Topical Report #1

Updated Net Zero Pathways for Australia

24 September 2025

NET ZERO AUSTRALIA

THE UNIVERSITY OF MELBOURNE
THE UNIVERSITY OF QUEENSLAND AUSTRALIA
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.

Outline of Topical Report

1 About the study

2 Results summary

3 Results

- 3.1 Energy production, storage, and build
- 3.2 Energy use, emissions and targets
- 3.3 Maps
- 3.4 Costs and investment

4 Implications of results

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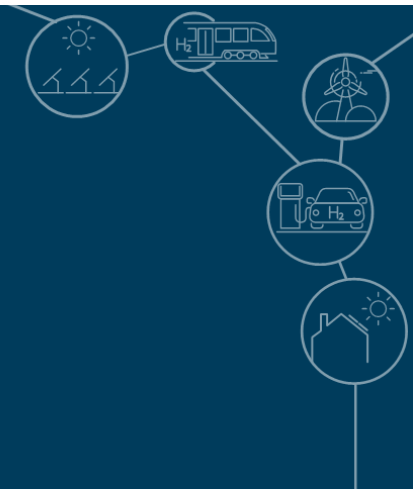
1 About the study



Aims of Net Zero Australia Phase 2

Phase 2 of the Net Zero Australia will undertake deeper analysis of specific challenges and aims to make practical recommendations on decarbonisation while acknowledging environmental and social objectives and trade-offs.

PHASE 2'S AREAS OF FOCUS

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 clean energy transition.

This first Report from Phase 2 updates our previous modelling, uses all the latest inputs and establishes an evidence base for further, deeper analyses.

We will be releasing Reports regularly, with our next planned Report and our annual conference in December.

11 December 2025

Net Zero Australia Conference

Brings the public, government, industry and academia together to discuss latest findings from the NZAu Project Team and guests.

Every quarter

Regular topical reports

Roughly quarterly Reports on topical matters with an associated public seminar.

Our next Reports will examine:

i. our progress to net zero; and

ii. integrating biodiversity protection and energy system planning.

Project governance

STEERING COMMITTEE

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

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SUPPORTERS

Gifts and grants ensure the Project's independence.

APA

Iberdrola Australia

FUTURE ENERGY EXPORTS Cooperative Research Centre

APGA

EnergyAustralia

ADVISORY GROUP

Crucial input is being provided by diverse Advisors*.

AUSTRALIAN CONSERVATION FOUNDATION

National Native Title Council

St Vincent de Paul Society VICTORIA good works

National Farmers Federation

INDEPENDENT MEMBERS

NOMINEES BY SUPPORTERS

* 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.

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What the NZAu Project does and does *not* do

The NZAu Project models pathways to net zero and other futures to illustrate:

- the scale, complexity and cost of decarbonising our energy system compared to not doing so;
- the potential implications of key choices; and
- the potential impacts across society, the economy and the environment.

We **do not** make forecasts or predictions. We also **do not** analyse the projected costs of the damages caused by climate change, and which other, specialist studies have shown to be very large.

MODELLING APPROACH

- Least-cost optimisation
- Several, carefully chosen Scenarios
- Linear emissions reduction for the Net Zero Scenarios
- Best available inputs and assumptions used
- Full disclosure and open review of our inputs, methods and findings
- 'Downscale' to model changes at a granular resolution

This Report updates our previous modelling with the latest inputs and only focuses on domestic decarbonisation.

MODELLING DIFFERENCES

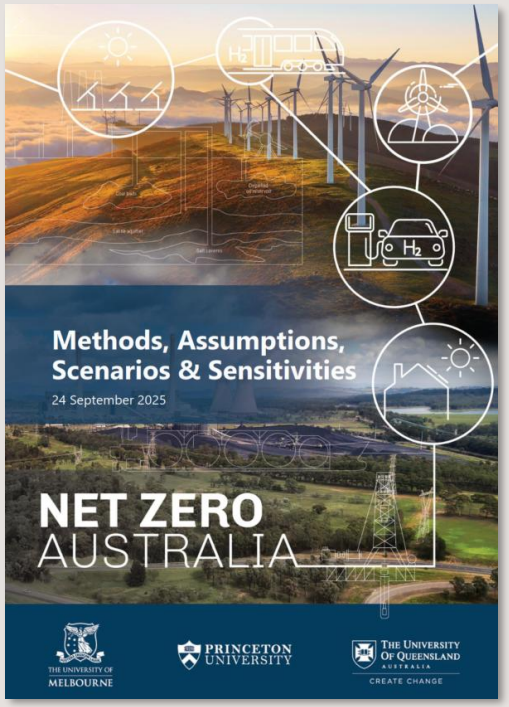
Element	Phase 1	Phase 2 – Topical Report #1
Fossil fuel exports	**Reduced linearly to zero** by 2060 from 2030	**Reduced in line with IEA World Energy Outlook** *Announced Pledges* Scenario. Australian fossil fuel exports reach ~6.8 EJ in 2050.
Clean commodity & energy exports	**Energy exports held constant** at 15 EJ. Green options replace fossil fuels.	**Not in this report's scope,** industries grow with GDP and will be studied later in detail.
Engineered CO_2 storage potential	**Up to ~150 Mt/year**, for use across domestic and export.	**Up to ~75 Mt/year** for domestic use, with residual allocated to exports.
Capital & operating cost inputs	2022 ISP; NREL ATB for offshore wind	**Latest GenCost and AEMO inputs**, noting significant cost increases in many cases.

Decarbonisation options for heavy industry and Australia's exports will be the subject of other Reports given their importance to both national GDP and the global abatement task.

Please see our website for all our methods, assumptions and supplementary results.

netzeroaustralia.net.au

DETAILED ASSUMPTIONS



SUPPLEMENTARY RESULTS

Phase 2 models four Scenarios for the domestic system

	REF	CPOL	NZ2050	NZEXT
	Reference	Current Policies	Net Zero 2050	Net Zero Extended
Domestic emissions[1]	No constraint imposed, determined by model [2]	No constraint imposed, determined by model [2]	Linear to net zero in 2050	Linear to net zero in a year determined by model
Gov. support mechanisms	None imposed	Modelled to 2050 if funded and estimated significant	None imposed	None imposed
Key asset annual capacity additions[3]	Not binding	Not binding	10% compound annual growth rate	5% compound annual growth rate
Fossil fuel exports	Reduced in line with IEA World Energy Outlook *Announced Pledges* Scenario			
Electrification	As per historic rates	As per historic rates, unless increased via policy	Nearly full electrification of transport/buildings by 2050	Slower electrification than NZ2050
Nuclear allowed?	No		Yes	Yes
~Degrees warming aligned[4]	~4-4.5°C [5]	~3-3.5°C	~2-2.5°C	~3°C

1. We will examine exports separately and in much more detail later in the Project.
2. The Reference Scenario and Current Policies Scenarios have no emissions objective. The other Scenarios start from current emissions and track linearly to net zero emissions.
3. Key assets include: utility scale solar, onshore wind, offshore wind, CO2 injection, nuclear, biofuels, DAC, and low/no emissions retrofits in iron & steel, bauxite, and clinker production.
4. Uses IPCC's 6th Assessment Report emissions budgets, with temperature ranges attributed using current shares of either population or emissions. Other methods could be applied.
5. Note this excludes the offshore emissions that result from the use of Australia's fossil fuel exports.

Further detail on Scenario design

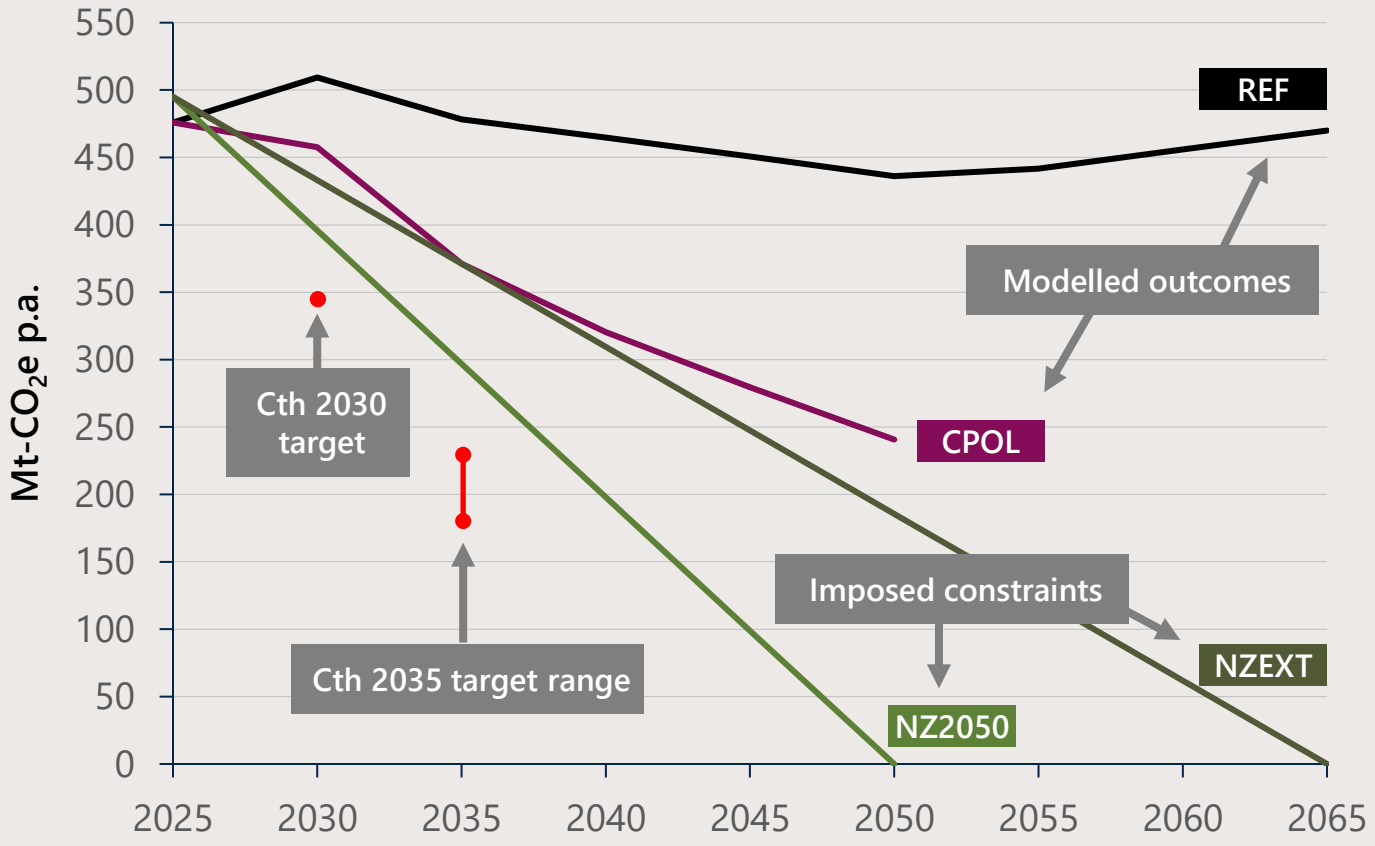
DESIGN CRITERIA

CPOL **CURRENT POLICIES:**

1. **must include a funded mechanism**; and
2. must make a **significant contribution** to decarbonisation in its sector[1]; and
3. **are extended to 2050** by assuming a reasonable continuation of annual activity.

We then incorporate 11 POLICIES in our model out of more than 40 examined.

EMISSIONS CONSTRAINTS & TRAJECTORIES



1. We define a policy with a 'significant contribution' as one that delivers at least 10% of the estimated net zero requirement for the category and the region that the policy is impacting, based on NZAu Phase 1 results.

