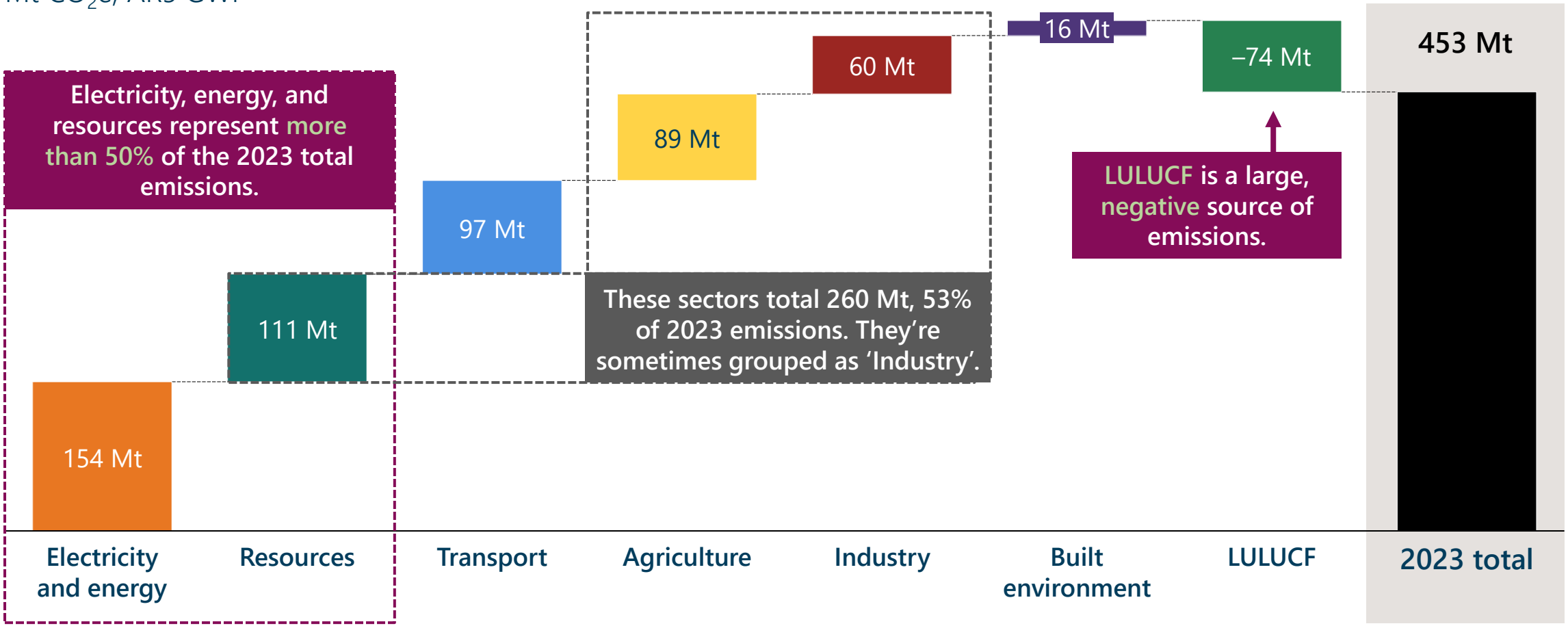
4.1 Outcomes



The energy and resources sectors emit more than 50% of Australia's emissions.

2023 Australian Paris Agreement greenhouse gas inventory, by sector *(as defined in Aus. Gov. Net Zero Plan)*

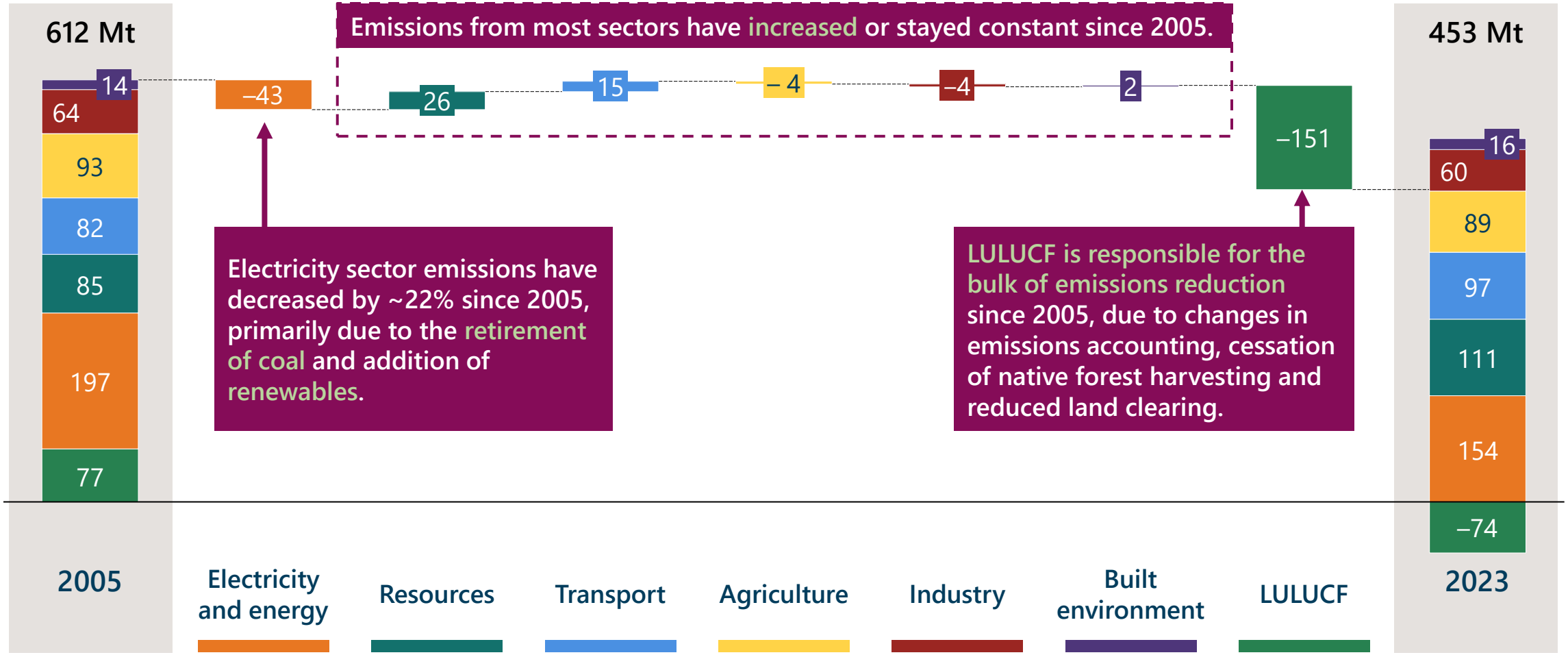
Mt CO_2e, AR5 GWP



Note: emissions within categories do not align directly with those reported in Australian Government's 2025 Net Zero Plan as i) they use 2024 data not yet publicly released, and ii) the above chart attributes Paris reported emissions categories to the Net Zero Plan's categories, which is likely not a perfect attribution.
Sources: DCCEEW 2025, Australia's National Greenhouse Accounts; DCCEEW 2025, Australia's Net Zero Plan;

Without LULUCF, emissions have not changed significantly since 2005. This means that renewable investment has largely been offset by demand growth.

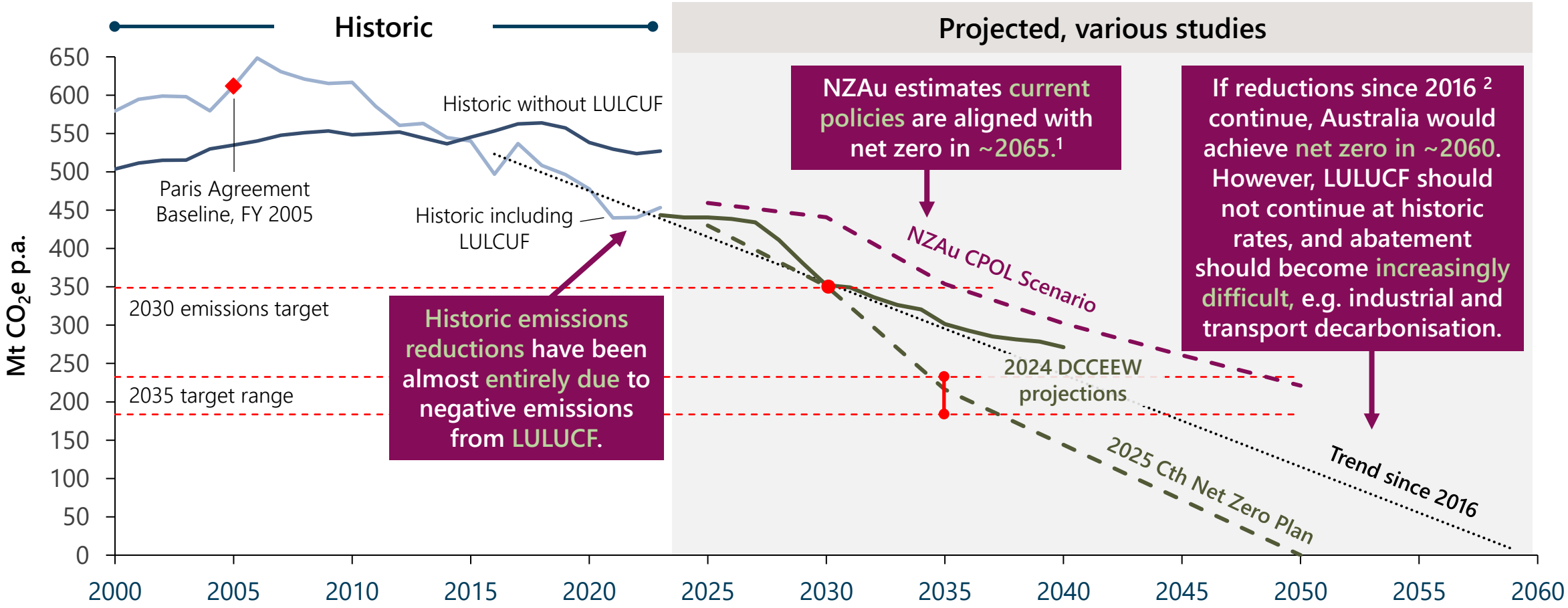
Sectoral breakdown of changes in national greenhouse gas emissions inventory, 2005 to 2023 (Mt CO_2e, AR5 GWP)



Source: DCCEEW 2025, Australia's National Greenhouse Accounts

If trends since 2016 continue, domestic emissions will decline to roughly the 2030 target but not the 2035 or 2050 targets.

Historic domestic greenhouse gas emissions, targets, and projected trajectories (Mt CO2e, AR5 GWP)



1. NZAu's Current Policies Scenario (CPOL) is likely an underestimation of abatement as i) it excludes individually small, but collectively significant policies, and ii) it does not include announcements made since September 2025 (e.g. funding for low carbon liquid fuels). 2. Year the Paris Agreement was signed.

Sources: DCCEEW 2025, Australia's National Greenhouse Accounts; DCCEEW 2025, Australia's Net Zero Plan; DCCEEW 2024, Australia's emissions projections 2024; McCall et al., 2025, *Topical Report #1: Updated Net Zero Pathways for Australia,* Net Zero Australia

Most modelling emphasises very large reductions in electricity and energy, resources and transport emissions, complemented by carbon removals.

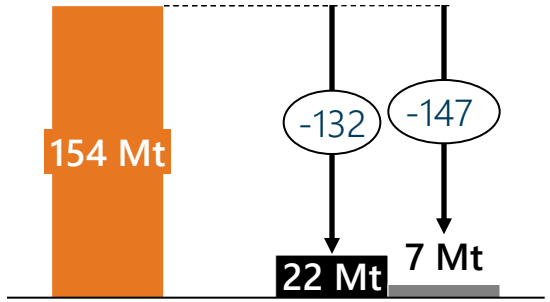
Direct emissions by sector, 2023 inventory vs 2050 modelling by Net Zero Australia and The Treasury

Mt CO_2e p.a.

BIGGEST CONTRIBUTORS TO EMISSIONS REDUCTION

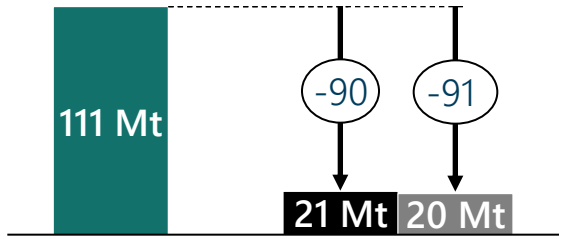
NEGATIVE EMISSIONS

Electricity and energy



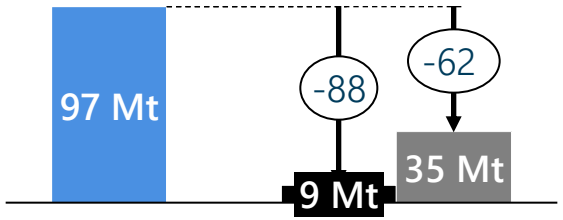
Reduced to near zero by 2050, driven by deployment of renewables, storage, gas firming, and replacement of coal.

Resources



Mining and natural gas processing emissions fall due to reduced production, fuel switching, and technology to capture and store carbon.

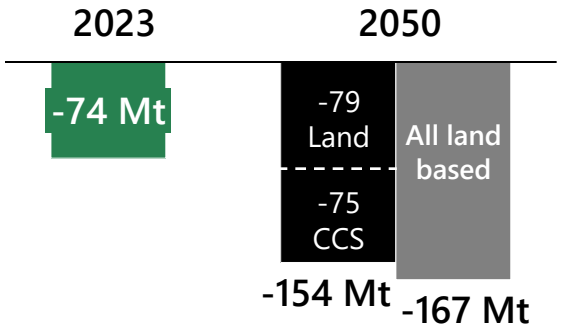
Transport



Both models see significant abatement from deployment of hybrids, EVs, and roll out of renewable fuels for heavy transport and aviation.

Carbon removals[1]

Land-based sequestration and/or CCS are likely needed to offset significant residual emissions. Views on the abatement potential of both vary.



NZAu - NZ2050 Scenario Treasury - Baseline Scenario

1. Includes nature-based abatement (LULUCF) and engineered carbon removals. Treasury modelling only includes nature-based abatement, as shown.

Sources: McCall et al., 2025, *Topical Report #1: Updated Net Zero Pathways for Australia,* Net Zero Australia; DCCEEW 2025, Australia's Net Zero Plan

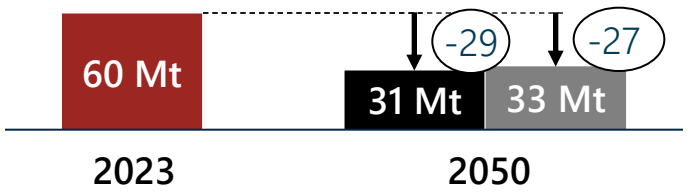
Industry, agriculture, and the built environment are not expected to be large direct contributors to the decarbonisation task.

Direct emissions by sector, 2023 inventory vs 2050 modelling by Net Zero Australia and The Treasury

Mt CO_2e p.a.

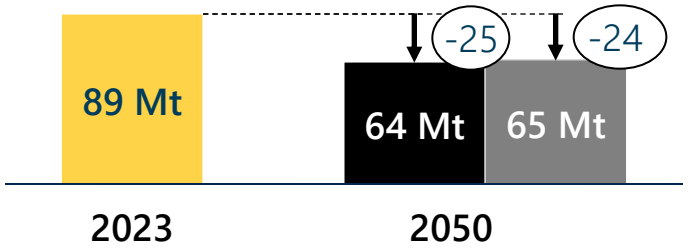
LESS SIGNIFICANT CONTRIBUTORS TO ABATEMENT

Industry
(Manufacturing and construction)



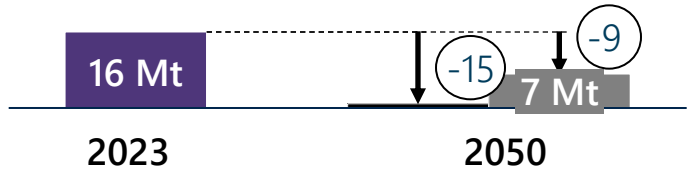
Industry must roughly halve emissions, with relatively few, more expensive decarbonisation options. Specific pathways for industrial decarbonisation is a focus of future work for NZAu.

Agriculture



An optimistic uptake of agricultural mitigation measures still results in modest sectoral abatement if demand for products grows as projected.