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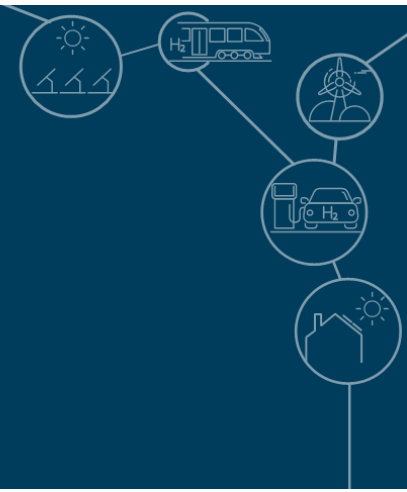
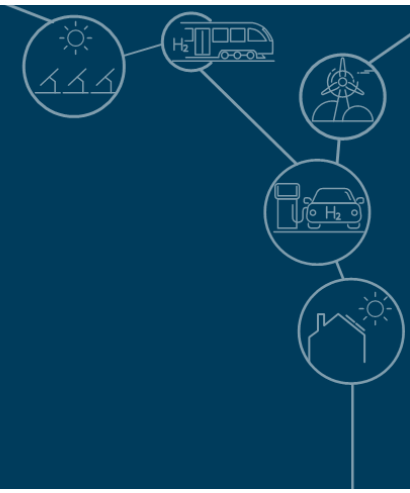
2 Results summary



Summary of modelling results

Energy production, storage, and build	• Renewables dominate, with 5-10%+ annual growth for many technologies in the net zero Scenarios. • Solar and battery storage are prioritised. • Firming will mainly be provided by batteries and gas, with investment primarily in batteries. • Many different energy systems achieve essentially the same emissions and total transition costs. • Net Zero Scenarios need ~2+ times existing electricity transmission, and new CO_2 and H_2 pipelines.
Energy use, emissions, and targets	• Emissions reduction is fastest in electricity; transport and heavy industry are slower. • The agriculture and land sector is not expected to be a source of offsets for other sectors. • CCS has an important role in all decarbonised futures. • Cth 2030 and 2035 targets are achieved in 2031+ and 2038+ respectively, depending on Scenario. • Additional action is needed to achieve 82% renewables by 2030, with 2033+ projected.
Maps	• New build electricity, hydrogen, CO_2 and water transmission connects major centres.
Costs and investment	• Decarbonisation tasks and costs vary widely across end-use sectors, with industry most impacted. • Achieving net zero is capital intensive across supply-side and demand-side sectors.

3 Results



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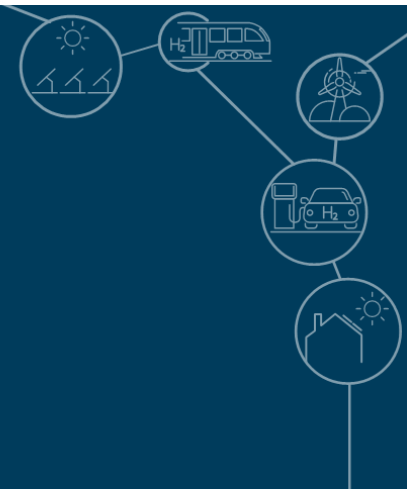
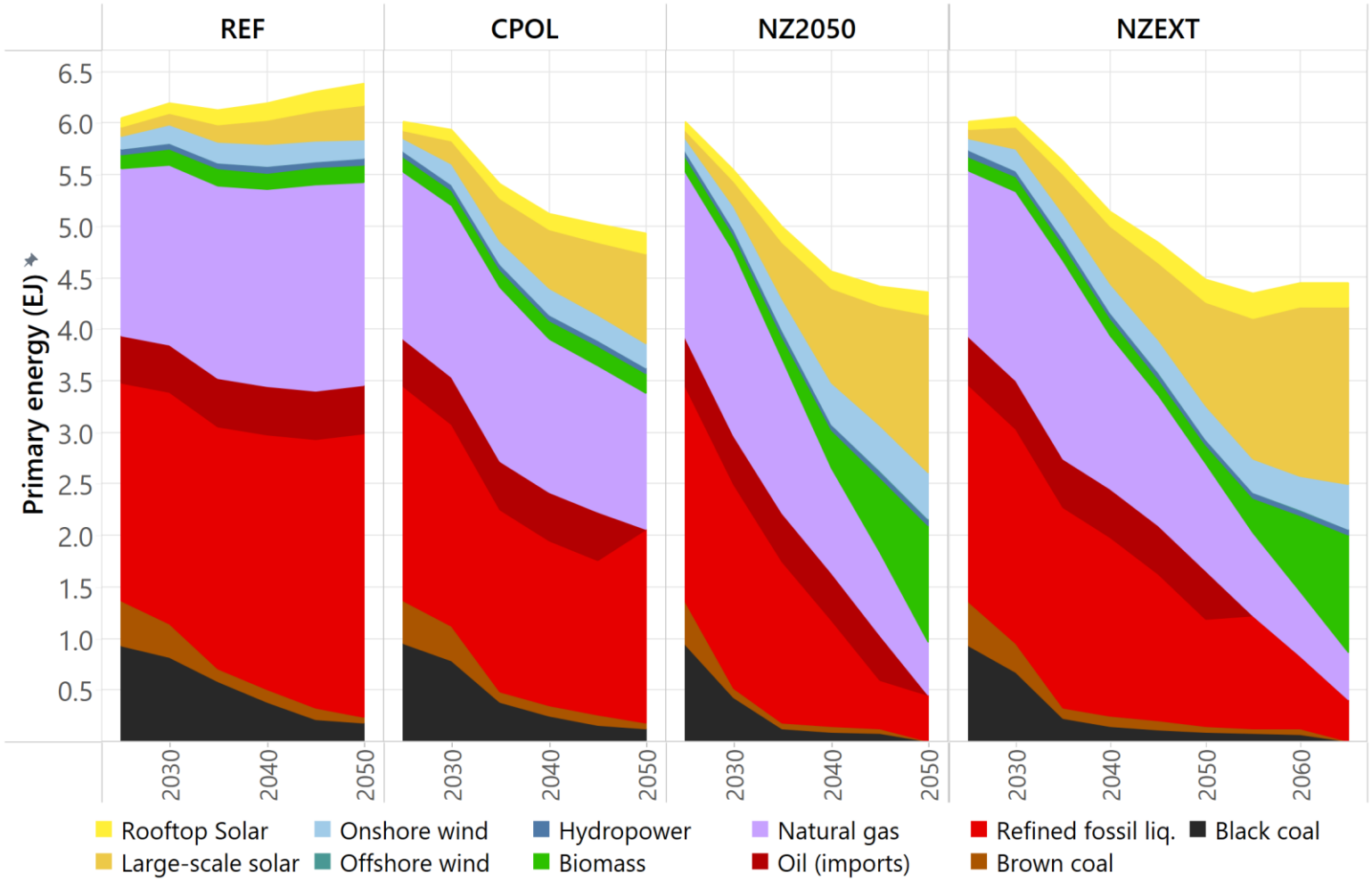
3.1 Energy production, storage, and build



Renewables dominate, with 5-10%+ annual growth for many technologies in the net zero Scenarios.

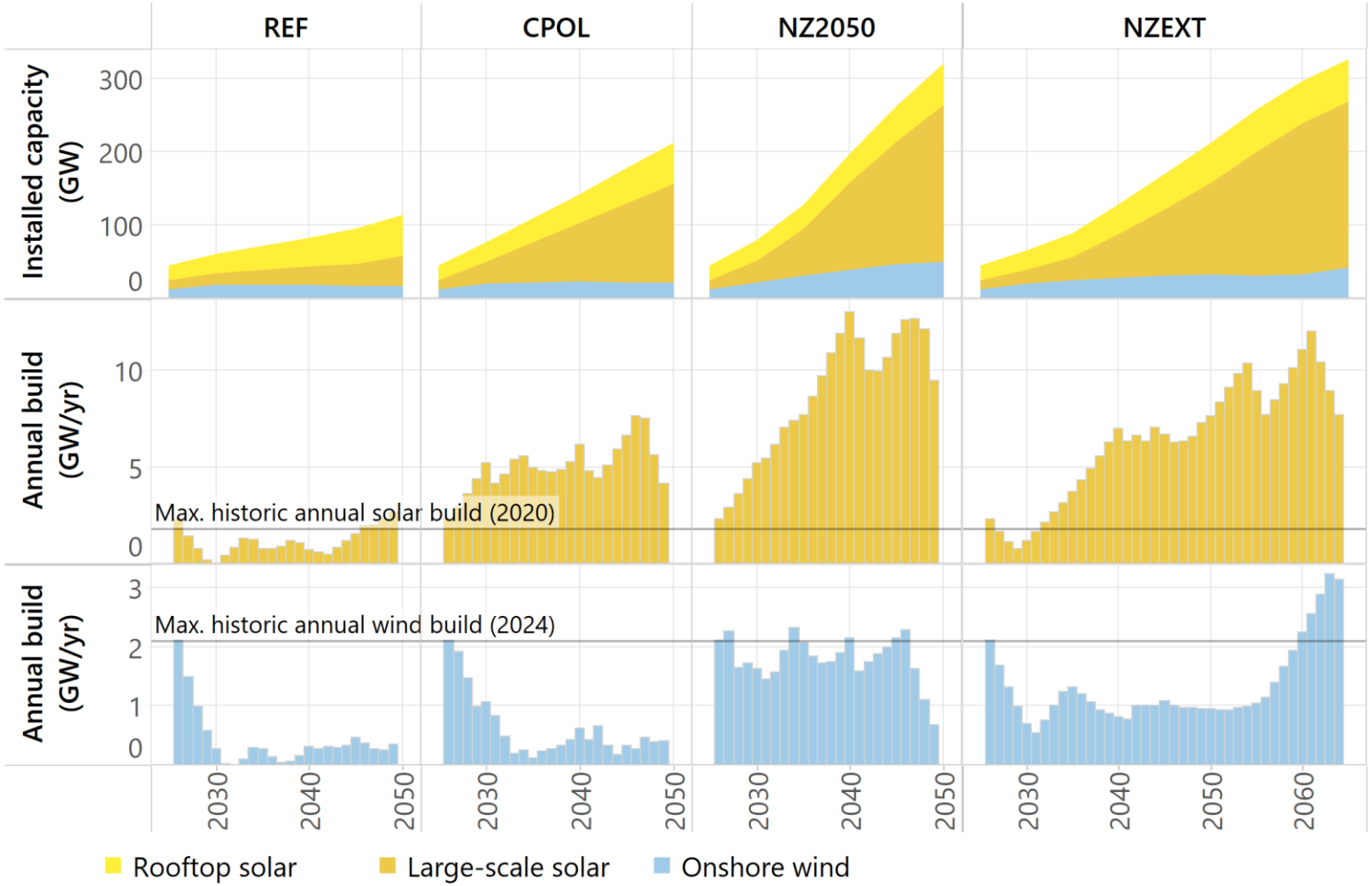
Projected domestic primary energy (EJ p.a).



- Renewables, and especially solar, become the dominant source of primary energy.
- Achieving significant biomass supply requires organised distribution and processing of a limited and uncertain resource. If biomass costs aren't as projected, other renewables and electrolysis will likely be the main beneficiaries.
- Natural gas and fossil fuel liquids have a small ongoing role in the net zero systems, offset by other means.
- An extended net zero timeline still sees a rapid ramping down in coal, but a longer tail for fossil fuel liquids and natural gas.

Solar and battery storage are prioritised.