Built environment
(Residences and offices)

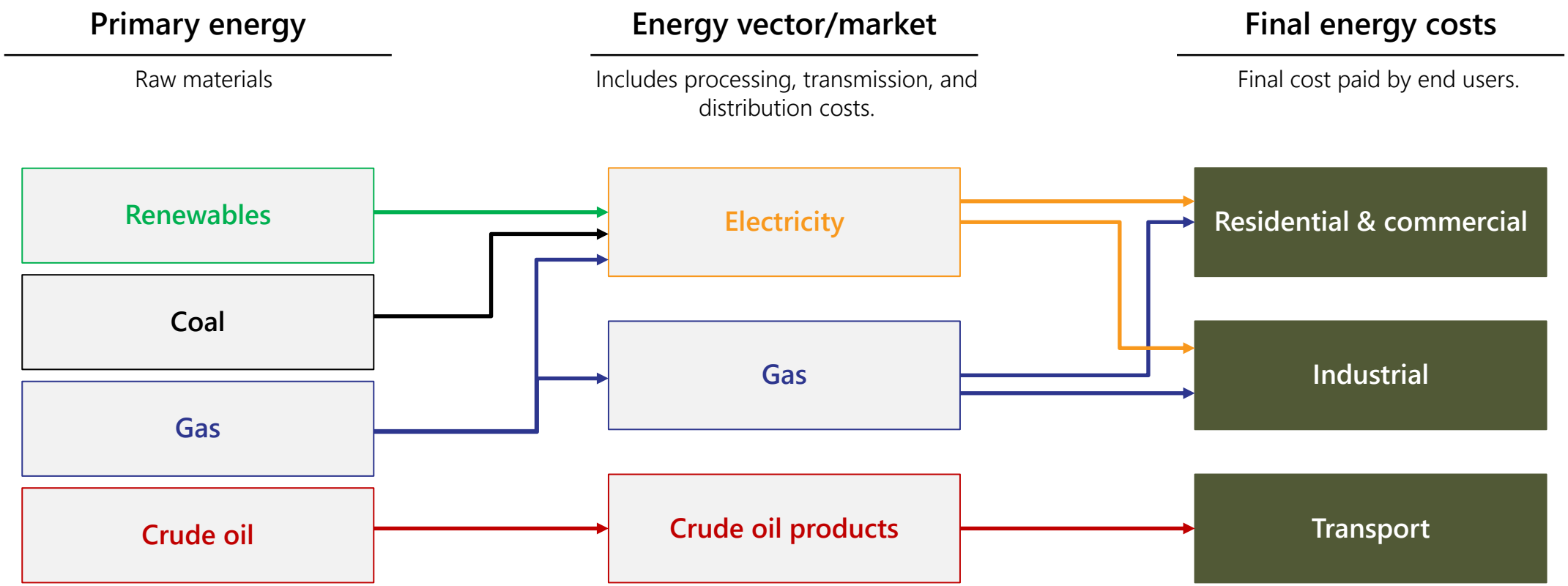


Buildings are not a large contributor to direct emissions today, so their contributions to decarbonisation must be small, e.g. substituting away from gas use in homes.

NZAu - NZ2050 Scenario Treasury - Baseline Scenario

Sources: McCall et al., 2025, *Topical Report #1: Updated Net Zero Pathways for Australia,* Net Zero Australia; DCCEEW 2025, Australia's Net Zero Plan

Analysis of energy costs ($/MWh and $) should consider several energy supply chains by end user.

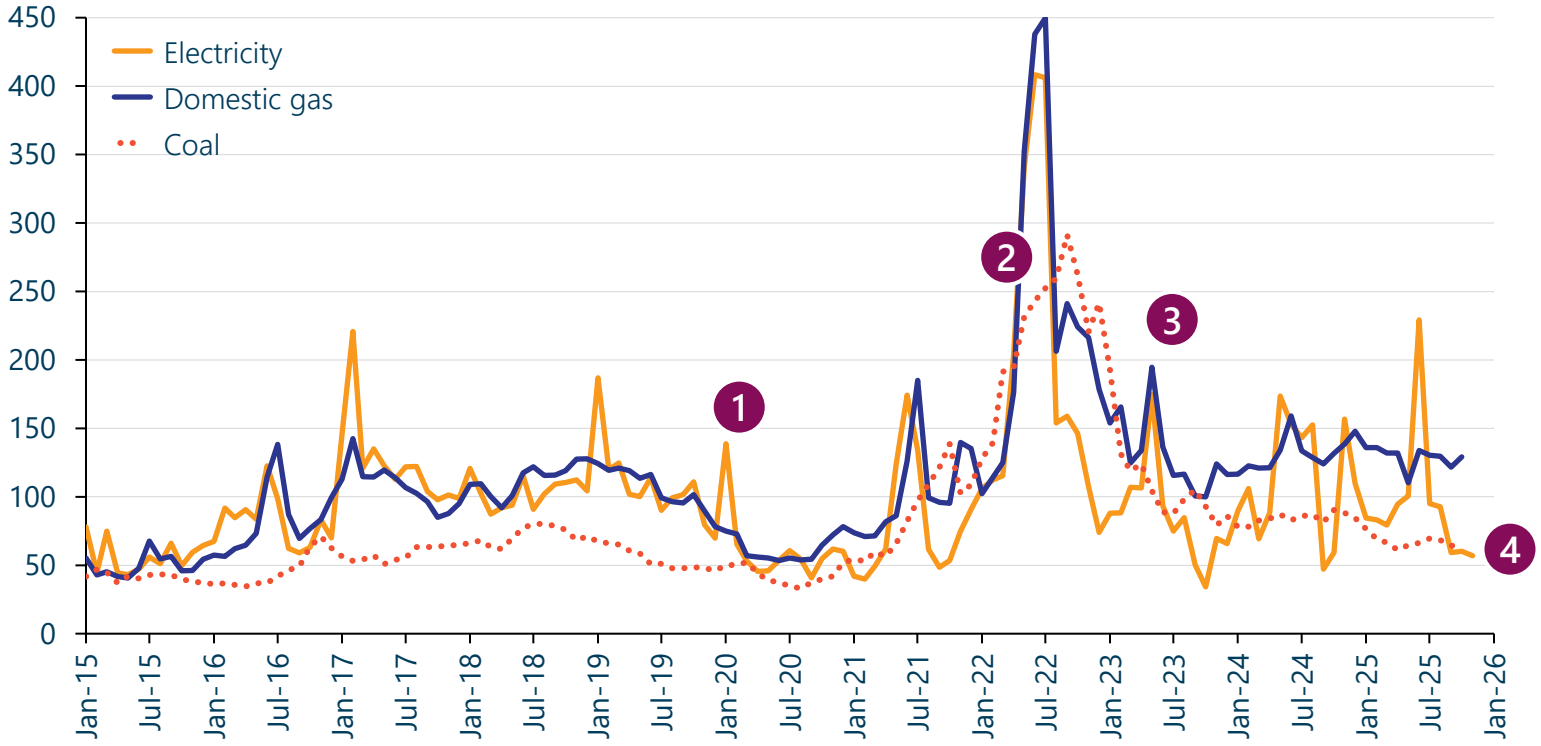


How do these costs affect each other and to what extent have they changed in the last 10 years?

East Coast wholesale electricity prices correlated with East Coast wholesale gas prices up until ~2023, after which this correlation weakens.

Average monthly wholesale electricity[1], wholesale domestic gas[2], and coal[3] prices

$/MWh electricity equivalent (e.e, real $2024-25)



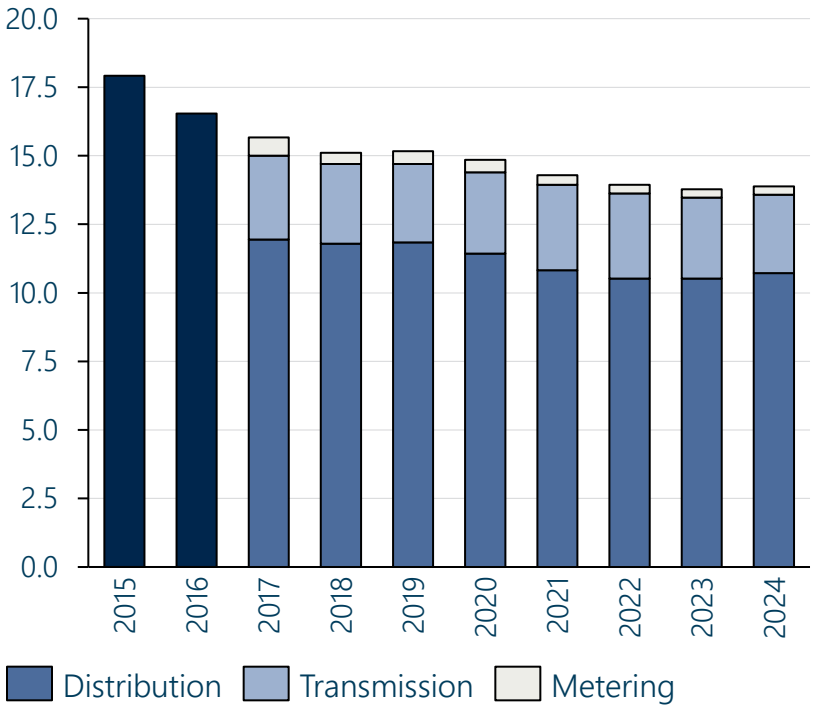
1. AEMO Market Management System data accessed 30 November 2025. Data is reported average monthly 5-minute spot price by NEM region, averaged based on regional electricity demand in 2023-24 as per Australian Energy Statistics.
2. Ex-post gas price as reported by AEMO in the DWGM, Gas Supply Hub, and STTM markets. $/GJ converted to $/MWh thermal then adjusted to $/MWh electricity equivalent (e.e) assuming a thermal efficiency of 36%.
3. Australian Newcastle coal prices sourced from World Bank Commodity Price Data (The Pink Sheet).

Key dates/trends

1. **Feb 2020**: Travel restrictions are established for Australia in response to the pandemic.
2. **Feb 2022:** Start of the current phase of the Ukraine war, with monthly gas prices peaking at over $40/GJ thermal shortly after.
3. **July 2023:** Gas Market Code regulation commences with a sale price cap of $12/GJ thermal ($120/MWh e.e).
4. Electricity prices correlated with natural gas prices until ~2023. Fluctuations since have become **more pronounced** and are **less correlated** with gas and coal (and oil) prices.

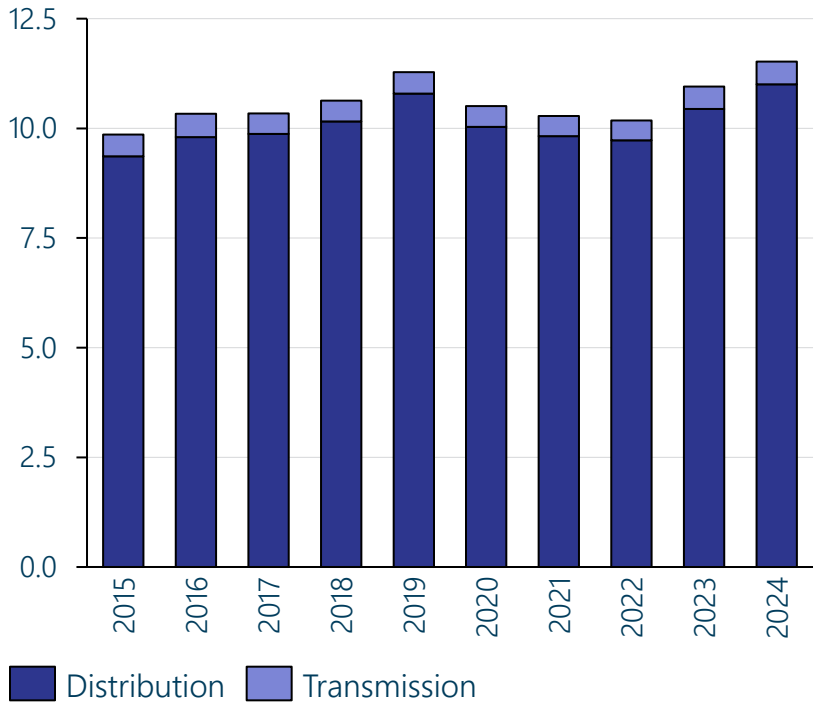
East Coast electricity network costs have fallen since the mid-2010s, while gas distribution costs have fluctuated, mainly due to reduced gas use since 2022.

Average annual residential/ commercial electricity network costs
(c/kWh, real $2024-25)



Source: ACCC, Inquiry into the National Electricity Market: December 2024 Report –financial year converted to calendar year by averaging overlapping years. Final data point is 2023-24, so 2024 calendar year assumed to be the same as FY 2023-24.

Average estimated annual residential/ commercial gas network costs
($/GJ, real $2024-25)



Source: Revenue: Australian Energy Regulator, State of the Energy Market 2025, Chapter 5; Gas use: DCCEEW, Australian Energy Update 2025. **Method**: $/GJ estimated by dividing actual regulated revenue p.a. (distribution and transmission) by gas consumption p.a. in VIC, NSW, ACT, and SA. Note that unregulated network costs are not included and are estimated to increase TX across all years by ~0.5 $/GJ, based on private communications with domain specialists.

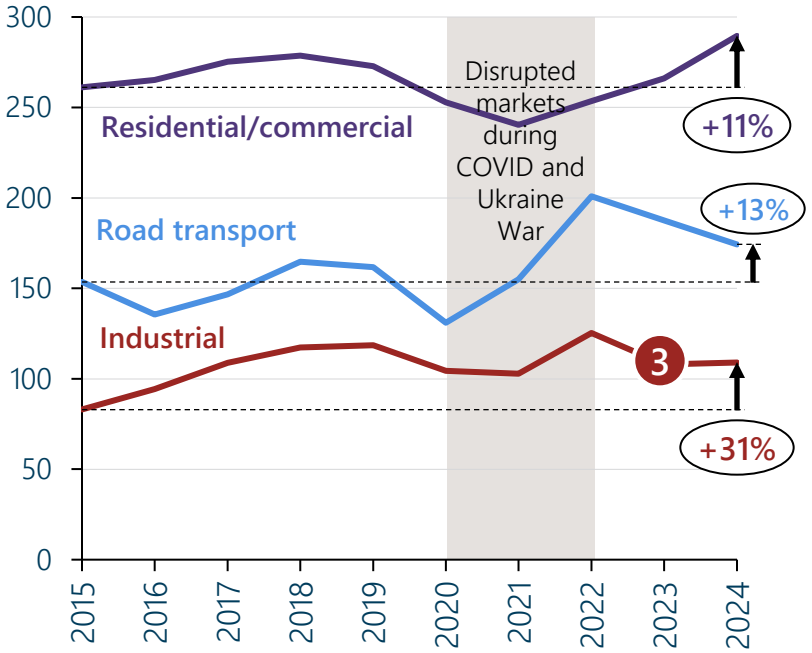
Key points

- **Higher electricity network investment** observed before 2016 **has reduced,** with average network costs falling in the past ~10 years.
- **Distribution** costs are the **main component** of electricity network costs, representing **over 70%** of the final cost stack.
- Electricity and gas **transmission costs have been reasonably steady** since ~2016. This will likely increase for electricity as in-train projects are completed.
- **Gas distribution** costs have **fluctuated** since ~2016, with recent increases per GJ mainly due to less gas use.

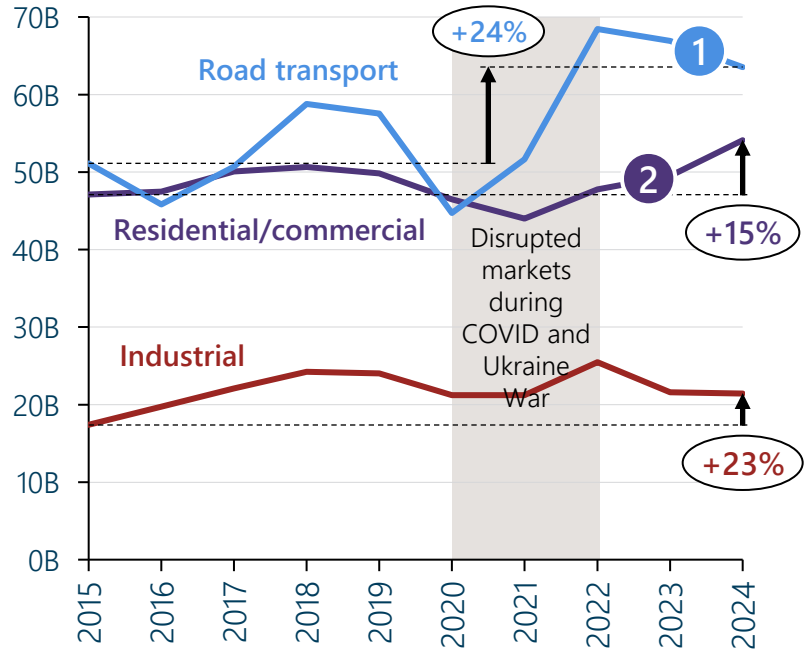
Transport and industry have seen larger energy cost increases since 2015, with residential/commercial energy costs also rising.