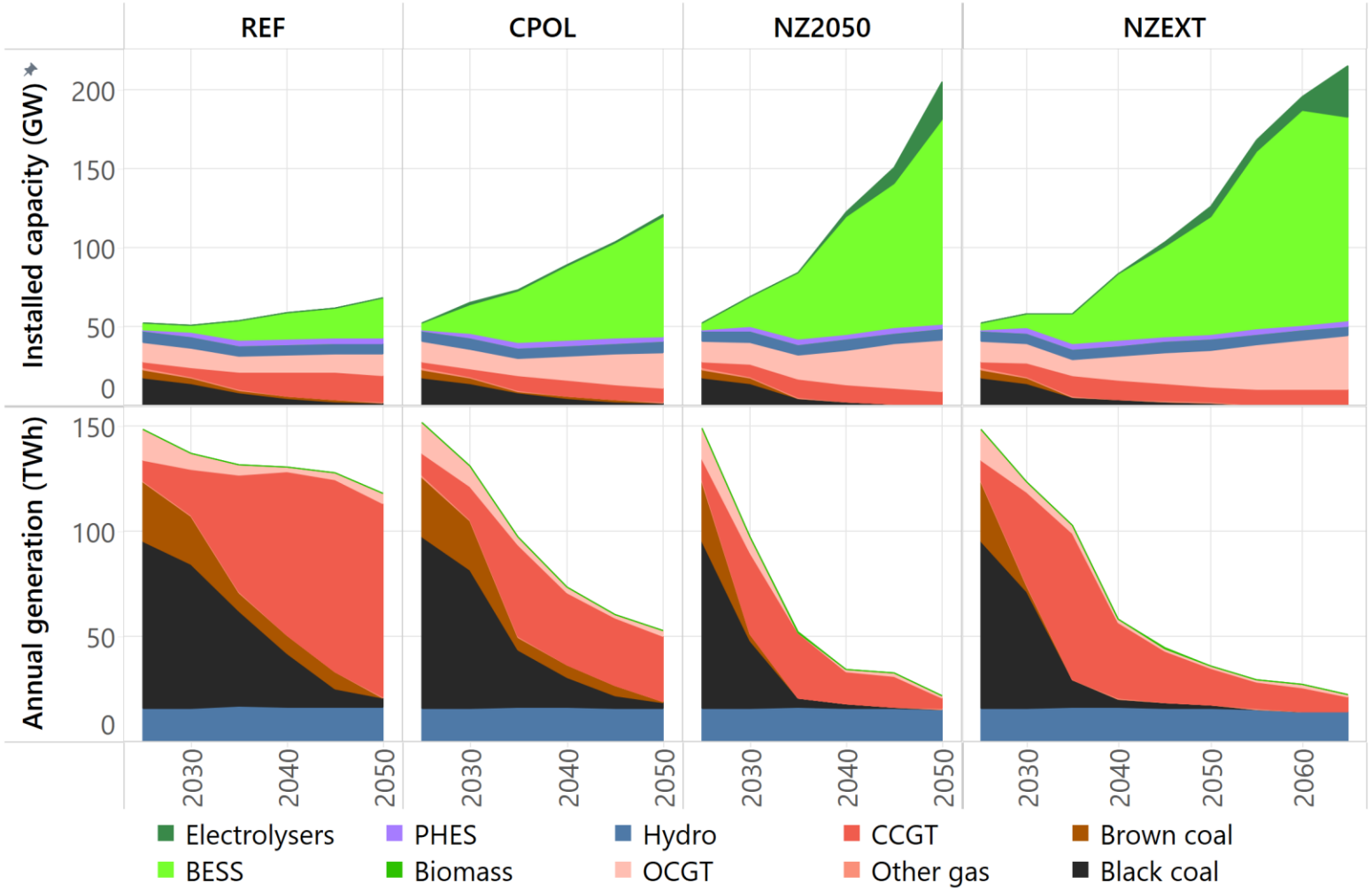
Top: **Installed domestic renewable generation capacity (GW);** Bottom: **projected required annual build relative to historic benchmarks (GW p.a.).**



- We find ~300 GW of renewable capacity is needed to reach net zero by 2050.
- Annual capacity addition needs to grow at ~10% year-on-year to achieve net zero by 2050.
- Additions peak at ~13 GW/yr for utility-scale solar.
- A 5% CAGR constraint on capacity build achieves net zero by ~2065, with lower CAGR constraints always meaning slower decarbonisation.
- Wind's annual capacity addition doesn't grow mainly because solar with storage is projected to be more competitive.

Firming will mainly be provided by batteries and gas, with investment primarily in batteries.

Top: **Projected annual domestic firming and storage capacity (GW);** Bottom: **annual electricity generation by firming technology (TWh p.a.).** Note varying axes.

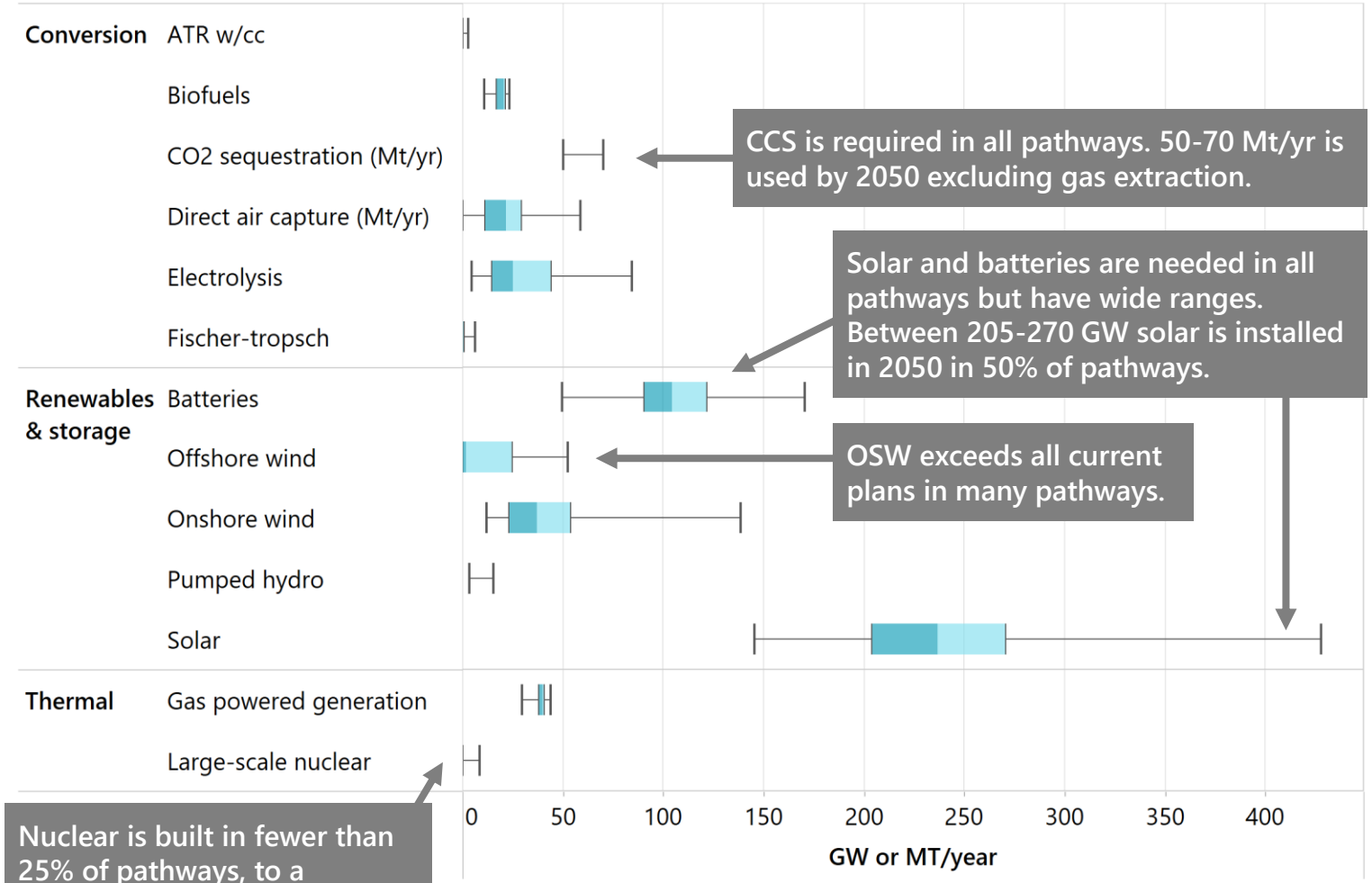


Note: batteries have an average of 6 hours storage.

- Net Zero by 2050 retires coal early, with minimal use of only black coal beyond 2035.
- These results reconfirm that energy storage and gas peaking are the main sources of firming in high renewable systems.
- However, these new results find:
  1. much stronger growth in batteries and solar because their low costs outcompete other options;
  2. no growth in pumped hydro beyond Snowy 2.0 or other firm generation, e.g. nuclear; and
  3. some growth in electrolysis / green hydrogen offering flexible load.

Many different energy systems achieve essentially the same emissions and total transition costs.

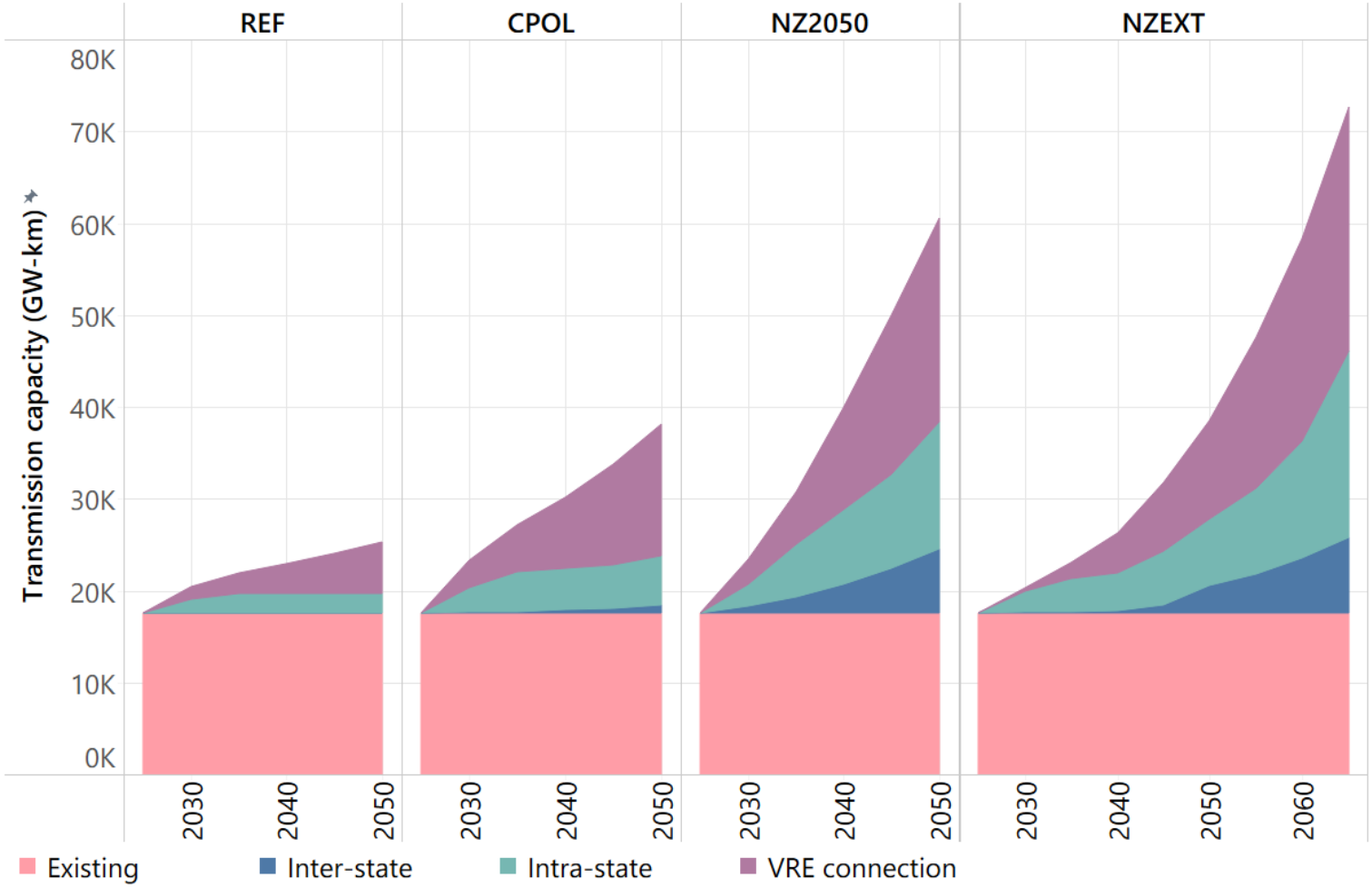
Variations in 2050 capacities (GW or Mt p.a.) of major assets in different NZ2050 Scenarios that are all within 1% of the optimal NPV found.



- The blue regions denote the build in +/−25% of the pathways surrounding the optimum. The bars represent the range of all builds found.
- Results show a wide range of combinations that achieve essentially the same **emissions and total transition costs**.
- The optionality in renewables is particularly strong, with onshore and offshore wind build very large in some cases.
- The smaller range in gas generation build demonstrates a consistent need for all decarbonised pathways.