Average annual estimated retail energy prices/consumer costs by end use sector

a) Per unit energy prices (real $2024-25 per MWh)



b) Absolute costs (real $2024-25)



Method: we estimate average costs by multiplying average annual use by energy vector (electricity and gas for R&C/I and petrol/diesel for transport) by the average annual costs per unit energy. **Energy use sources:** Australian Energy Update 2025, Tables H and F.
Electricity cost sources: ACCC, Inquiry into the National Electricity Market: December 2024 Report.
Gas cost sources: Wholesale/network costs as per citations on previous slides. Residential gas retail costs assumed to be 20% of total gas costs, as per AER State of the Energy Market 2025, Chapter 6. Given the lack of independently available, public data on actual gas costs for large consumers, industrial gas users are assumed to only be connected to the gas *transmission* network, so costs here represent wholesale + transmission costs. Table D7 from the ACCC's Gas inquiry June 2025 interim report, shows that prices offered by retailers to the east coast gas market have closely tracked gas spot prices, meaning our approach offers a reasonable estimate of the costs faced by industrial users.
Diesel/petrol cost sources: Historical ULP and Diesel Terminal Gate Price Data, Australian Institute of Petroleum, accessed December 2025.
Other assumptions: Oil consumption is excluded from industrial energy costs but is significant, particularly for mining & agriculture.

Key points

1. Increased petrol and diesel prices alongside increased demand has driven an **~24% increase** in road transport energy costs ($).
2. ACCC & AER data suggests that **average** residential/commercial energy costs have **increased by ~11% ($/MWh) and ~15% ($)** since 2015. Other sources, such as the *St Vincent de Paul Society's Tariff Tracker, suggest larger rises.*
3. Estimated industrial energy costs per unit energy have **increased ~31%** since 2015, primarily due to estimated delivered gas costs increasing from ~$20/MWh to ~$49/MWh.

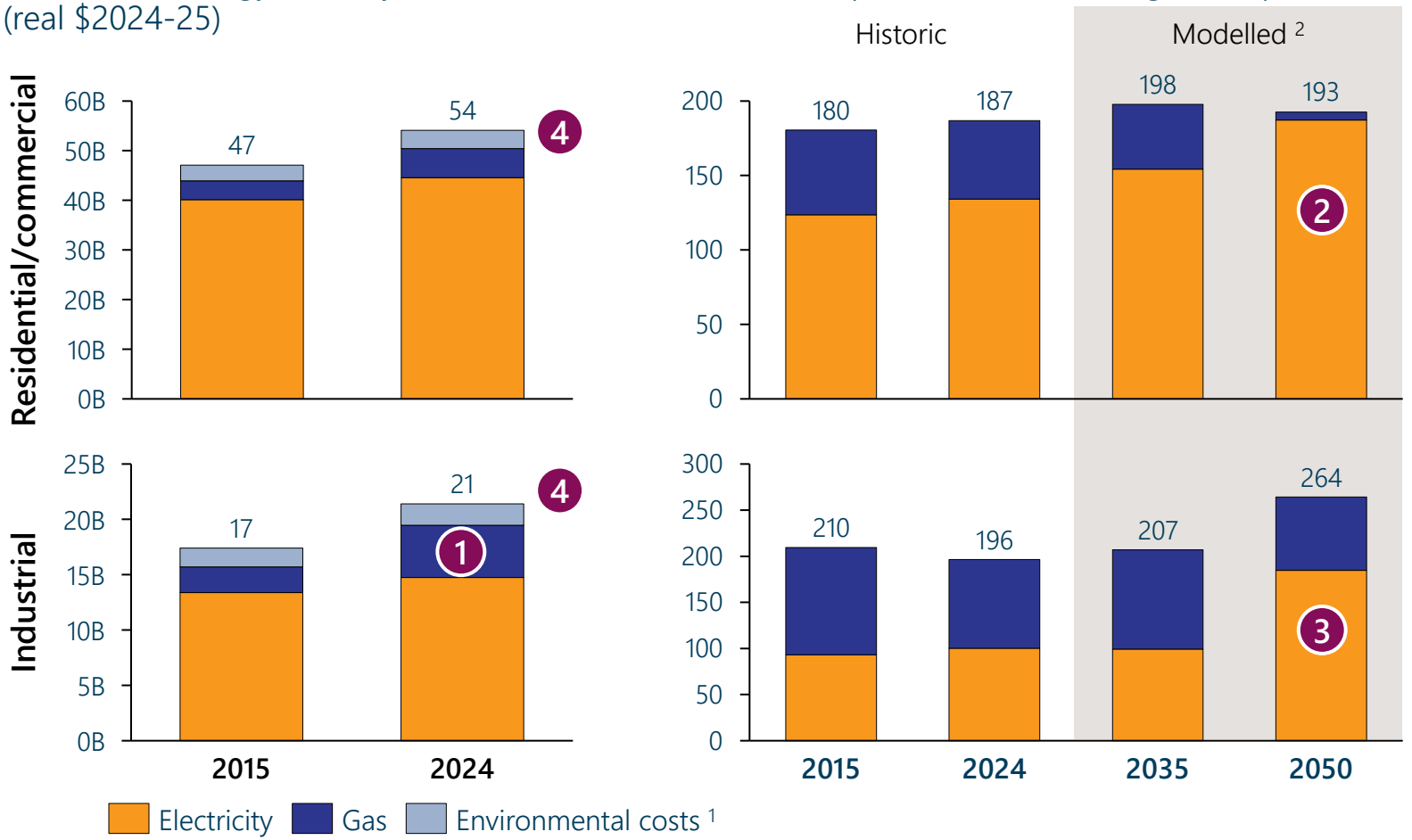
These are averages: significant heterogeneity in electricity and gas loads across all sectors will drive significantly different outcomes, e.g. older homes with gas in VIC cf. all electric homes without solar in QLD, or an aluminium smelter cf. a chemicals manufacturer.

Environmental costs, including renewable policy costs, are a small share of total East Coast average energy costs, with cost ($) increases across all sectors.

Average annual estimated energy costs and consumption by end use sector

a) Absolute energy costs by vector (real $2024-25)

b) Consumption (TWh, excluding rooftop solar)



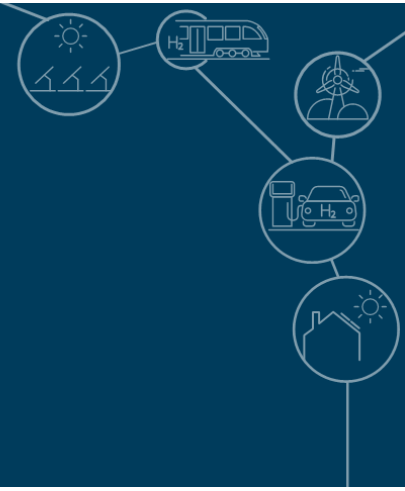
1. As reported by the ACCC, Inquiry into the National Electricity Market: December 2024 Report.
2. McCall et al., 2025, *Topical Report #1: Updated Net Zero Pathways for Australia,* Net Zero Australia, including demand met by rooftop solar.

Key points

1. **Increased wholesale domestic gas prices** over 2015-2024 appear to be the main driver of increased industrial energy costs.
2. Electrification of residential and commercial sectors by 2050 **creates significant equity concerns for consumers,** particularly for those unable to afford/install new electrical appliances and other behind-the-meter assets, e.g. solar and batteries.
3. Industrial energy users have **fewer options** to avoid exposure to wholesale gas and electricity prices and associated network costs, with slower electrification rates and ongoing use of gas to 2050+.
4. While 'environmental costs' do not include the full costs of renewable integration, **they are currently a small part of total estimated energy costs**. A detailed determination of renewables' full impact on system costs is out of scope for this report and will be examined later in the NZAu Project.

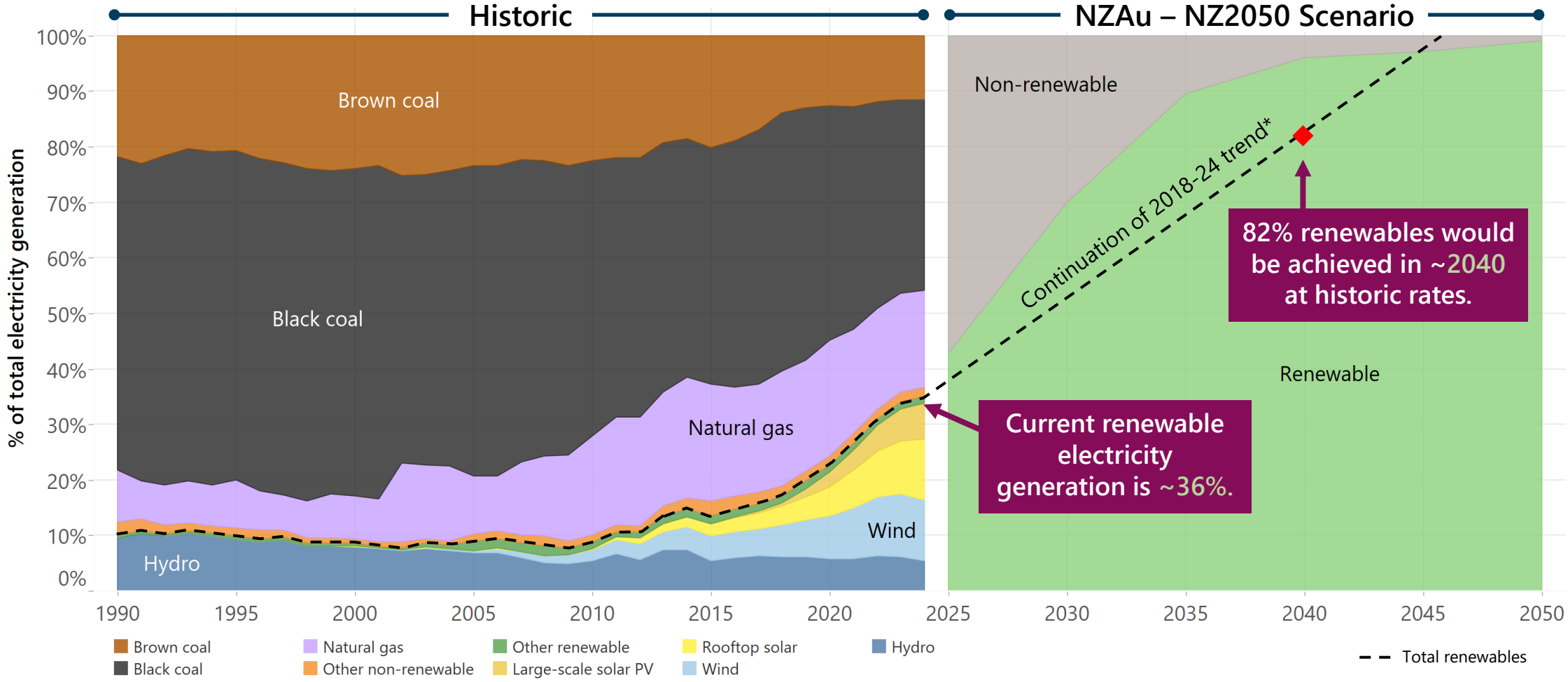
Return to structure

4.2 Drivers



Renewable electricity generation has been growing roughly linearly since ~2018, and this would achieve 82% in ~2040.

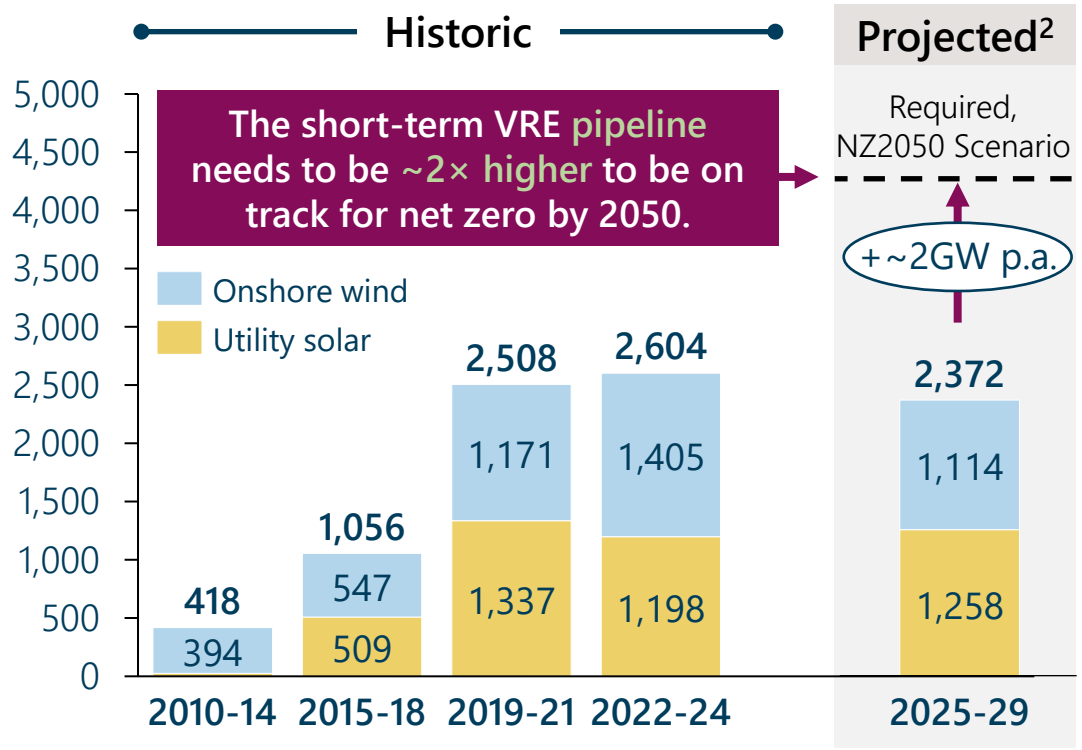
Historic and projected electricity generation by fuel type, % of total generation (% of GWh)



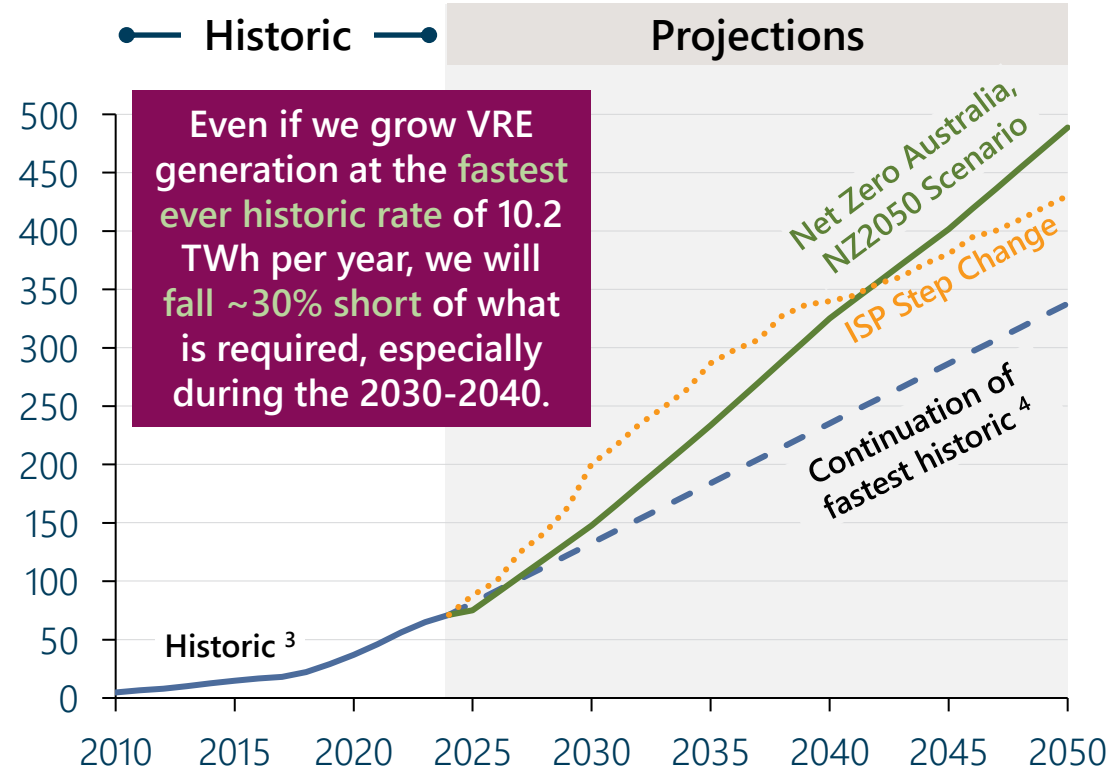
*Assumes continuation of average historic trend since 2018 of ~+3% renewables per year.
Source: DCCEEW August 2025, Australian Energy Statistics, Table O Electricity generation by fuel type

Annual renewable build rates are not expected to grow in the next 5 years, when acceleration is needed.

Average annual new onshore wind and utility solar capacity[1] additions in the NEM (MW p.a.).