Net Zero Scenarios need at least ~2 times existing electricity transmission.

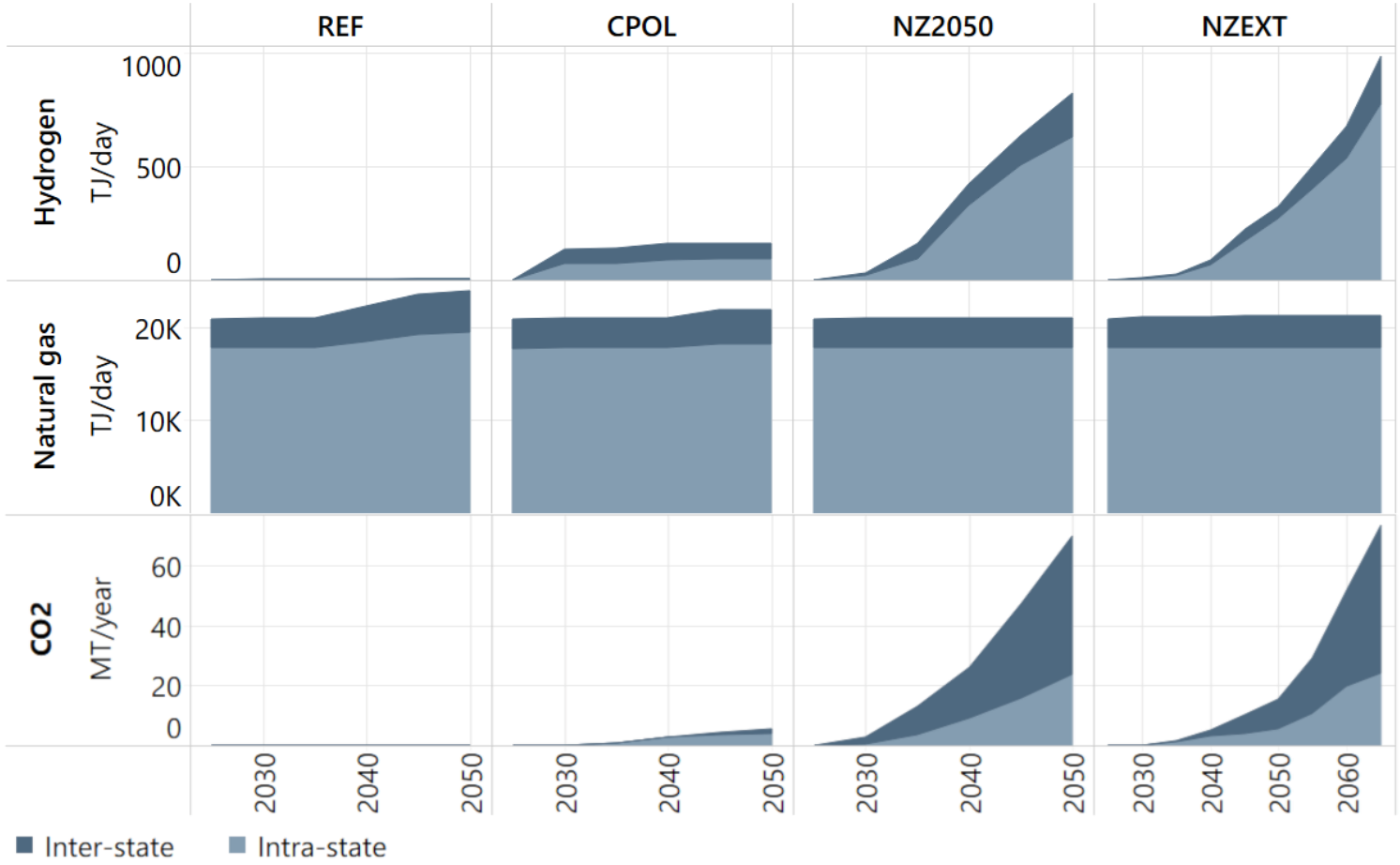
Projected additional electricity transmission capacity (GW-km).



- The bulk of new transmission build is required to connect new **renewable energy systems.**
- Cheaper solar and BESS can be located closer to major loads, often outcompeting wind with its need for greater geographic diversity and more transmission build.
- With the impact of solar, BESS, and cost increases in electricity transmission, the total domestic electricity transmission builds are about half the previous NZAu Phase 1 estimates.

Net Zero Scenarios need new hydrogen and CO_2 pipelines.

Projections of hydrogen, natural gas, and CO_2 pipeline capacity (TJ p.d., Mt-CO_2 p.a.). Note varying x- and y-axes



- Natural gas transmission capacity is maintained in all Scenarios, while natural gas **use** falls in the Net Zero Scenarios.
- Two new significant networks are needed for net zero:
  1. transmission of CO_2 from industrial and biomass sources to different reservoirs for geological sequestration; and
  2. transmission of hydrogen from renewable- and biomass-based production facilities to industrial and transport consumers.

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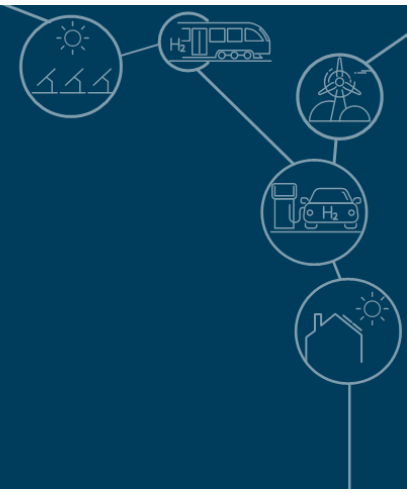
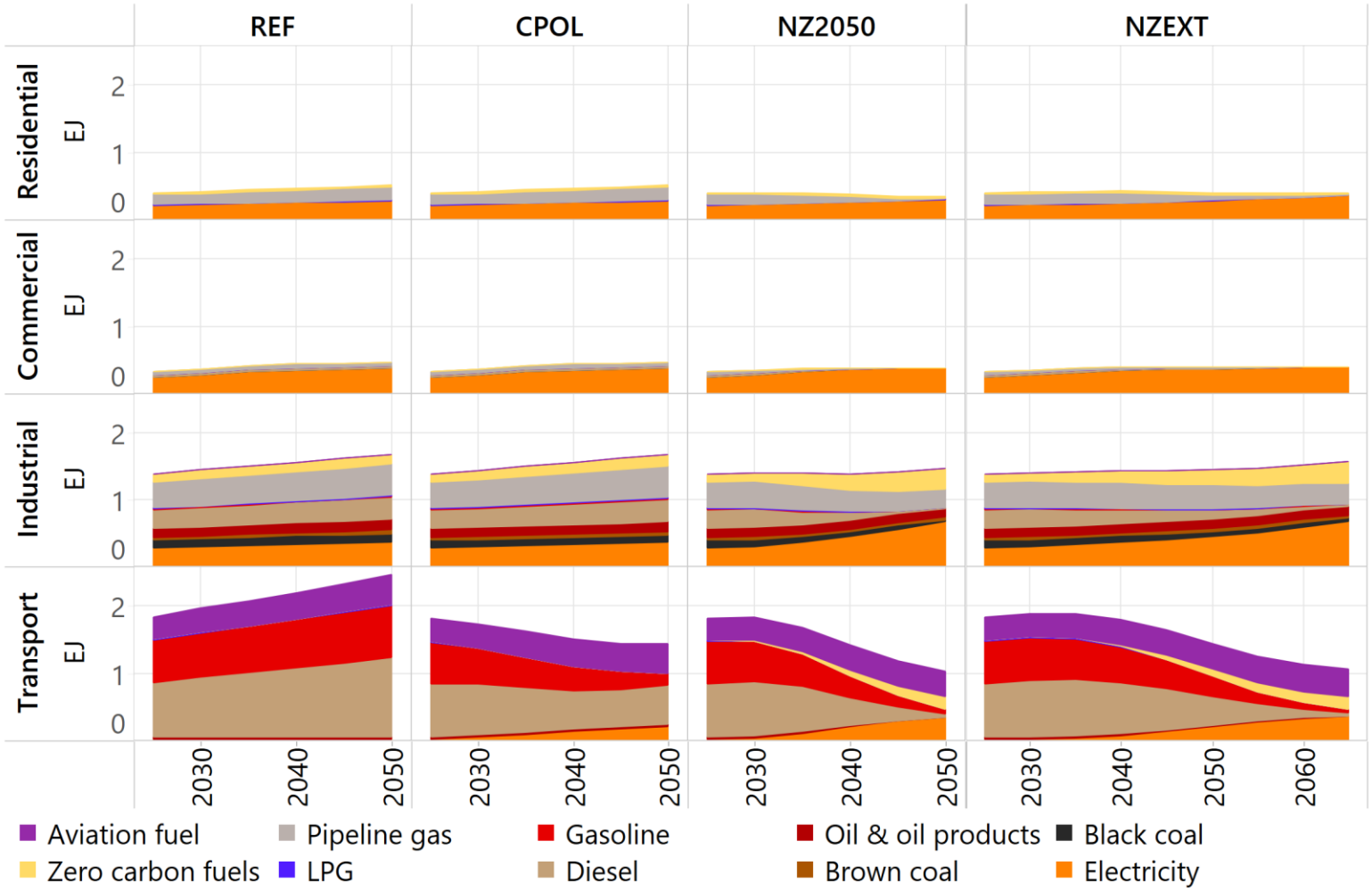
3.2 Energy use, emissions, and targets



Fossil fuel use in industry and transport is reduced through electrification, deployment of zero carbon fuels, and energy efficiency improvements.

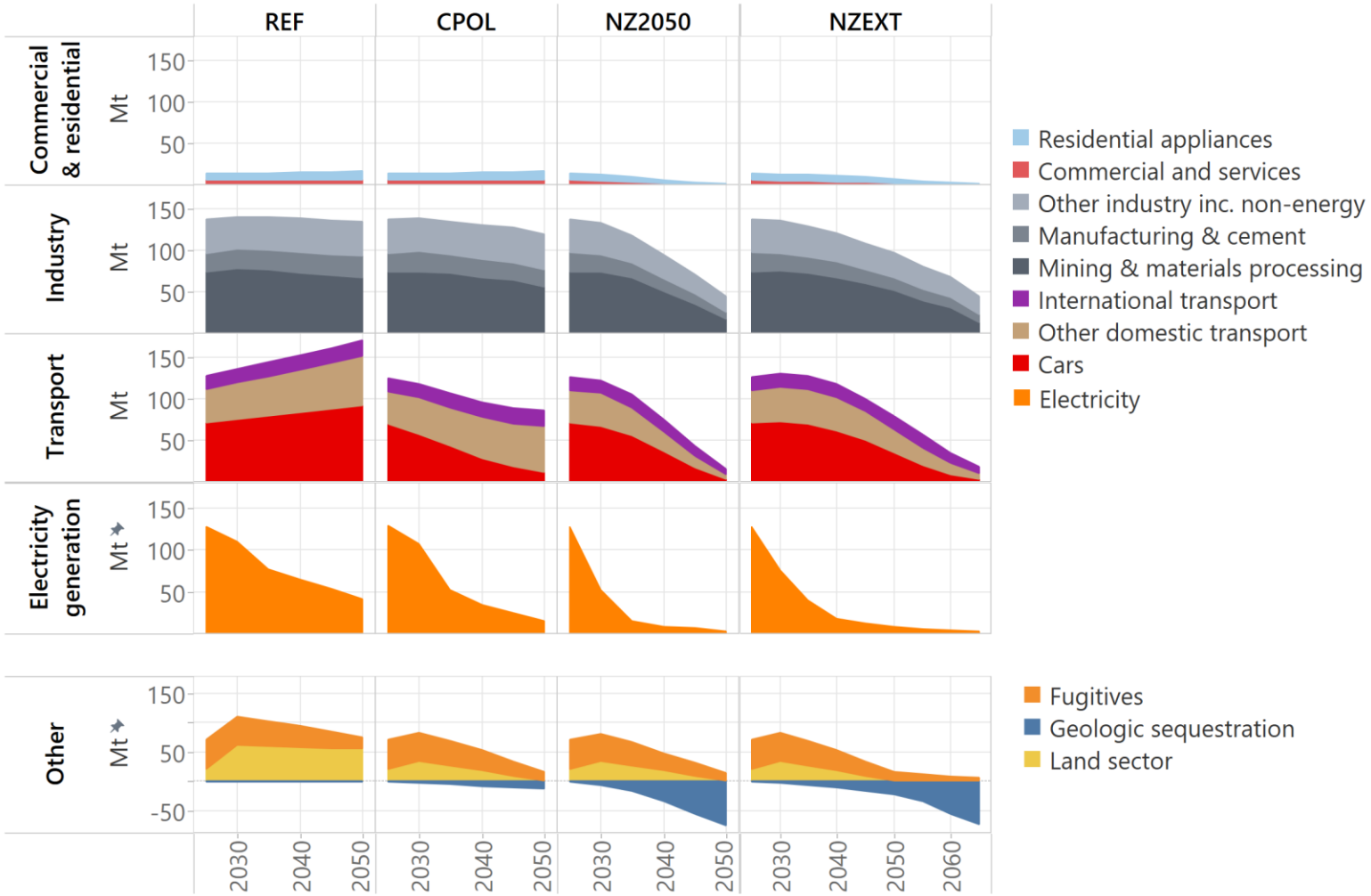
Final energy consumption by sector (EJ p.a.).