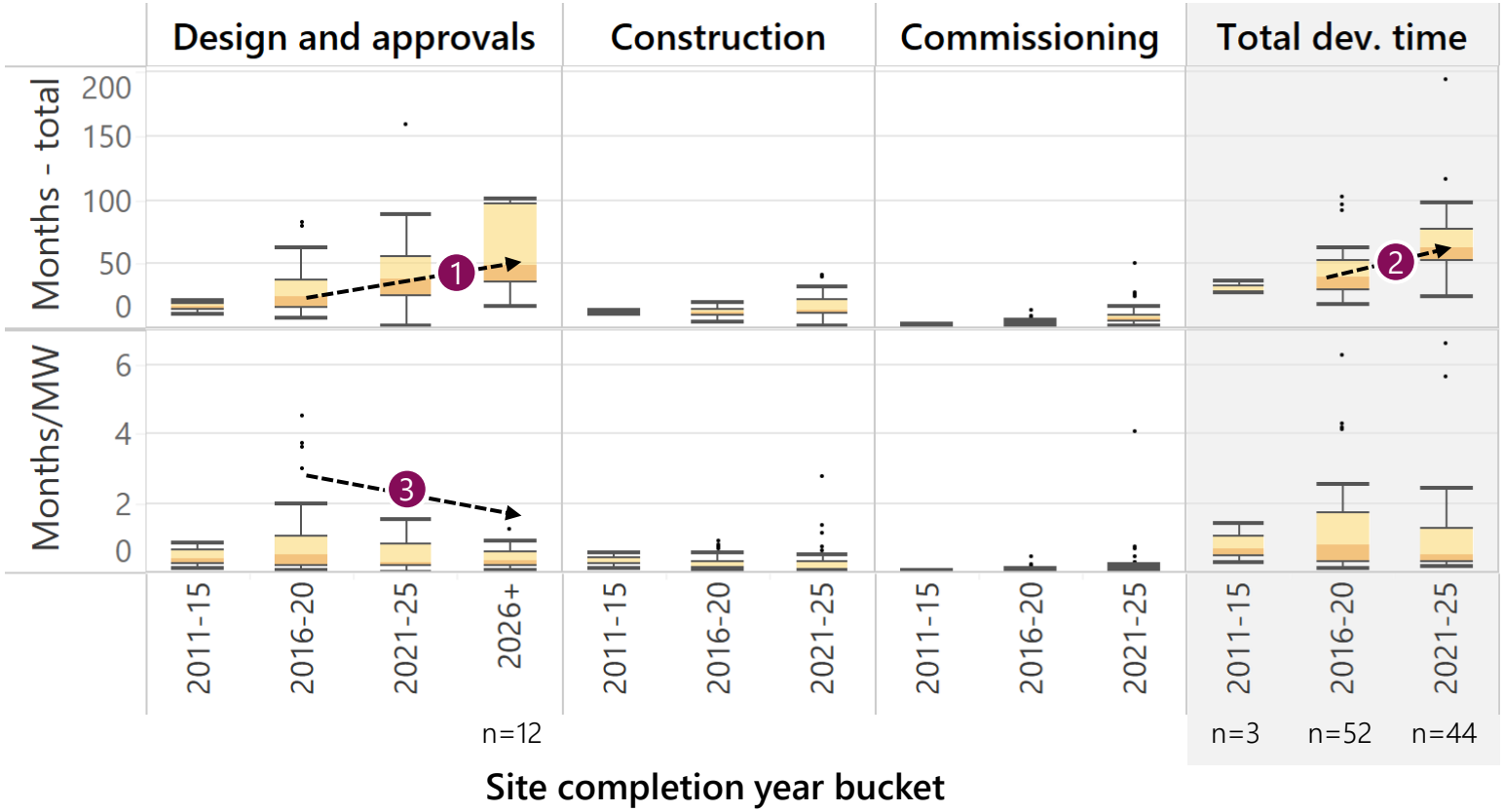
Total generation from installed onshore wind and utility solar capacity, NEM states (TWh p.a.)



1. Capacity is defined as the availability of the project, in MW AC, as reported by AEMO.
2. Includes existing, committed, and anticipated projects according to AEMO Generation Information with a full commercial use date between start 2025 and end 2029. Note this is likely an underestimation of what will be developed by 2029 as new projects mature, particularly given extensions to the Capacity Investment Scheme. **Sources**: Available capacity at end of calendar year, 2010-2024, Australian Energy Market Operator, Market Management System data, accessed April 2025; AEMO Generation Information July 2025, accessed September 2025.
3. Sourced from DCCEEW August 2025, Australian Energy Statistics, Table O Electricity generation by fuel type, excludes WA and NT.
4. Assumes annual growth of fastest historic rate, FY 2021-22 of ~10,200 GWh additional wind/solar generation.

Recent solar projects are taking longer to design and approve but are getting larger. These larger farms are increasing MW commissioned per month.

Utility solar project development times[1], by stage (months, months per MW-AC capacity)[2]



1. **Design and approvals[3] is the main driver of development times and has been increasing for solar. For projects completed in 2021-25, it was ~60% of the median total development time.**
2. **Median total solar development times over 2021-25 were ~50% higher than 2016-20, taking >5 years.**
3. **While absolute design and approval times are deteriorating, solar development time per MW is improving. Thus, increased farm size is the main driver of improved MW commissioned per month.**

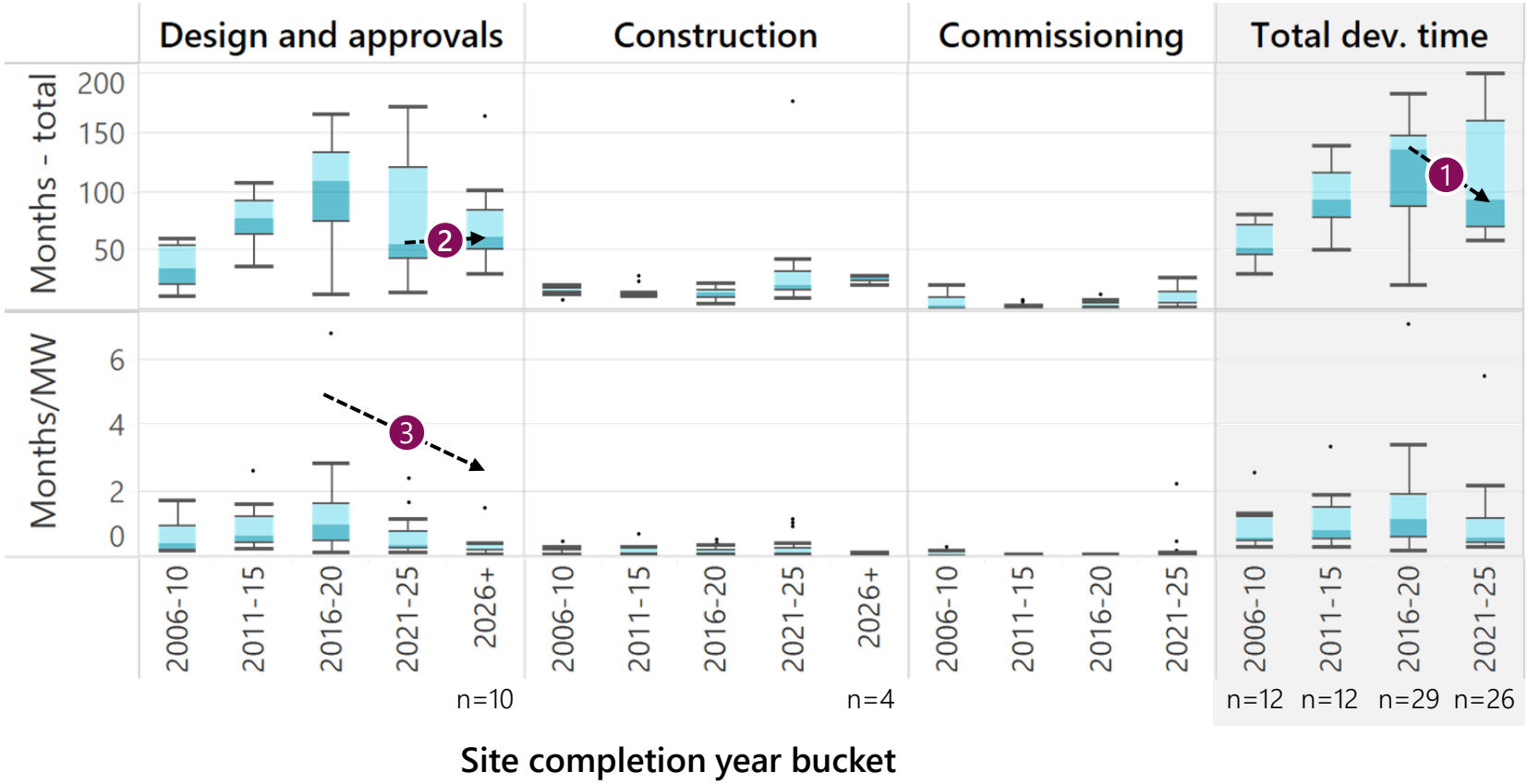
[1] Analysis builds on the approach developed by Clapin and Longden (2024). Site commitment date is based on the establishment date of the Australian Company Number for the project, cross referenced with the earliest mention of site selection via internet searches. Construction commencement uses press releases, new articles, and project websites. The start of commissioning is based on when the project first supplied energy to the grid, using AEMO data. Completion is assumed to be the month that the project has availability >80% of nameplate capacity in AEMO's data. NZAu analysis augments Clapin and Longden's data base with **47 additional wind and solar projects**. Projects <10 MW are filtered out.

[2] The yellow regions denote the **time in +/−25% of the projects surrounding the median**. The bars represent the range of all builds found within +/− 1.5* IQR. Outliers are shown as dots.

[3] Design and approvals refers to the time between site commitment and start of construction.

Total development times for wind are improving after historic highs, with larger farms again helping but projects still taking ~8 years on average.

Utility wind project development times[1], by stage (months, months per MW-AC capacity)[2]



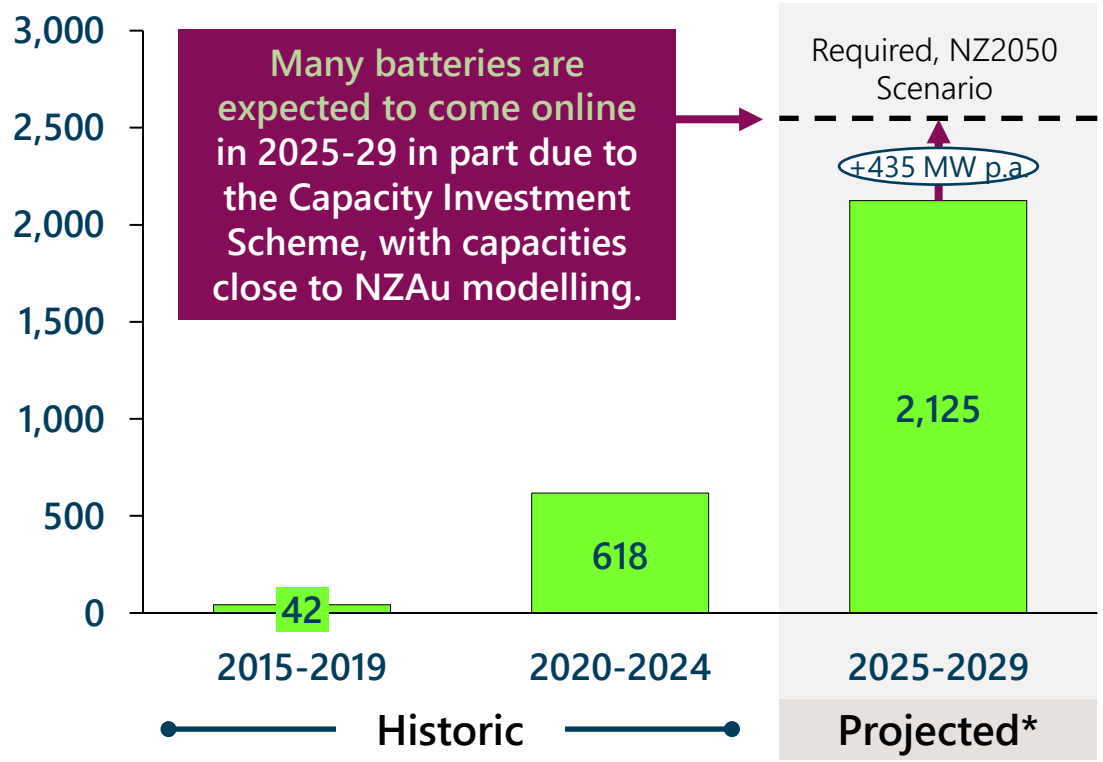
1. Median wind development times in 2021-25 improved 30% over those completed in 2016-20 but still take ~8 years.
2. Median design and approval times for wind projects completed in 2026+ are 12% higher than 2021-25 but have less variability.
3. Design and approval times per MW are decreasing, suggesting improvements to development processes, despite larger projects on average being built.

[1] Analysis builds on the approach developed by Clapin and Longden (2024). Site commitment date is based on the establishment date of the Australian Company Number for the project, cross referenced with the earliest mention of site selection via internet searches. Construction commencement uses press releases, new articles, and project websites. The start of commissioning is based on when the project first supplied energy to the grid, using AEMO data. Completion is assumed to be the month that the project has availability >80% of nameplate capacity in AEMO's data. NZAu analysis augments Clapin and Longden's data base with **47 additional wind and solar projects**. Projects <10 MW are filtered out.

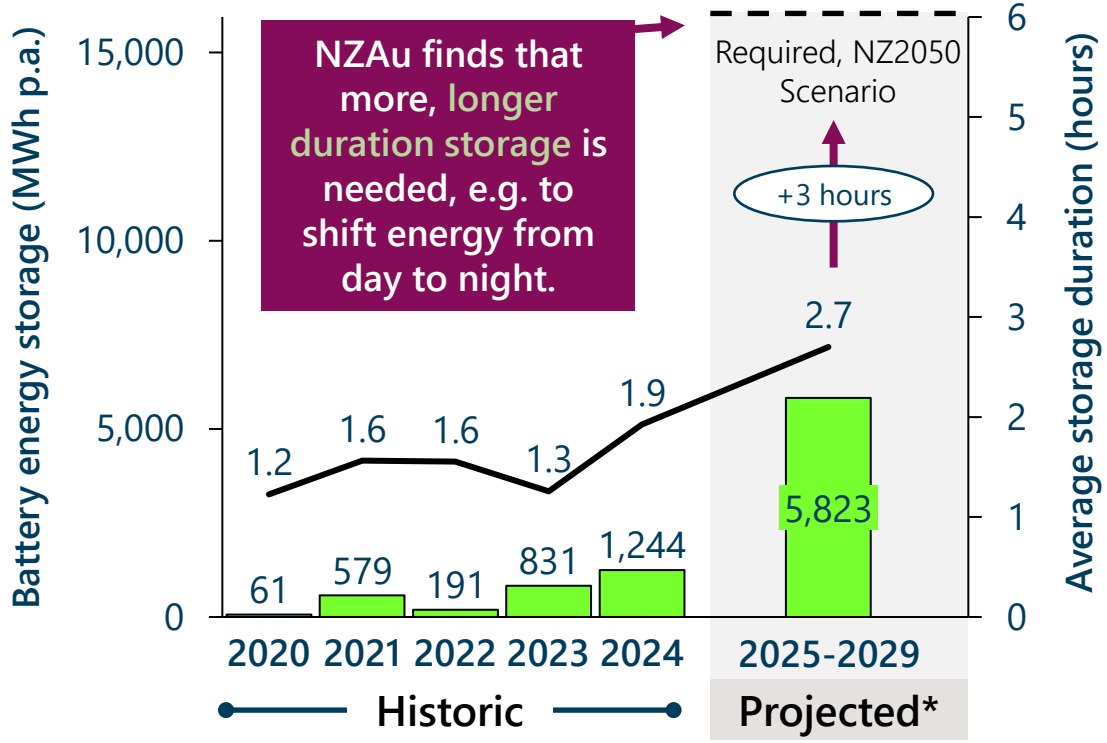
[2] The blue regions denote the **time in +/−25% of the projects surrounding the median**. The bars represent the range of all builds found within +/− 1.5* IQR. Outliers are shown as dots.

The battery storage pipeline is healthy, but more is needed to incentivise longer storage duration.

Average annual new battery capacity additions in the NEM (MW p.a.).



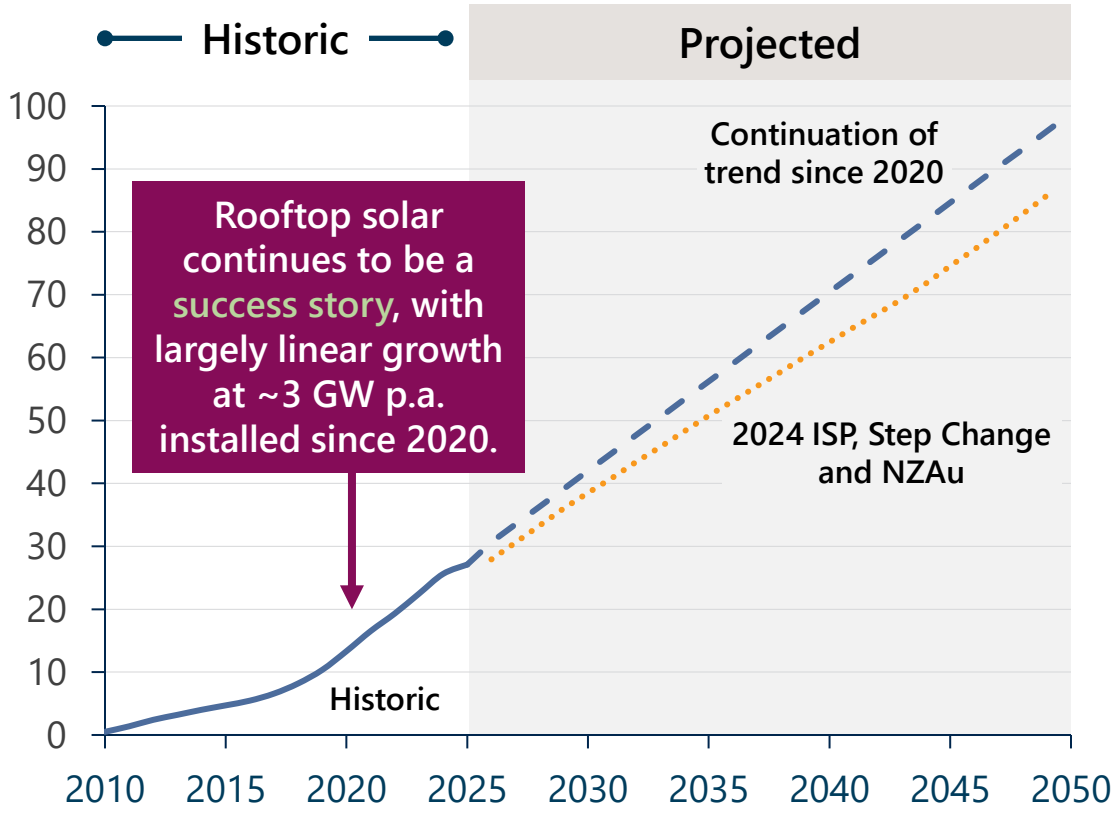
Average new annual battery energy storage (left, MWh p.a) **and storage duration** (right, hours) **in the NEM**.



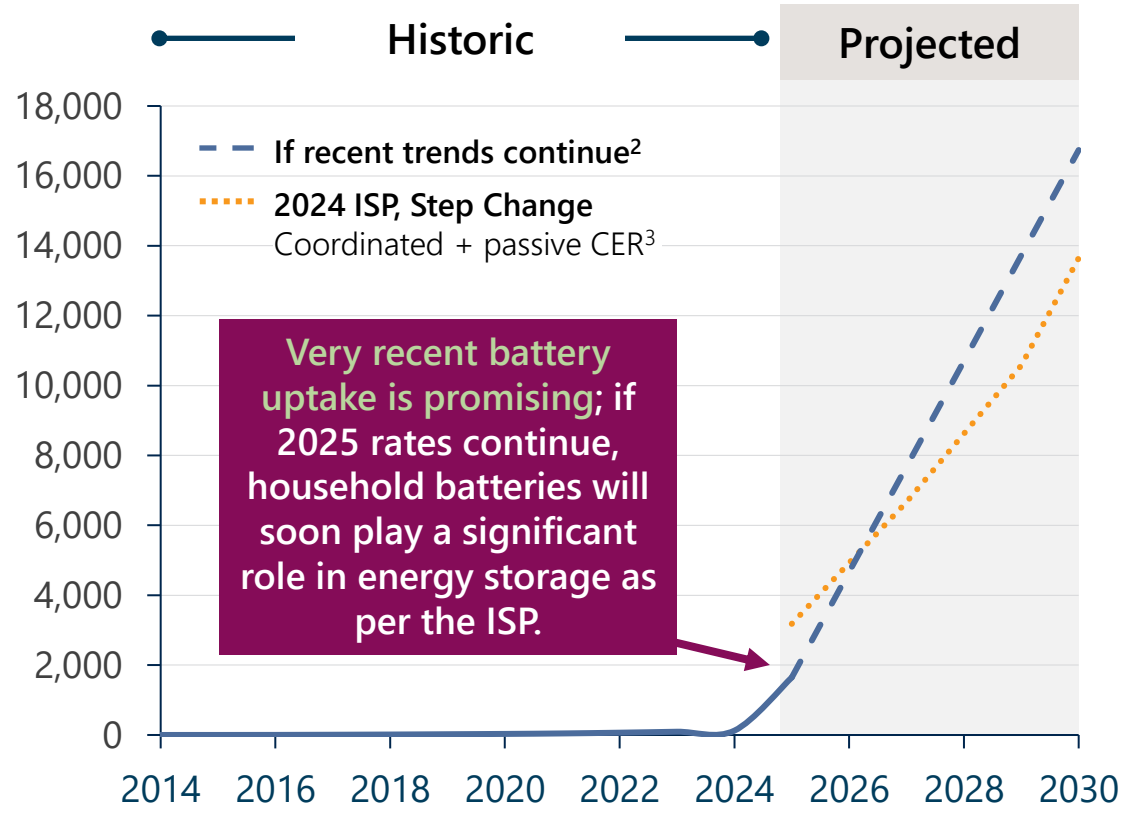
*Includes existing, committed, and anticipated projects according to AEMO Generation Information with a full commercial use date between start 2025 and end 2029.
Sources: Available capacity at end of calendar year, 2010-2024, Australian Energy Market Operator, Market Management System data, accessed April 2025; AEMO Generation Information July 2025, accessed September 2025.

Rooftop solar and batteries are being installed at high rates and are on track to meet and potentially even beat ISP and NZAu projections.

Installed capacity of rooftop solar (GW)



Installed capacity of small-scale batteries (MWh)[1]

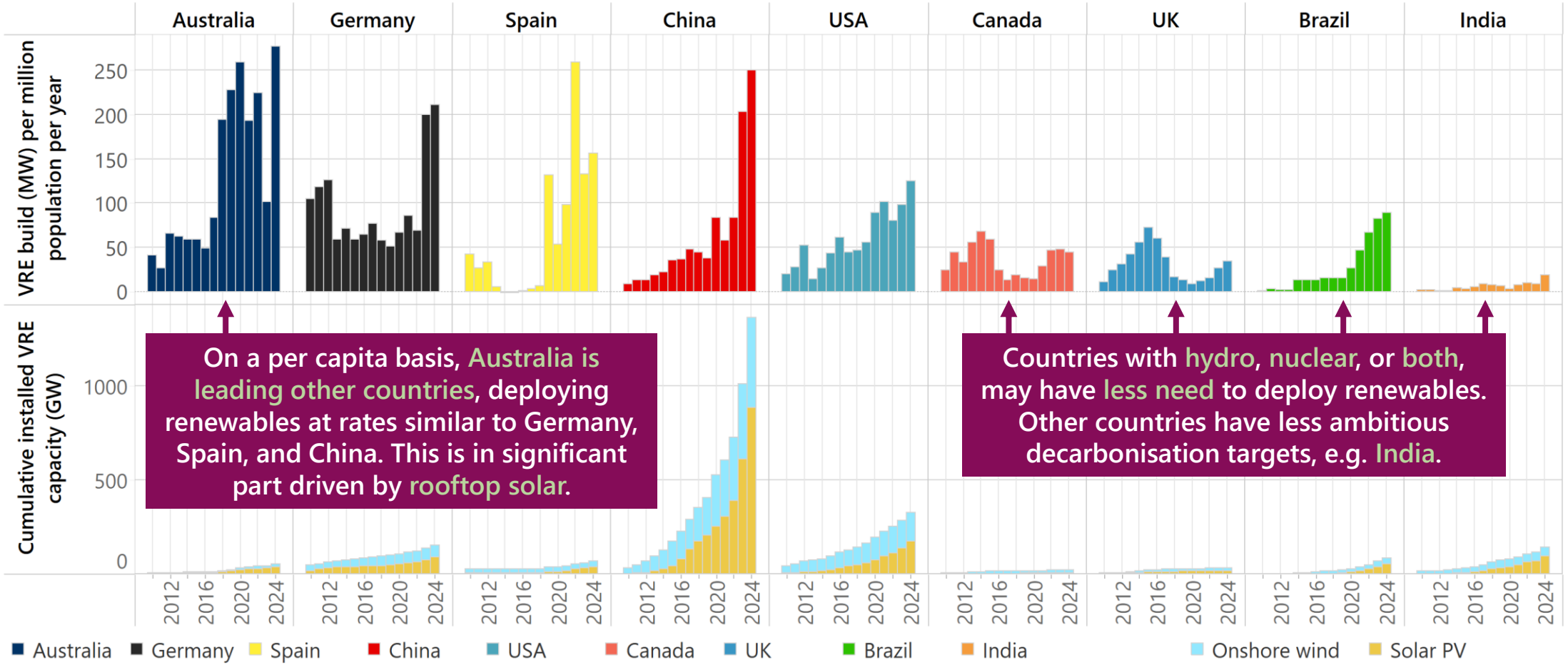


Source: Clean Energy Regulator, August 2025 Small-scale installation postcode data

1. Prior to July 2025, battery data was voluntarily reported. From 1 July 2025, solar batteries became eligible under the under the Small-scale Renewable Energy Scheme. We assume all registrations under the scheme in July and August (latest data) are in addition to these voluntary figures.
2. Assumes that monthly installation rates continue as per the July/August 2025 uptakes reported by the CER (~250 MWh per month, 3,000 MWh p.a.).
3. Household batteries are only one type of CER which includes also for example vehicle to grid charging.

Despite domestic challenges, Australia is outcompeting other countries in deployment of renewables on a per capita basis.

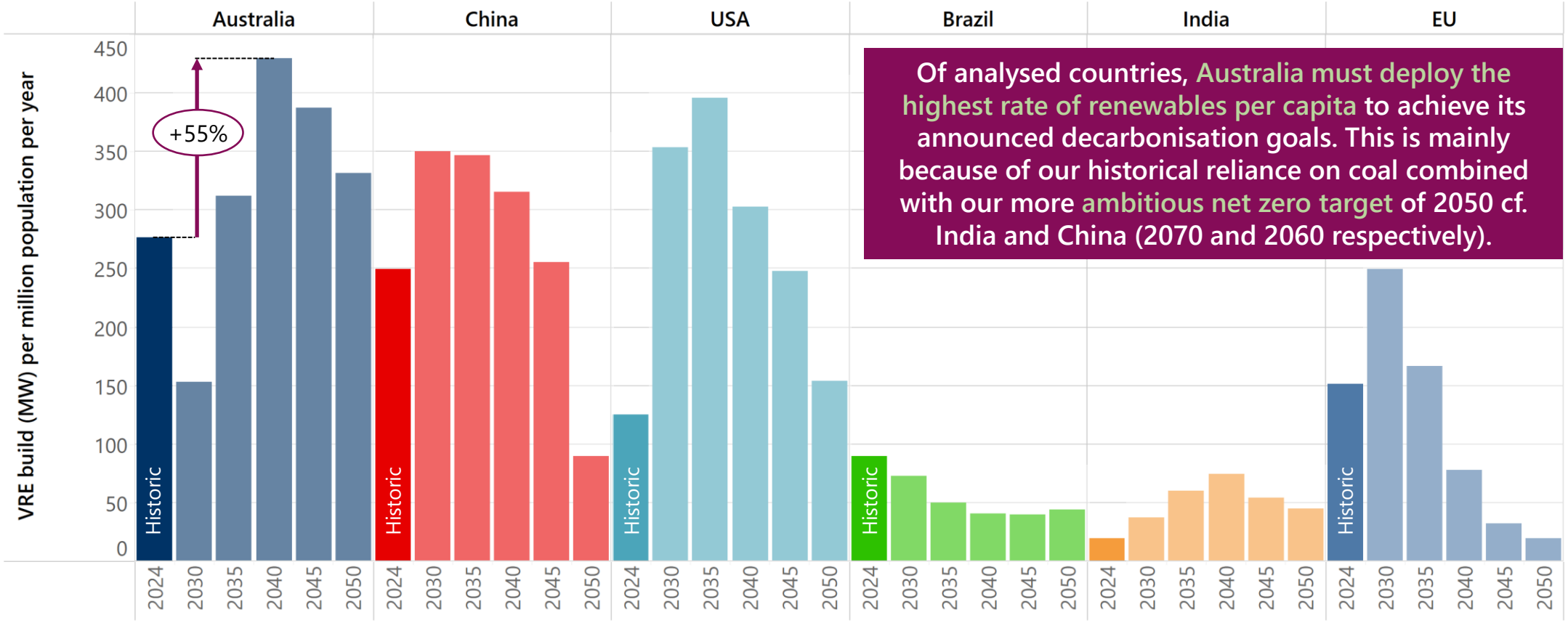
Top: **onshore wind and solar (including rooftop) build per year, per million population** (MW per million people p.a.)
Bottom: **cumulative deployed wind and solar capacity** (GW)



Sources: Available capacity at end of calendar year, 2010-2024, Australian Energy Market Operator, Market Management System data; Australian Bureau of Statistics (March 2025), National, state and territory population; International Renewable Energy Agency, 2025, Electricity statistics by Country/area, Technology, Data Type, Grid connection and Year

Yet, to achieve net zero, we must continue to grow VRE build for longer than others, largely due to Australia's reliance on coal.

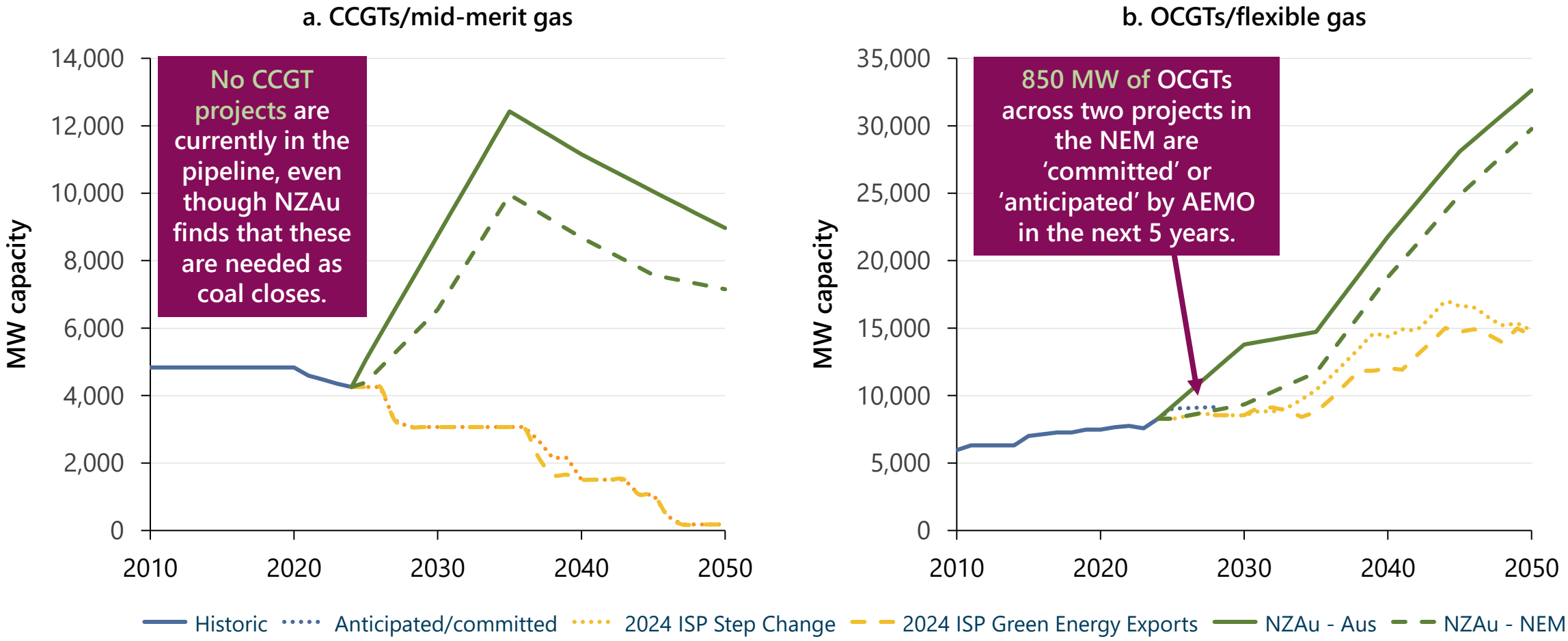
Required onshore wind and solar (including rooftop) build per year, per million population (MW per million people p.a.), NZAu NZ2050 Scenario for Australia, cf. IEA Announced Pledges Scenario for other countries



Historic sources: Available capacity at end of calendar year, 2010-2024, Australian Energy Market Operator, Market Management System data; Australian Bureau of Statistics (March 2025), National, state and territory population; International Renewable Energy Agency, 2025, Electricity statistics by Country/area, Technology, Data Type, Grid connection and Year
Projected source: International Energy Agency World Energy Outlook 2024 Announced Pledges Scenario; Net Zero Australia NZ2050 Scenario

Significant growth in gas fired generation capacity is needed, providing system services as coal power retires.