- Despite aggressive electrification, the Net Zero Scenarios retain consumption of fossil fuels in the Transport and Industry sectors.
- In the Net Zero Scenarios, this ongoing fossil fuel consumption is offset by engineered carbon removals.
- Transport energy reduces despite population and economic growth.
- Commercial and Residential energy consumption are much smaller than Industry and Transport in all cases, and it is mostly electrified by 2050 in the Net Zero Scenarios.

Emissions reduction is fastest in electricity generation; transport and heavy industry are slower.

Projected annual direct emissions, by sector and subsector (Mt-CO_2e p.a.).



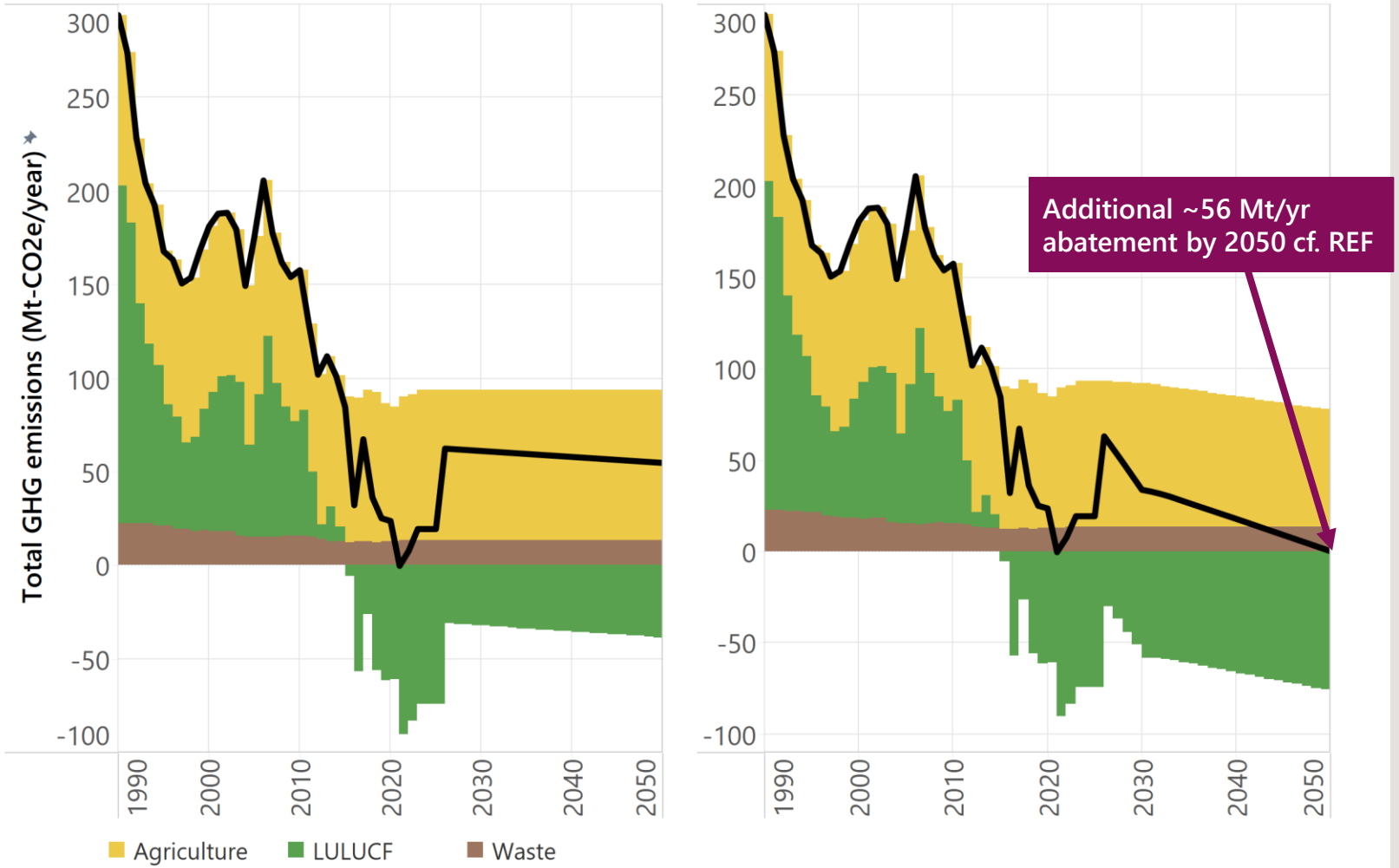
- Industry, transport, and electricity generation each account for significant emissions.
- Only electricity generation sees significant abatement under the Current Policies Scenario.
- Direct emissions from residential and office buildings (e.g. gas heating) are comparatively small.
- The New Vehicle Efficiency Standard sees direct fuel emissions from cars in the Current Policies Scenario decrease more rapidly than the Net Zero Scenarios, but electricity emissions must correspondingly increase.

The agriculture and land sector is not expected to be a source of offsets for other sectors.

Historical and projected land sector GHG emissions (Mt-CO_2e p.a.).

REFERENCE SCENARIO

CPOL, NZ2050, NZEXT

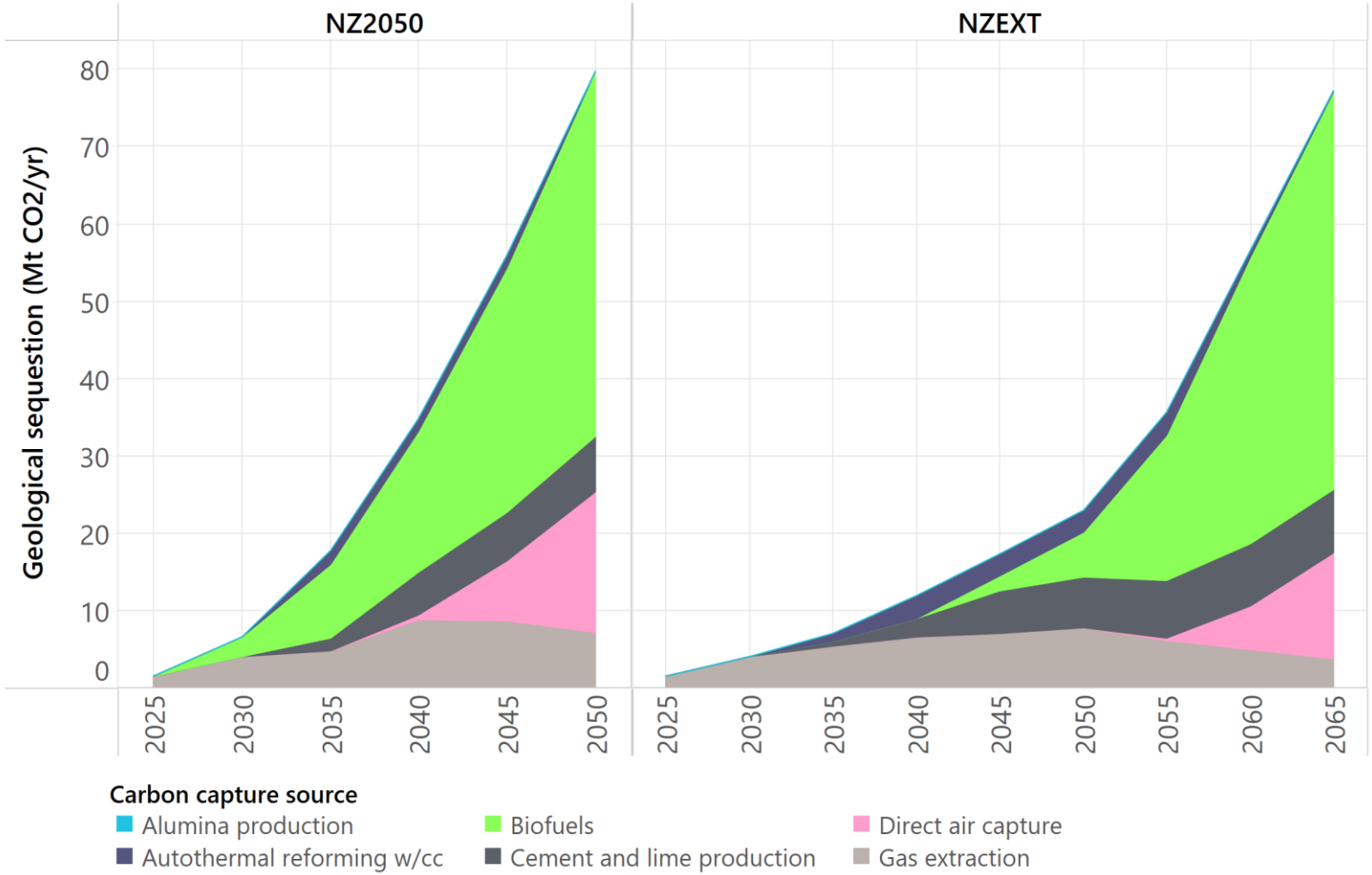


- A combination of agricultural emissions management and concerted afforestation (in CPOL, NZ2050, NZEXT) means that the agriculture and land sector essentially reach net zero on their own.
- Thus, the agriculture and land sector isn't projected to be a significant source of offsets for other sectors.
- Land sector abatement and CCS are therefore strongly coupled – if one achieves less, then the other is needed more to help the full system reach net zero.

CCS has an important role in all decarbonised futures.

Geological carbon dioxide sequestration by upstream source (Mt-CO_2 p.a.).

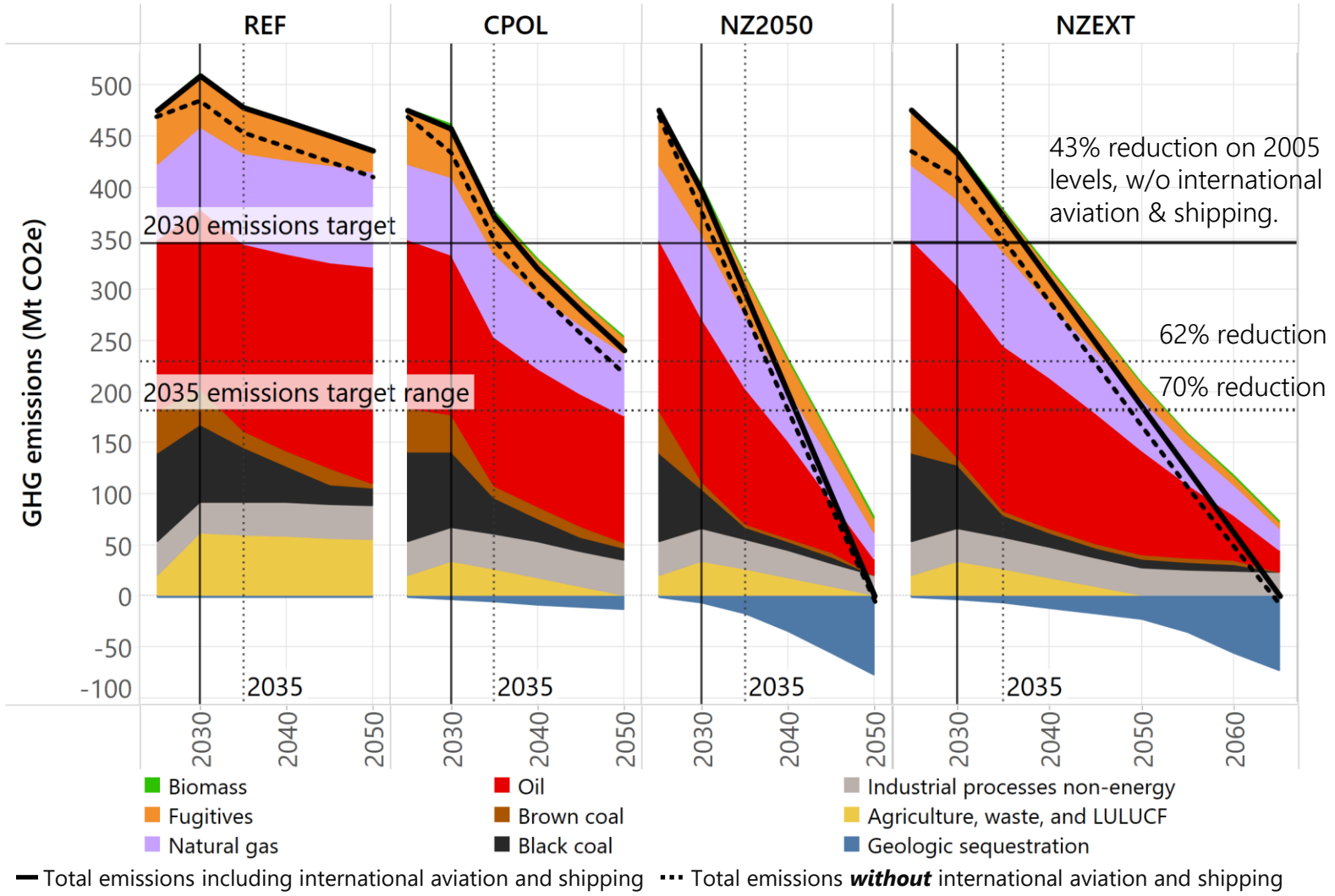
Note: no additional CCS is used in the REF or CPOL Scenarios, so are not shown.



- Biofuel production is the dominant CO_2 source for CCS, producing hydrogen while also achieving net-negative emissions.
- Net-negative emissions are provided from direct air capture and bioenergy with CCS to primarily offset residual emissions from hard-to-abate sectors, e.g. transport (aviation) and industry (LNG processing, chemical manufacturing, and aluminium smelting).

Commonwealth 2030 and 2035 emissions targets are achieved in 2031+ and 2038+ respectively, depending on Scenario.

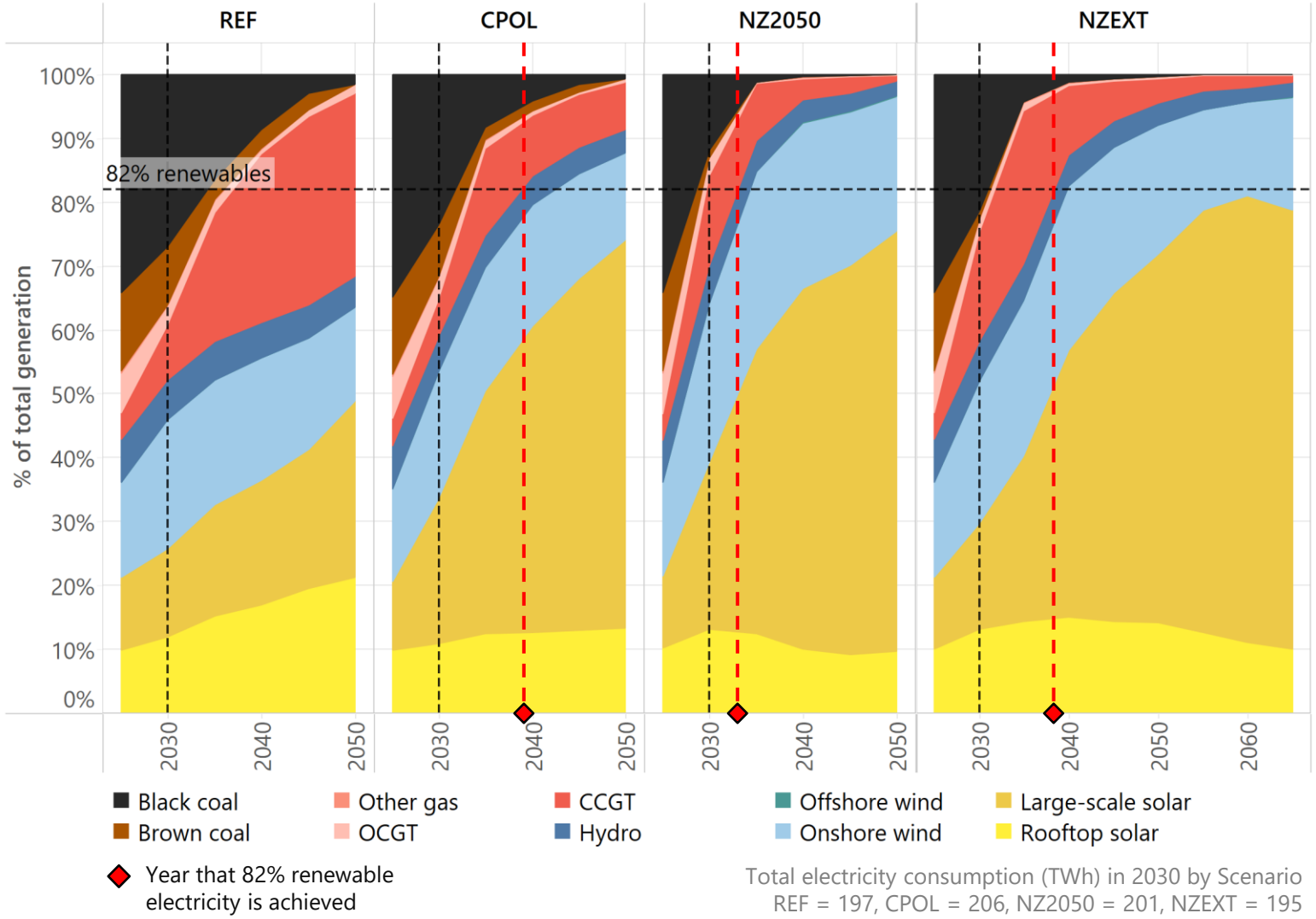
Projected annual domestic emissions, by source (Mt-CO_2e p.a.).



- Our 2025 emissions are higher than the 2023 National Inventory by ~25 Mt-CO_2e mainly because we include international aviation and shipping.
- Fossil fuels are the main emissions source, with industry and transport the largest users.
- We find a significant contribution from CCS in both Net Zero Scenarios, again suggesting that renewables and CCS are both required.
- Note that our Current Policies Scenario definition excludes abatement from many smaller policies, and announcements of the last week, so may underestimate abatement.

Additional action is needed to achieve 82% renewables by 2030, with 2033+ projected.

Proportion of total electricity demand met by technology type (% of TWh p.a.).



Total electricity consumption (TWh) in 2030 by Scenario
REF = 197, CPOL = 206, NZ2050 = 201, NZEXT = 195

- The Current Policies Scenario achieves ~59% renewables by 2030.
- The Net Zero 2050 Scenario achieves 82% renewables in ~2033; *later* than the Commonwealth's 2030 target.
- No Scenario reaches 100% renewables, noting in particular:

1. ongoing use of gas peakers is again required in our modelling for reliability, with their emissions offset; and
2. deeper analysis is required to assess system reliability and security with majority renewables.

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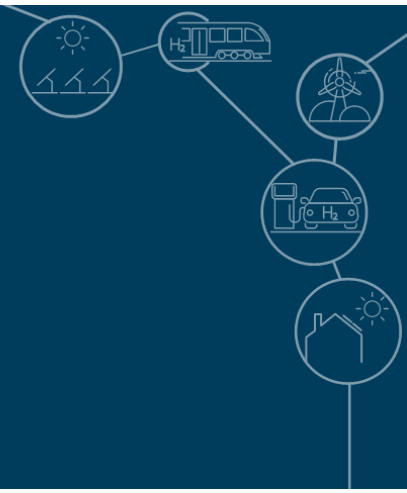
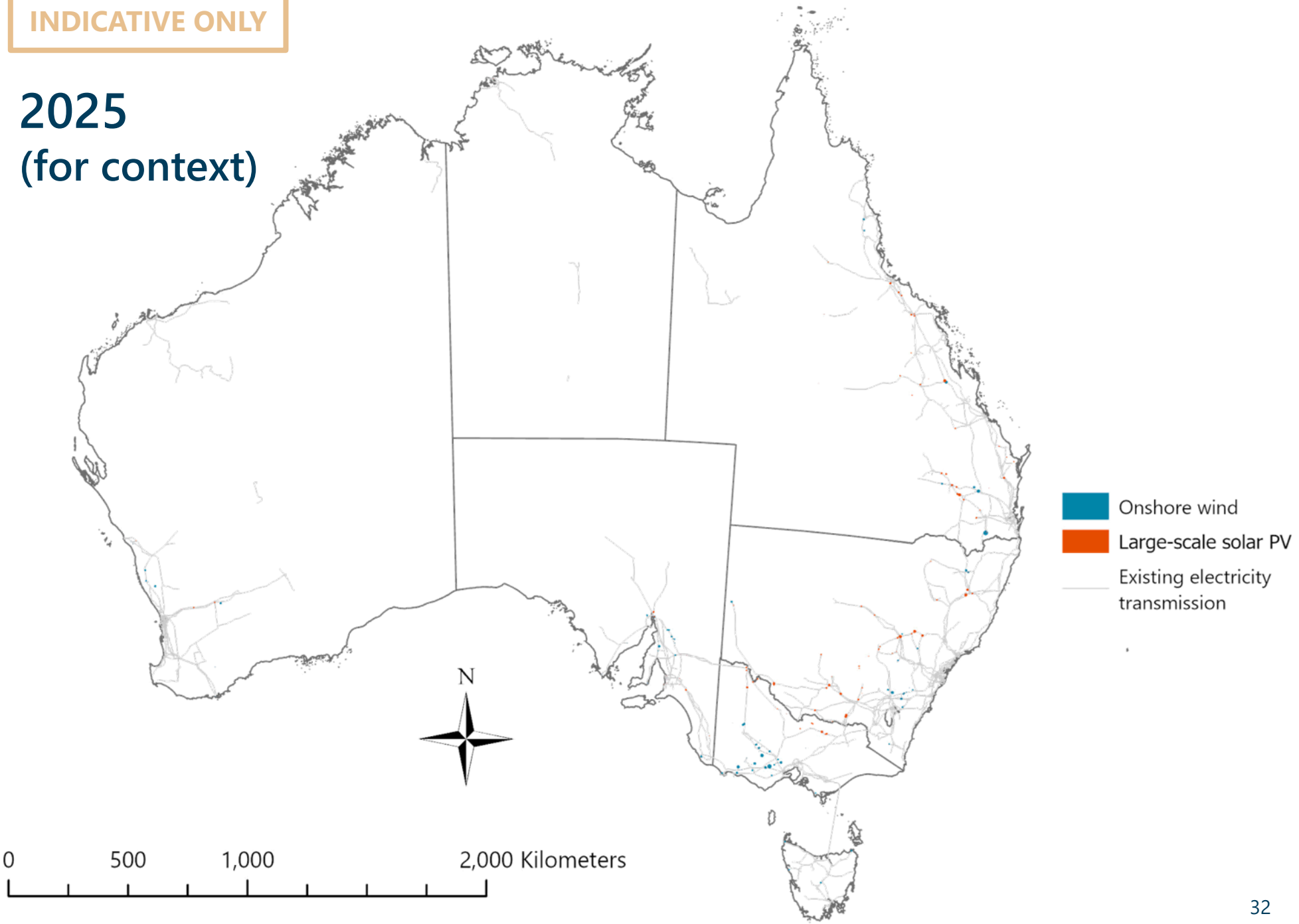
3.3 Maps



INDICATIVE ONLY

2025
(for context)

New build electricity, hydrogen, CO_2, and water transmission connects major centres.