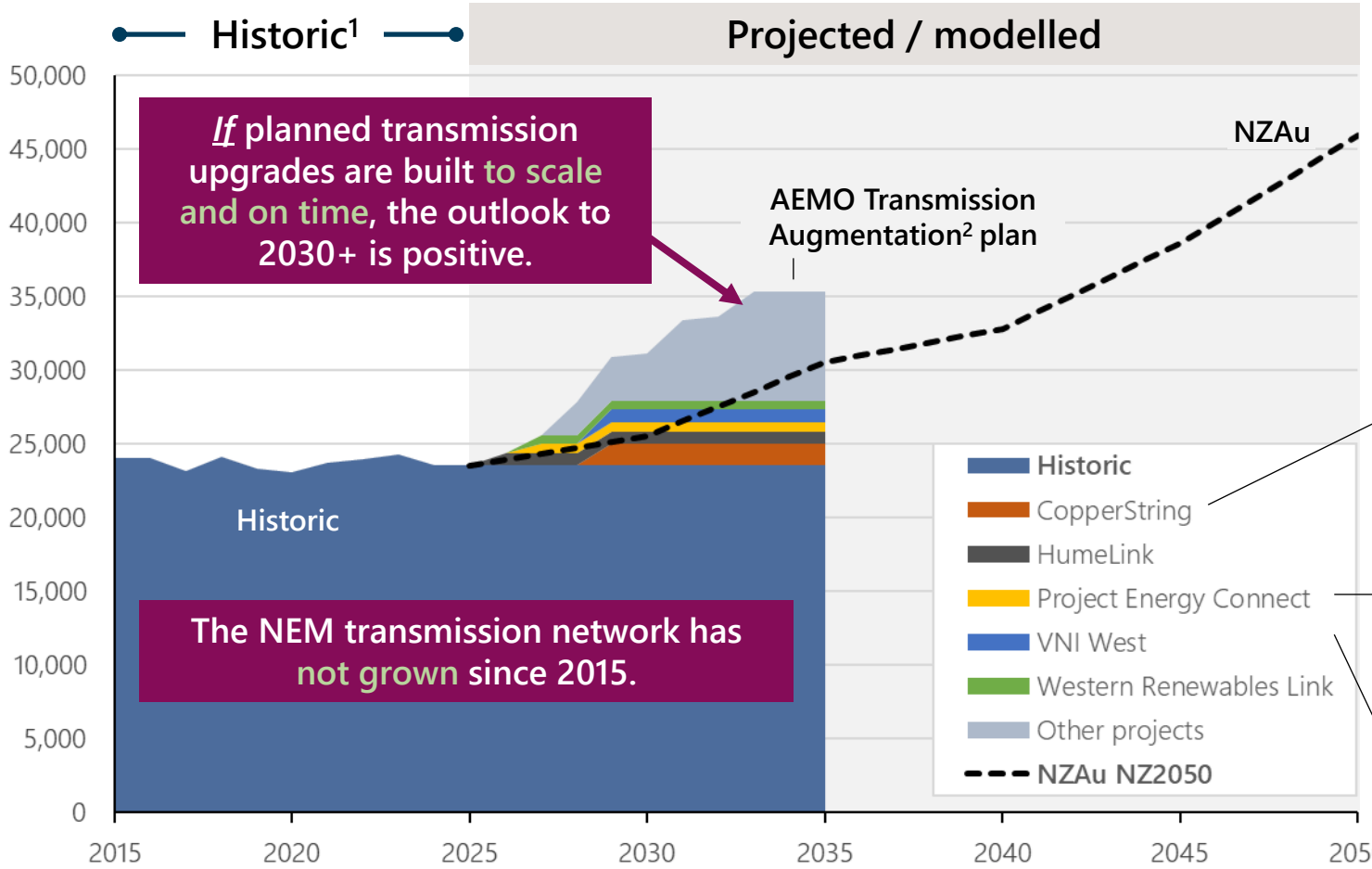
Historic and projected future installed capacity of gas fired generation in the NEM (MW)



Sources: Historic data sourced from available capacity at end of calendar year, 2000-2024, and up to October 2025. Australian Energy Market Operator, Market Management System data, accessed September 2025; Projections sourced from AEMO Generation Information July 2025, accessed September 2025, committed and anticipated projects only.

Transmission plans are sufficient if they can navigate execution challenges including high costs, local opposition and biodiversity protection.

Capacity-length NEM transmission build, historic and projected, compared to modelled outcomes (GW-km)



Yet, meeting the stated timelines of these projects (as modelled in the ISP) requires an expansion of current transmission capacity-length by 40% by 2033.

Some projects are facing cost increases, local opposition and delays:

CopperString's 500 kV design was going to cost ~$14B, cf. initial plans that cited ~$1B.[3] The adjusted plan is also now 330 kV.

Project Energy Connect in NSW is ~4 years delayed due to contractor issues, with initial plans to complete commissioning in 2024 not achieved.[4]

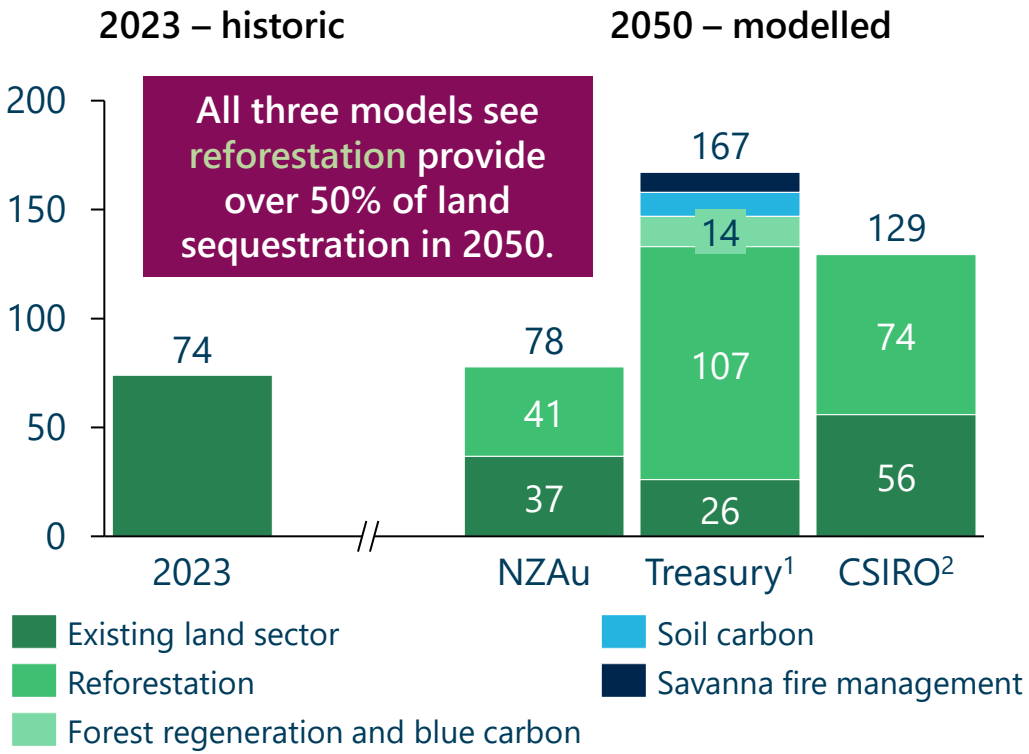
VNI West has been delayed ~2 years, with costs expected to double or even triple original plans.[5]

[1] Capacity length is used to communicate both length and relative significant of proposed network upgrades. Historic values sourced from Economic Benchmarking provided by individual TNSP RIN Responses to the Australian Energy Regulator.
[2] Augmentation information sourced from AEMO's Transmission Augmentation information, July 2025, and the *Appendix 5. Network Investments* of the 2024 ISP.
[3] The Queensland Cabinet and Ministerial Directory, 2025; [4] ABC News, August 2025; [5] Transgrid, 2025

Achieving significant land-sector abatement will require a dedicated reforestation effort at an unprecedented scale, likely *in concert* with CCS.

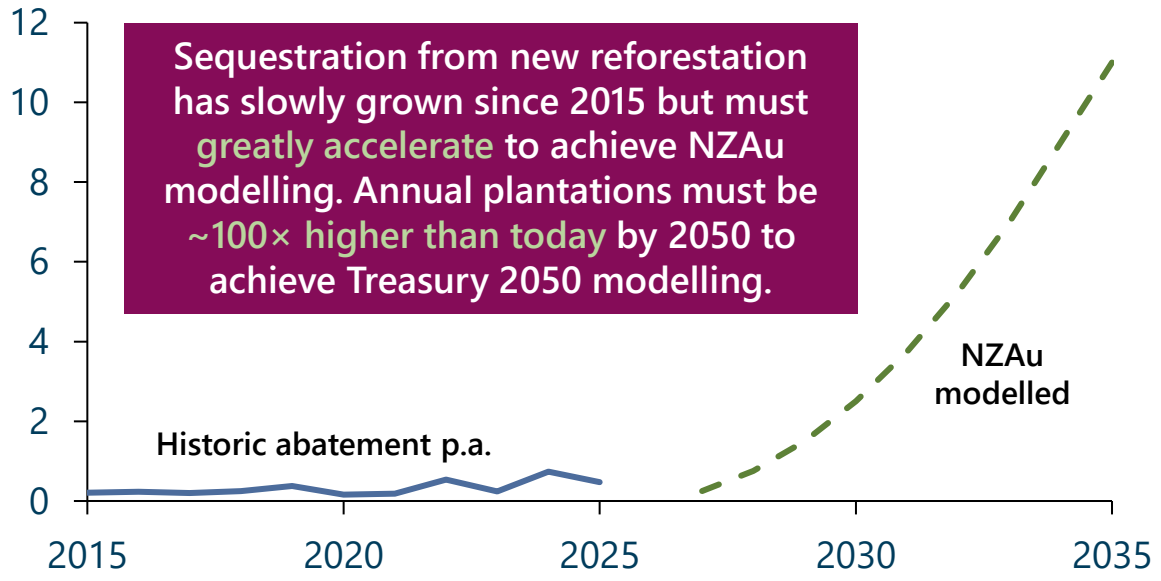
Models agree the land sector will play a critical role in decarbonisation.

Land sector sequestration by subsector, historic vs modelled, Mt CO_2e p.a.



Yet the change required is without precedent.

Historic[3] vs modelled annual sequestration from reforestation, Mt CO_2e p.a.



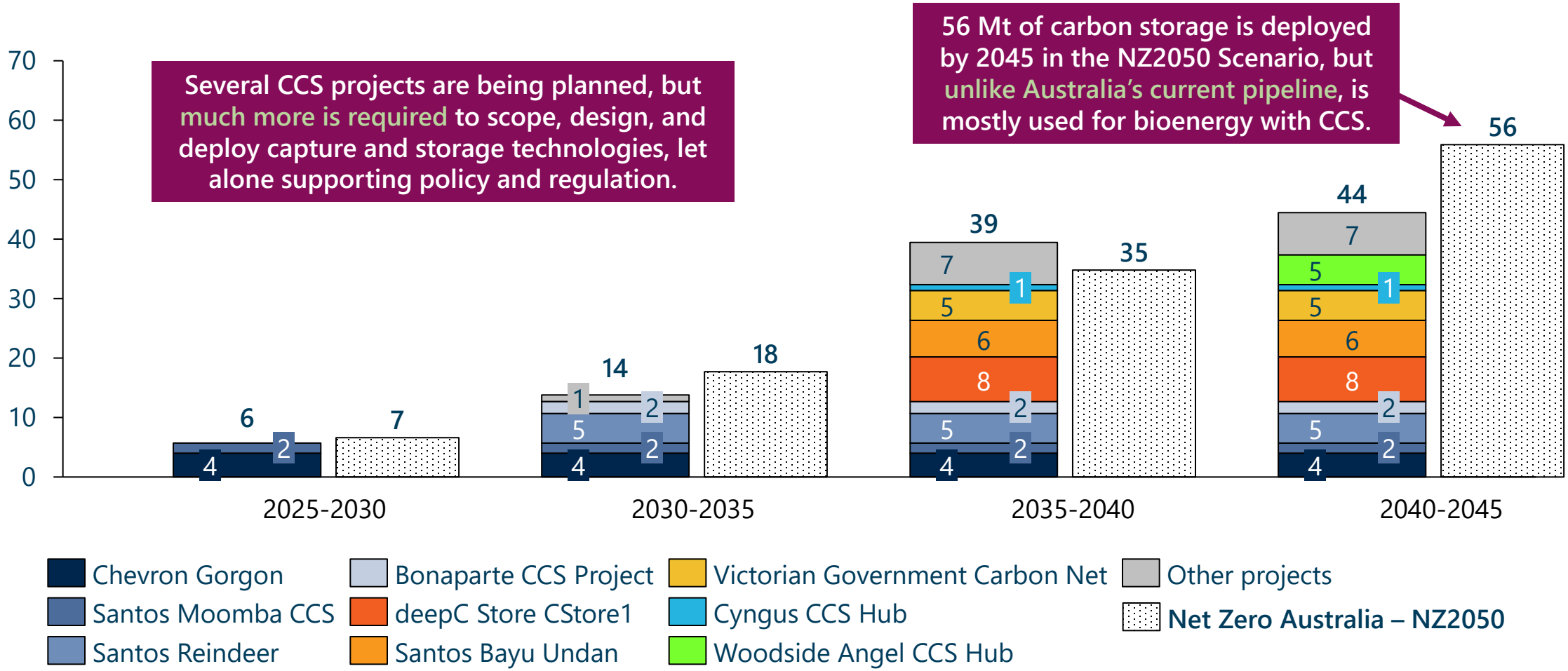
NZAu plantation rates reach 200,000 hectares per year in 2034, which is slightly smaller than the ACT **every year**. To achieve Treasury or CSIRO modelling will require even more land per year.

1. The Treasury, September 2025, *Australia's Net Zero Transformation: Treasury Modelling and Analysis*, Baseline Scenario
2. Verikios, G., et al. 2025, *Modelling Sectoral Technology and Emissions Pathways to 2035 and Net Zero Emissions – Final Report*, CSIRO A50/G2 Scenario
3. Historic data is in financial years using Australian Carbon Credit Unit data, July 2025. We filter for reforestation and plantation methodology determinations and show Kyoto ACCUs issued in each financial year. Data represents 524 unique projects.

More CCS is needed, with most proposed projects supporting gas processing and not yet contributing to hard-to-abate industry and negative emissions.

Projected Australian engineered CO_2 storage capacity by project, vs NZAu modelling

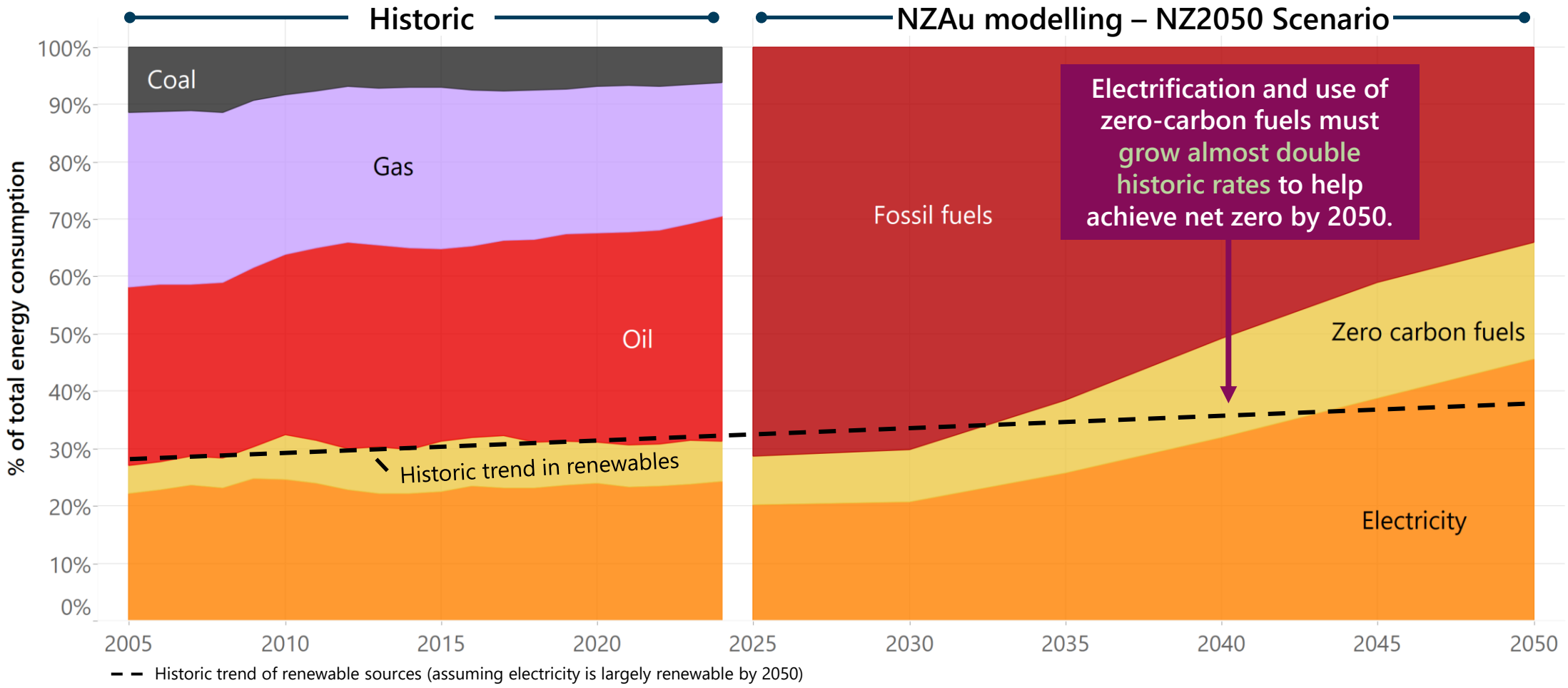
2025-2045, Mt CO_2 p.a.