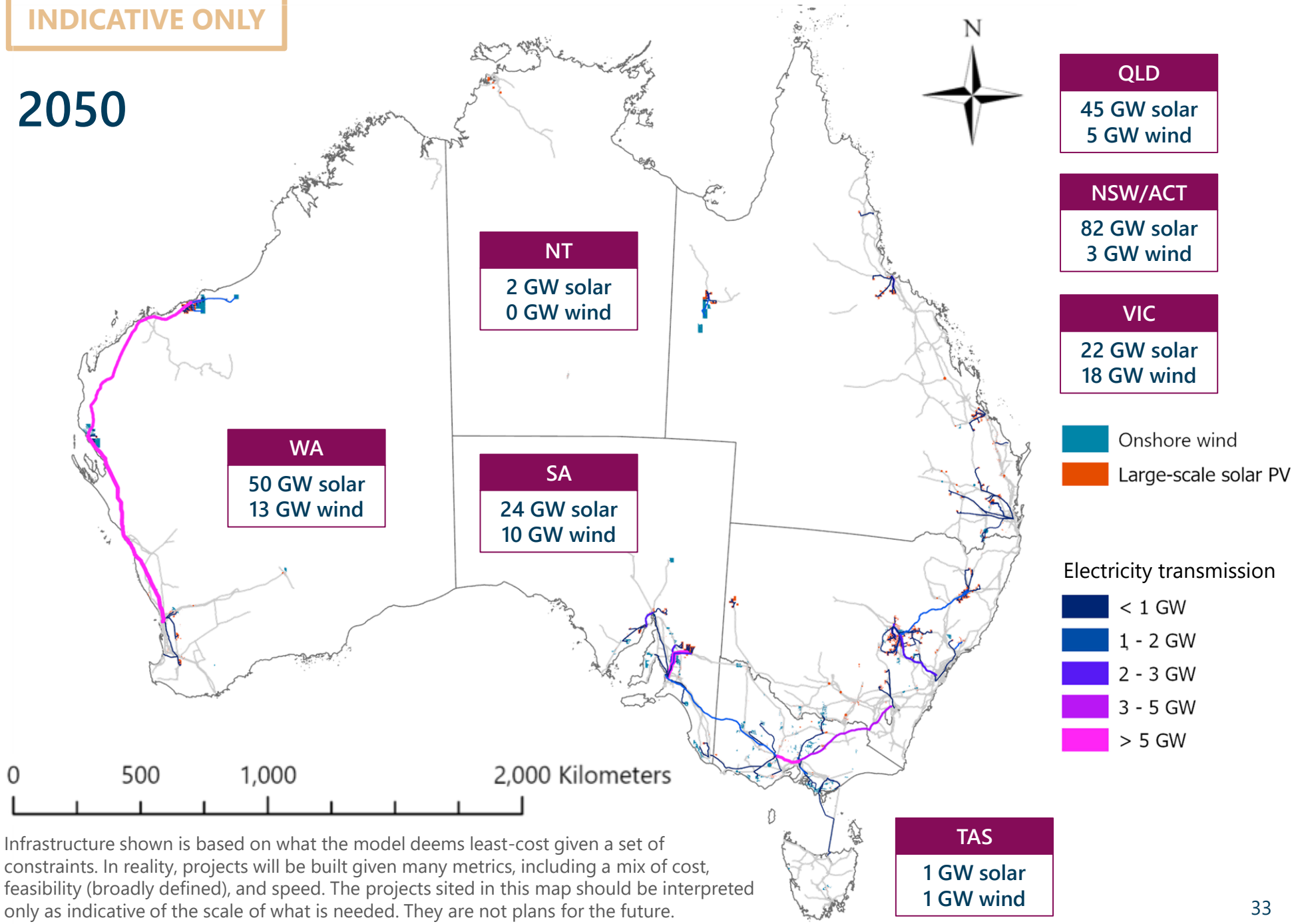


New build electricity, hydrogen, CO_2, and water transmission connects major centres.

NZ2050: 2050

INDICATIVE ONLY

2050



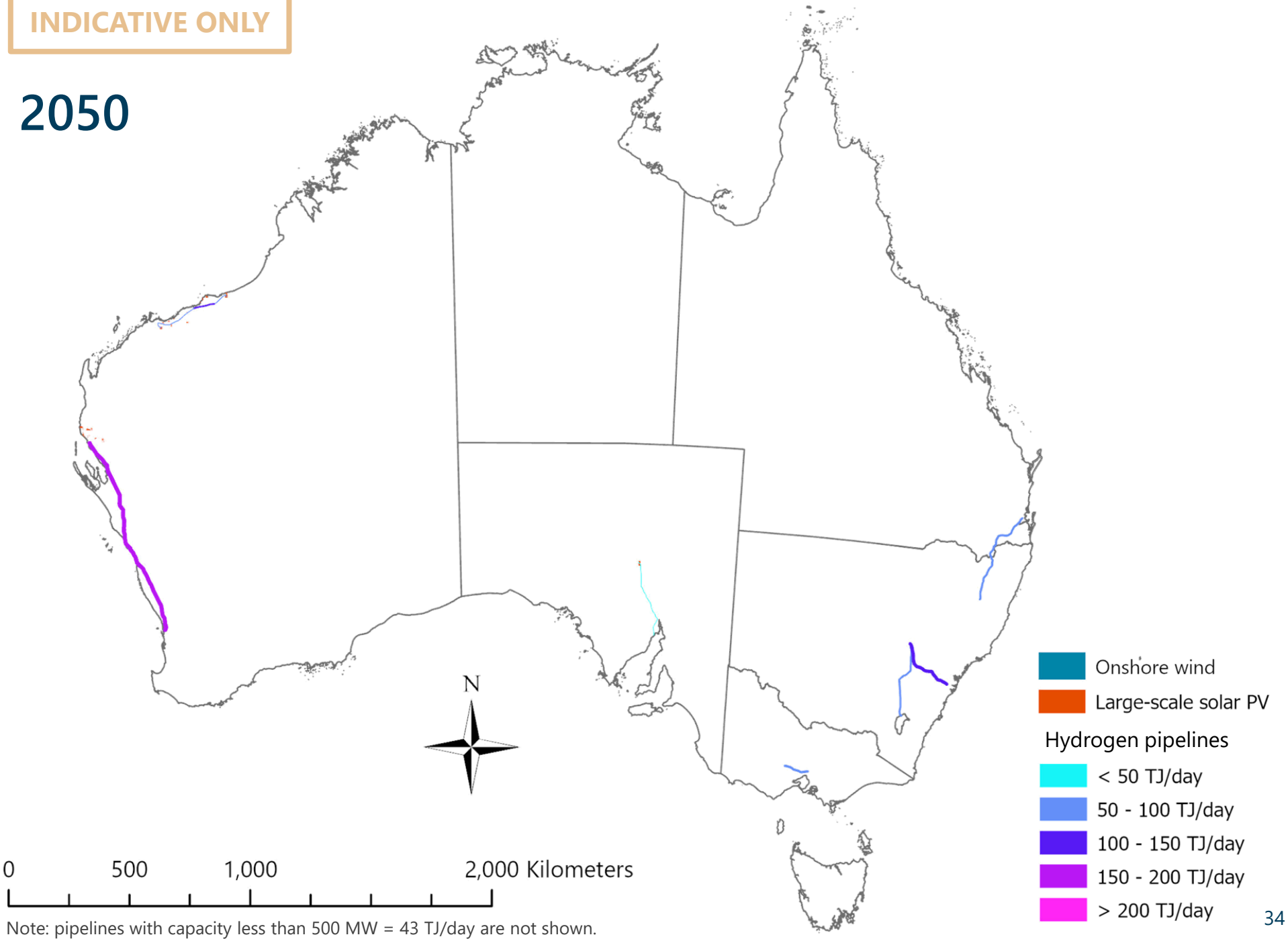
Note: candidate projects are restricted from being built on: active mines; communities; inland water bodies; defence zones; transport infrastructure; existing energy infrastructure; irrigated areas; areas with slope greater than 10 degrees; offshore shipping lanes; populated areas; and protected areas including Species of National Environmental Significance (SNES) and Ecological Communities of National Environment Significance (ECNES).

Infrastructure shown is based on what the model deems least-cost given a set of constraints. In reality, projects will be built given many metrics, including a mix of cost, feasibility (broadly defined), and speed. The projects sited in this map should be interpreted only as indicative of the scale of what is needed. They are not plans for the future.

INDICATIVE ONLY

2050

New build electricity, hydrogen, CO_2, and water transmission connects major centres.



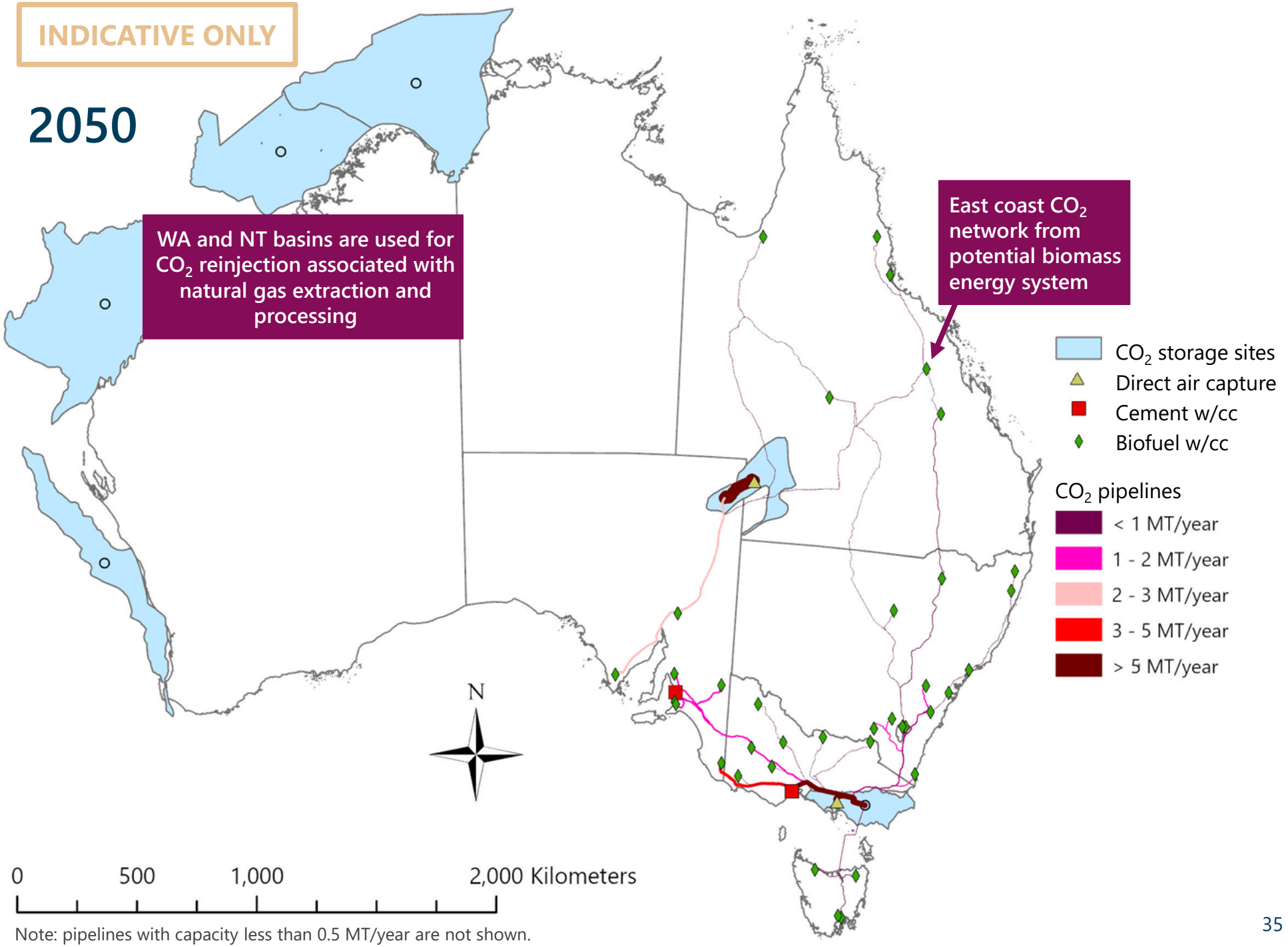
Note: pipelines with capacity less than 500 MW = 43 TJ/day are not shown.