Sources: Global CCS Institute Project Database, with projected operational dates adjusted to later years based on their advice.

Renewable uptake, fuel switching, CCS deployment and energy productivity must all accelerate significantly for industry.

Industrial sector* energy consumption by fuel source (% of TWh/year)

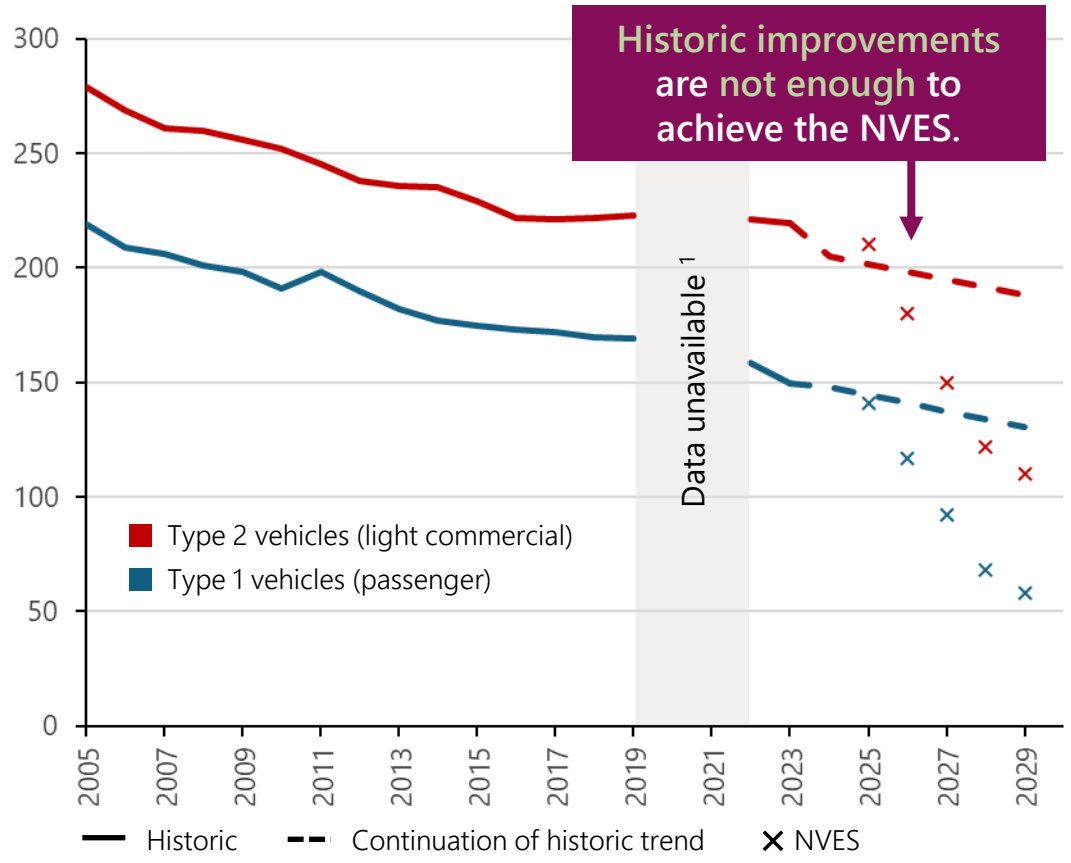


Source: Department of Climate Change, Energy, the Environment and Water, Australian Energy Statistics, Table H, August 2025; Net Zero Australia 2025
*Includes agriculture, mining, manufacturing, construction, and water and waste.

Australians will need to purchase many more hybrids and EVs to meet the New Vehicle Efficiency Standard (NVES).

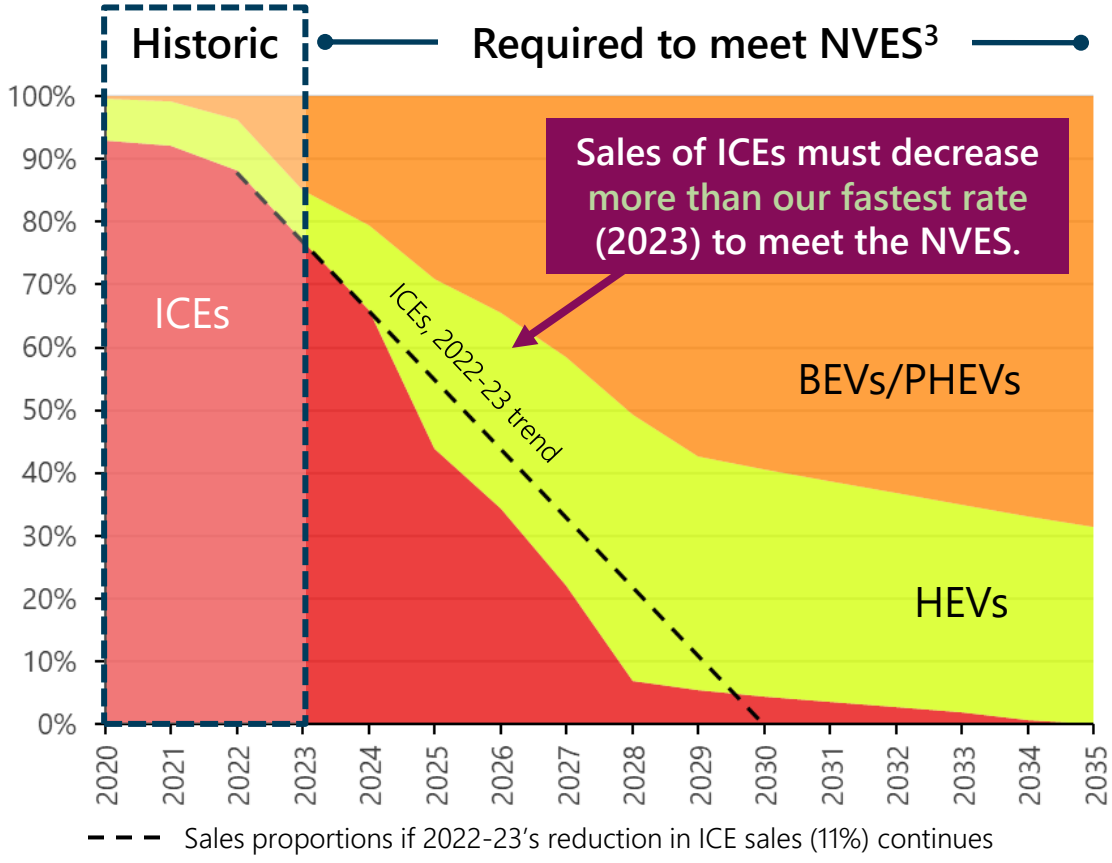
Emissions intensity by light duty vehicle class, new sales

g-CO_2e/km



Uptake of hybrid and electric vehicles

% total new passenger and light commercial vehicle sales[2]

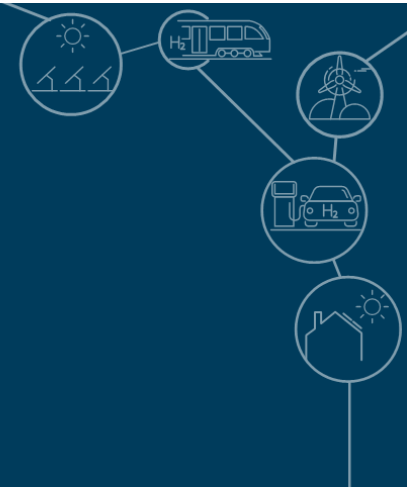


Sources: National Transport Commission, 2005-2024, *Light vehicle emission intensity in Australia* various reports, *New Vehicle Efficiency Standard Act 2024*

1. 2020-2021 data was reported in format that makes comparison across years difficult, so is excluded here.
2. ICE = internal combustion engine, BEV = battery electric vehicle, PHEV = plug in hybrid electric vehicle, HEV = hybrid electric vehicle
3. Based on Net Zero Australia modelling Current Policies Scenario, whereby HEVs and EVs are assumed to increase in adoption by equal parts to meet emissions standard.

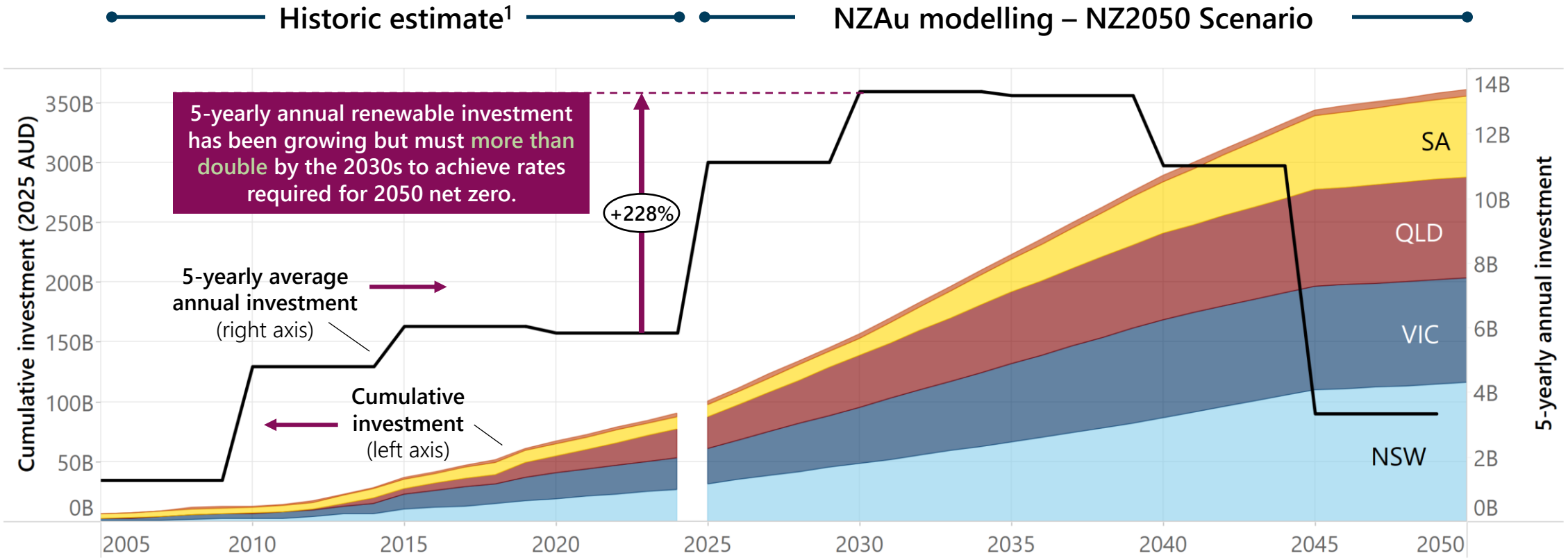
Return to structure

4.3 Enablers



Renewable investment has been growing steadily but must accelerate alongside capital growth in all abatement technologies and enabling infrastructure.

Estimated cumulative (left y-axis) **and annual** (right y-axis) **capital investment in onshore wind and utility scale solar generation projects, by NEM state, historic vs modelled -** 2025 AUD p.a.

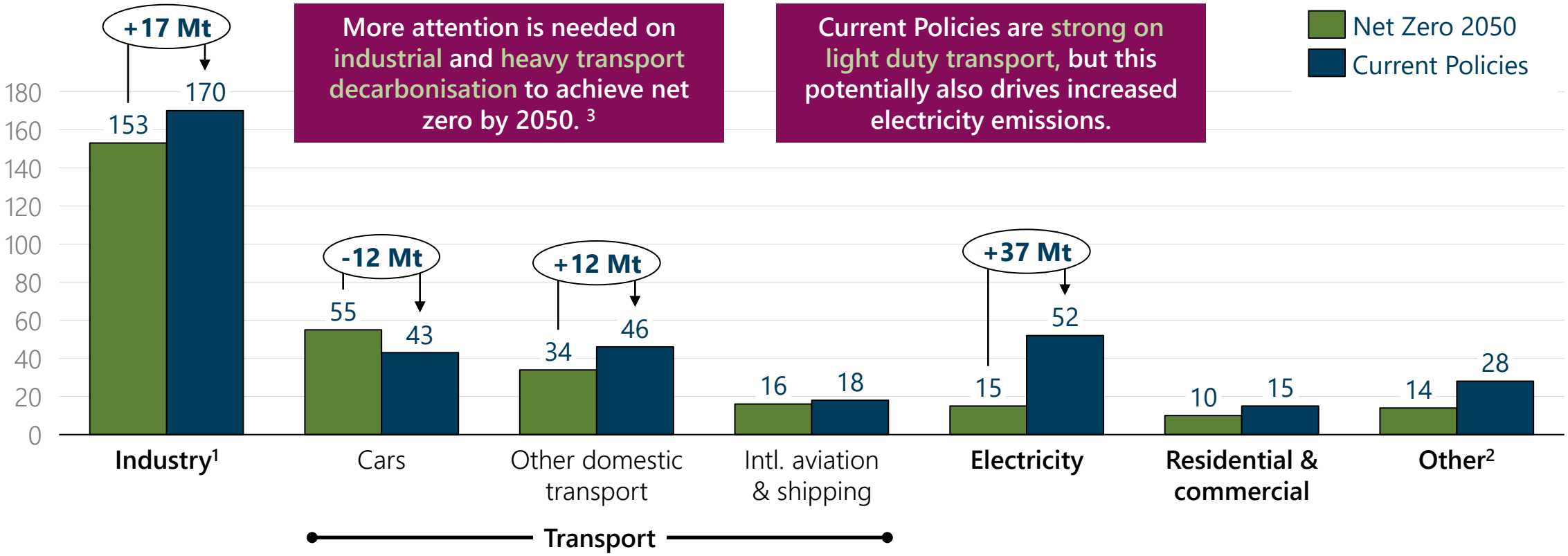


[1] **Method**: due a lack of available data due to commercial sensitivities, historic values are **estimated** for indicative comparison. We multiply capacities reported in AEMO data by the 2025 capital costs for onshore wind and utility solar reported in CSIRO's GenCost 2024-25 final report. We then add 6% to these figures as a high-level estimate of pre-FID costs. Finally, we shift all investment back to 5 years before each plant comes online as a proxy for development timeframes. This is the same method used to estimate capital investment in our modelling. Estimated historic values between 2020 and 2024 are derived using the Anticipated and Committed projects outlined in AEMO's Generation Information July 2025 with commercial dates before 2029.

Current policies overdeliver on light transport emissions by 2035, but the electricity, industrial, and heavy transport sectors trail.

2035 modelled emissions, absolute and difference between Net Zero 2050 and Current Policies Scenarios

Mt CO_2e p.a., Net Zero Australia modelling

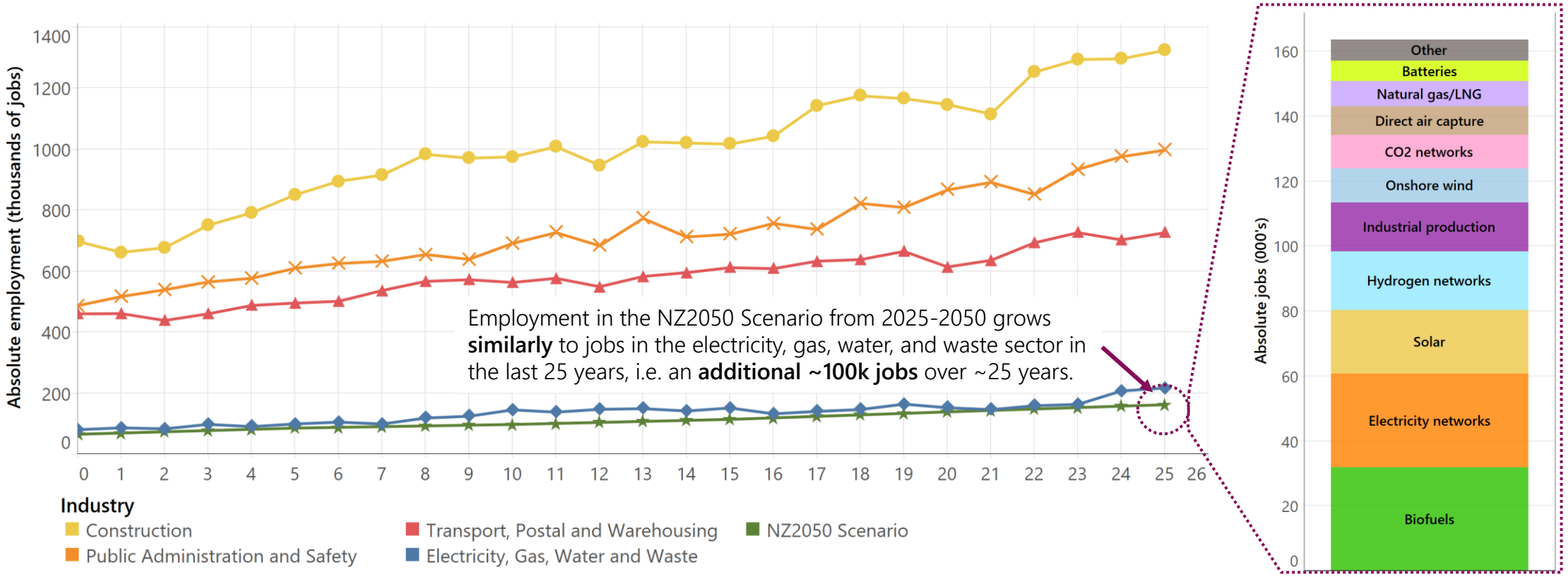


1. Includes natural resource extraction and processing, and manufacturing.
2. Includes agriculture, LULUCF, waste, and engineered carbon removals.
3. Note that the Current Policies Scenario on which this data is based has not been updated to include additional Commonwealth funding announced in September 2025.

Reaching net zero by 2050 requires growth in energy sector employment of ~100k jobs, consistent with several sectors' growth over the last 25 years.

Historic employment (thousands of jobs) **per industry over the last 25 years** (2000-2025, year 0 = 2000), **relative to projected employment** (thousands of jobs) **for NZ2050 Scenario** (2025-2050, year 0 = 2025, modelled energy system[1]).

NZ2050 Scenario: 2050 employment, by sector (thousands of FTE jobs).

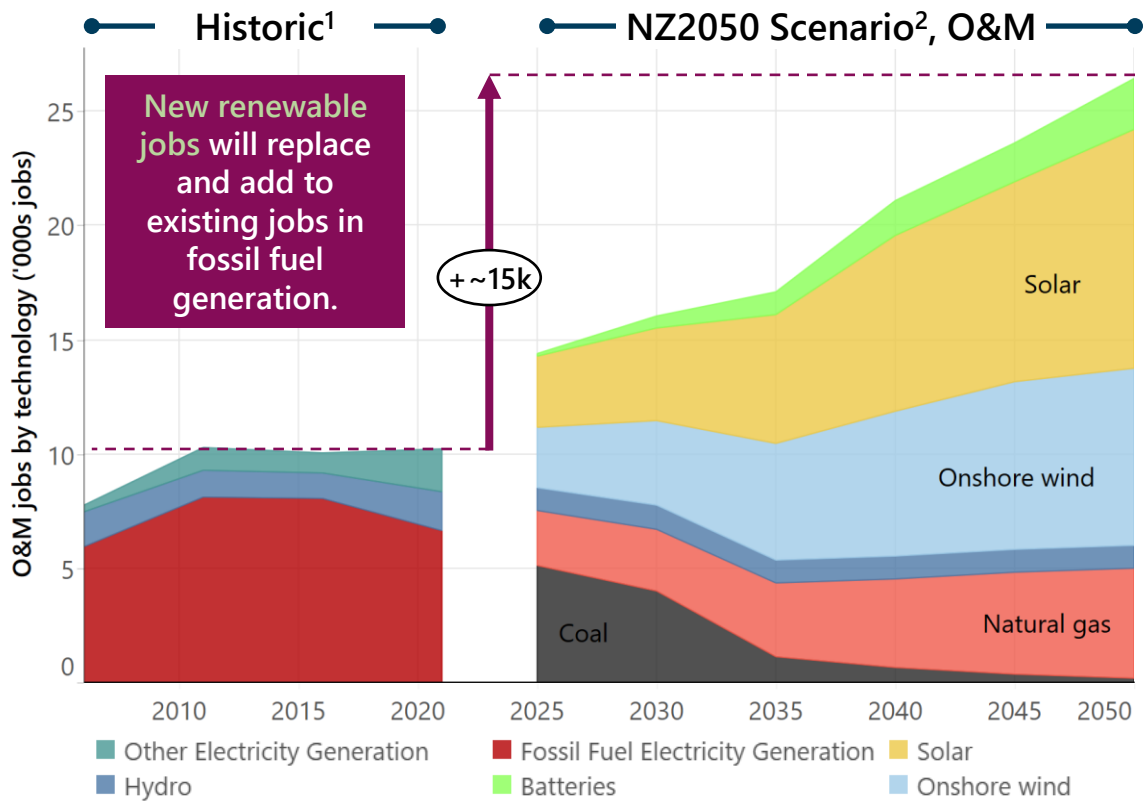


Historic data sourced from Australia Bureau of Statistics, *Labour Force Australia, Detailed*, October 2025 release. 1. Note that the NZ2050 Scenario presented here represents employment across **the modelled energy supply system** (not demand-side employment). This includes primary production, manufacturing, construction & installation, operations & maintenance, and decommissioning jobs in: electricity generation, transmission and distribution; fuels production and distribution; CO2 capture, transmission and storage; and selected heavy industry. This modelled employment is compared against **individual, economy-wide** sectors for the purposes of comparing scale and growth, and should not be read as an attempt to model any of the individual sectors presented.

We must greatly increase the workforce in electricity generation while supporting those transitioning out of coal power.

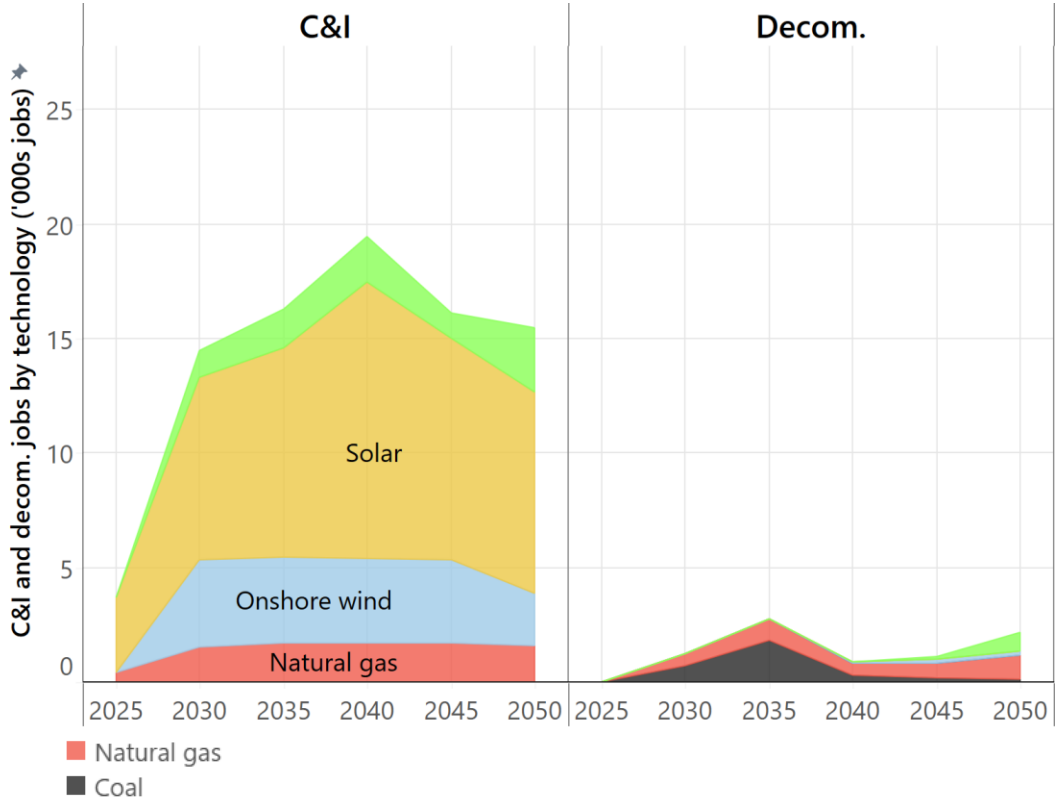
Over 25k jobs are expected to operate and maintain electricity generation infrastructure in 2050, cf. ~10k in 2021.

Electricity generation O&M employment, historic vs modelled, by technology ('000s of FTE jobs).



Alongside operations, new construction jobs are needed, peaking at ~19k new jobs in 2040.

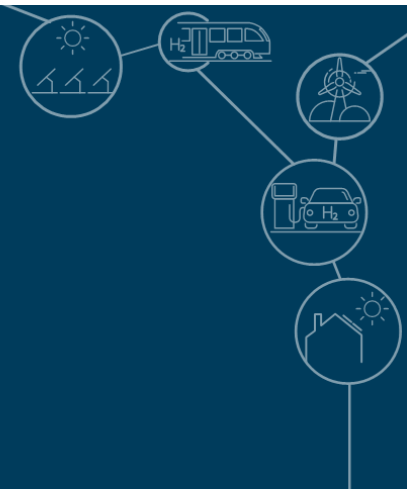
Modelled electricity generation construction & installation (C&I) and decommissioning jobs, by technology, 2025-2050 ('000s of FTE jobs).



1. Data sourced from Australian Bureau of Statistics Census of Population and Housing, 2006, 2011, 2016, and 2021. Figures presented are ANZSIC codes 2611, 2612, and 2619.
2. See McCall et. al 2025, 'Methods, Assumptions, Scenarios and Sensitivities Report', Net Zero Australia, Chapter 16, for details on workforce modelling methods.

Return to structure

5 Implications



Summary of progress

Progress to net zero by 2050 is varied, with bright spots in behind the meter resources and storage, and challenges with deployment of large-scale generation and carbon removals.

Outcomes

Emissions

AR Historic domestic greenhouse gas emissions, by sector.

Energy costs

AR Average annual energy costs by end use sector.

System security & reliability

NS Time per year that the reliability standard is not met.

Drivers

Low emissions electricity

AR Renewable proportion of electricity generation.

AR Average annual new onshore wind and utility solar capacity additions.

On Average annual new battery capacity additions and storage duration.

Off Historic and projected future installed capacity of gas fired generation.

On Historic and projected future installed transmission capacity and length.

AR Utility solar and onshore wind project development times.

Natural & engineered carbon removals

AR Projected Australian engineered CO_2 storage capacity.

Off Projected Australian land sector abatement.

Heavy industrial fuel switching

AR Electrification and renewable fuel uptake in the industrial sector.

Transport fuel switching & efficiency

AR Emissions intensity of light duty vehicle fleet.

On Uptake of hybrid and electric vehicles.

Energy efficiency & demand side resources

On Installed capacity of rooftop solar and small-scale batteries.

NS Average NatHERS / NABERS ratings for existing building stock.

Enablers

Access to finance

AR Capital investment in renewable generation projects.

Incentives and enforceable regulations

AR Emissions abatement expected from Current Policies, by sector.

Available workforce

On Historic employment per industry years relative to modelled employment.

Organisational trust

NS Social acceptance of energy infrastructure.

On On track AR At risk Off Off track NS Not in scope for this report.

Implications of progress

Outcomes

Drivers

Enablers

Reduced emissions to net zero by 2050

Progress

- Most models emphasise very large reductions in electricity, resources, and transport emissions, complemented by carbon removals, yet significant progress to date is only in electricity and LULUCF.
- Domestic emissions are declining in line with the 2030 target only if LULUCF trends continue, but not to net zero by 2050.

Implications

1. Despite decarbonisation commitments and several supporting policies, **Australia is yet to realise significant, direct abatement in several emitting sectors**. These sectors mostly feature new abatement policies today, e.g. 2023's reforms to the *Safeguard Mechanism*, 2025's *New Vehicle Efficiency Standard*, or no mandated policy, like heavy transport.
2. Even if historic LULUCF contributions continue, which we consider unlikely, **current decarbonisation rates align with a ~2060 net zero year.** Hitting the 2050 target therefore demands significant and simultaneous progress on several fronts.
3. **Much more focus is needed on the large emitters,** such as industrial heat and heavy transport, which have experienced the largest energy cost increases since 2015, posing significant risks.

Implications of progress

Outcomes

Drivers

Enablers

Energy costs

Progress

- East Coast wholesale electricity prices correlated with East Coast wholesale gas prices up until ~2023, after which this correlation weakens.
- East Coast electricity network costs have fallen since the mid-2010s, while gas distribution costs have fluctuated, mainly due to reduced gas use since 2022.
- Transport and industry have seen larger energy cost increases since 2015, with residential/commercial energy costs also rising.
- Environmental costs, including renewable policy costs, are a small share of total East Coast average energy costs, with cost ($) increases across all sectors.

Implications

1. **Increases in energy costs and their significant heterogeneity across all sectors needs close monitoring**, e.g. older homes with gas in VIC cf. all electric homes without solar in QLD, or an aluminium smelter cf. a chemicals manufacturer cf. potential large growth in data centres.
2. The large increase in estimated average industrial energy costs challenges viability and thus ability to decarbonise. Access to **affordable and reliable energy is essential for industrial decarbonisation**, otherwise current trends in industrial energy use will likely continue.
3. Although estimated **average** residential/commercial energy costs have increased less than for other sectors, **further rises will obviously challenge the public's ability and appetite to decarbonise and raise significant equity concerns.**

Implications of progress

Outcomes | **Drivers** | Enablers

Low emissions electricity grid	Energy efficiency and demand side resources

Progress

- Annual renewable build rates are not expected to grow in the next 5 years, when acceleration is needed.
- Solar development is taking longer, while wind projects, despite improving, still take ~8 years. Increased farm size is nonetheless helping.
- The battery storage pipeline is healthy, but more is needed to incentivise longer storage duration.
- Build rates for gas peakers and CCGTs are insufficient.
- Transmission plans are sufficient if they can navigate execution challenges.
- Rooftop solar and batteries are being installed at high rates and are on track to meet targets.

Implications

1. **Household solar and batteries** continue to **grow.** This shows a strong public desire for **distributed energy resources** that should be exploited.
2. Despite historic progress, large renewable project **deployment rates** are still far **too slow for a 2050 target**. More projects are needed and must be built more quickly. Acceleration across the project development cycle, including streamlined approvals within REZs and faster connection processes, may assist.
3. **Transmission delays** are inhibiting new generation connections and likely warrant concerted efforts by governments.
4. We need a **larger pipeline of gas turbines**. The NEM Review's suggested **Electricity Services Entry Mechanism** may assist.

Implications of progress

Outcomes | **Drivers** | Enablers

Natural & engineered carbon removals | **Heavy industrial fuel switching**

Progress

- Achieving significant land-sector abatement will require a dedicated reforestation effort at an unprecedented scale, likely in concert with CCS.
- More CCS is needed, with most proposed projects supporting gas processing and not yet expanding across hard-to-abate industry and negative emissions.
- Historic reductions in unabated fossil fuel use in industry are too slow for net zero around 2050; energy productivity, renewables and CCS must all accelerate.

Implications

1. **Land sector sequestration** requires **long-term funding**, **coordination**, and **regional-level planning** to achieve the scale that net zero by 2050 requires. **Agreements** would need to be negotiated with stakeholders and supported with planning and establishment of an **expanded supply chain**.
2. The CCS pipeline must **grow far beyond gas processing** to **industrial process point sources** and **net carbon removals.** The immediate focus should be on the development of a national CCS strategy that integrates CCS alongside other, significant means of achieving abatement.
3. The Government's recent production incentive for **low carbon liquid fuels** is well targeted but will likely need expansion.

Implications of progress

Outcomes

Drivers

Enablers

Transport fuel switching

Access to finance

Available workforce

Emissions coverage of regulations

Progress

- We need to purchase many more hybrids and EVs to meet the New Vehicle Efficiency Standard.
- Current policies overdeliver on light transport emissions abatement by 2035, but the electricity, industrial, and heavy transport sectors trail.
- Renewable investment has been growing steadily but must still accelerate.
- Reaching net zero by 2050 requires growth in energy sector employment of ~100k jobs, consistent with historic growth of several sectors.
- We must greatly increase the workforce in electricity generation while supporting those transitioning out of coal power.

Implications

1. Achieving the **NVES hinges on faster EV and hybrid uptake**. Yet, this standard is aggressive, and transport abatement may be offset by unwanted electricity emissions in the short term if EV uptake outpaces coal power replacement.
2. **Heavy industry and transport remain policy priorities**. Newly announced programs will assist, but the **focus** should be on **commercial demonstrations** of abatement technology (e.g. low carbon liquid fuels, industrial process retrofits, etc.), and building supporting **supply chains** (production, storage, distribution networks).
3. Absolute growth rate in jobs needed for net zero **has historic precedent** in other sectors, but close attention is needed to ensure a **sufficient pipeline** of workers to install, operate, and maintain new infrastructure (renewables, biofuels, networks).

Thank you

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