NZ2050: 2050

New build electricity, hydrogen, CO_2, and water transmission connects major centres.

INDICATIVE ONLY

2050

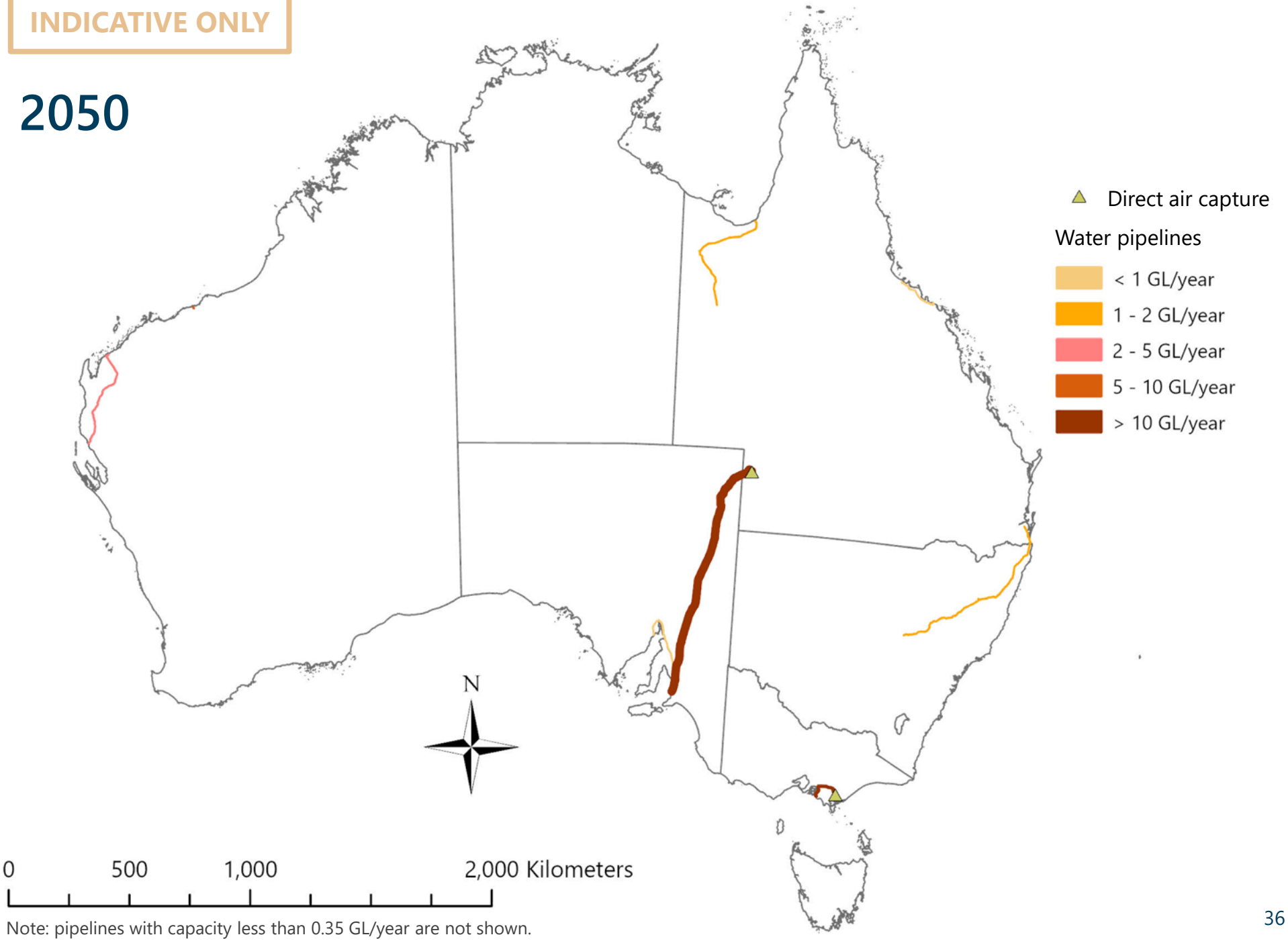


Note: pipelines with capacity less than 0.5 MT/year are not shown.

INDICATIVE ONLY

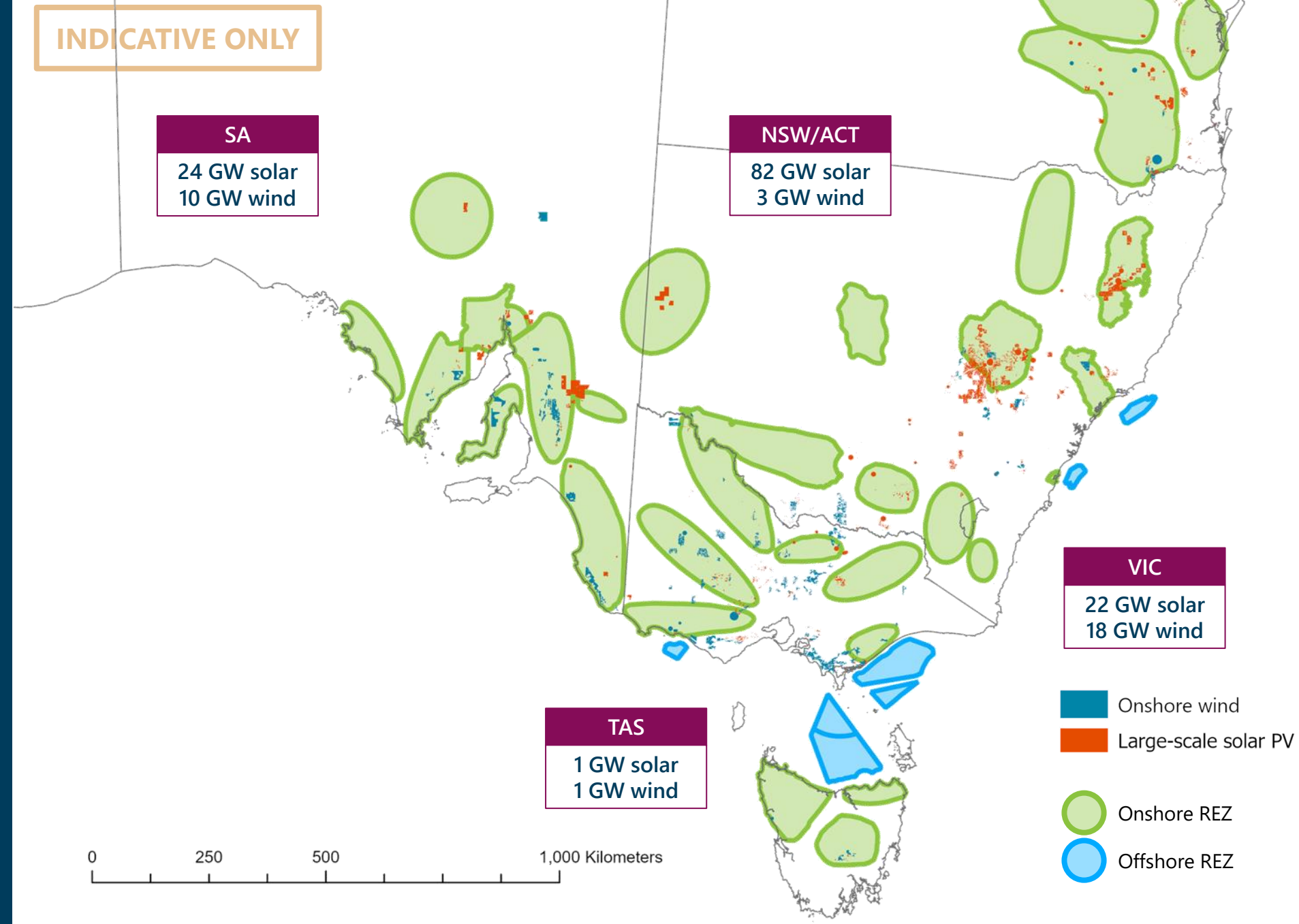
2050

New build electricity, hydrogen, CO_2, and water transmission connects major centres.



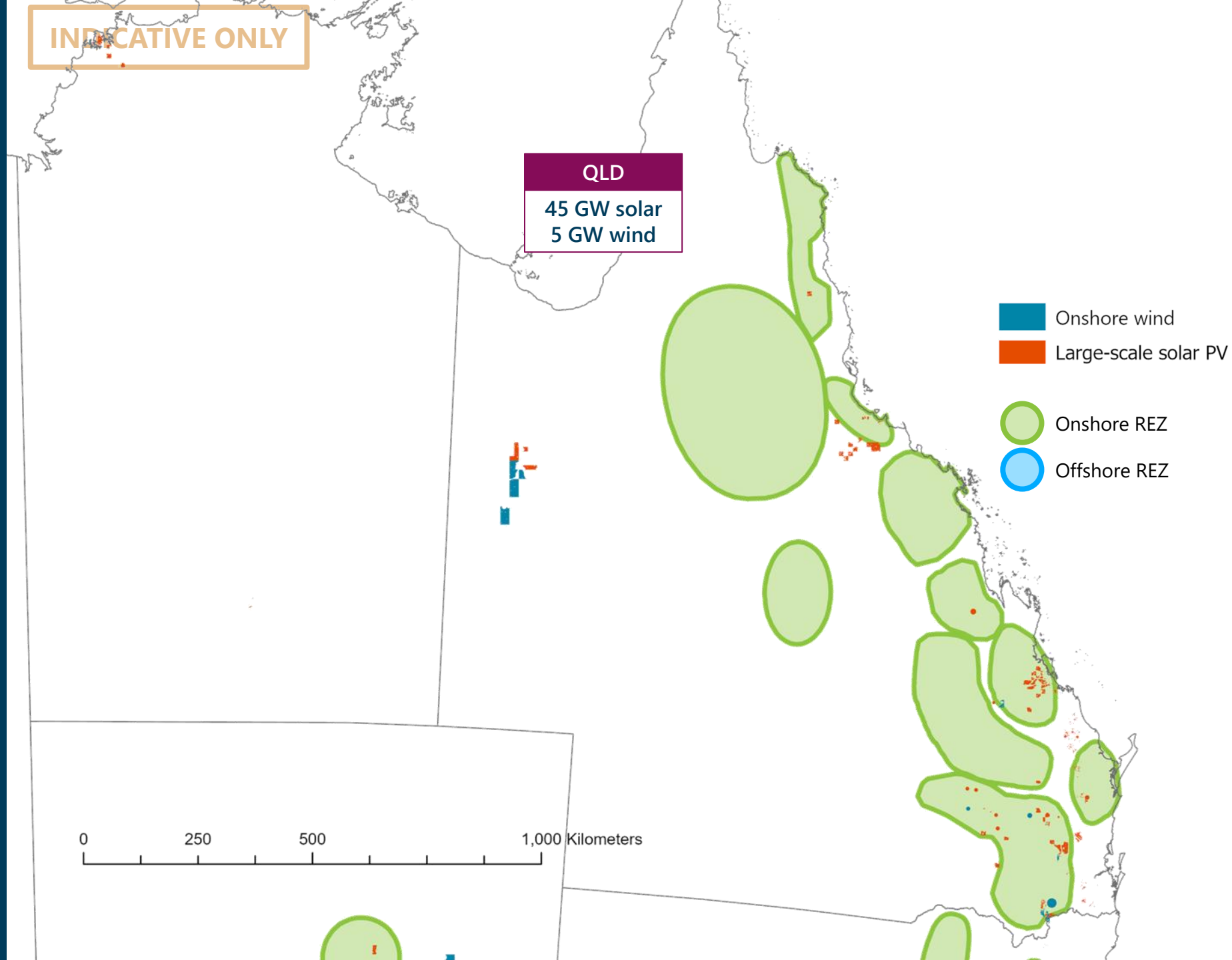
Note: pipelines with capacity less than 0.35 GL/year are not shown.

Renewables required in all states, with solar and wind capacities depending on local conditions.



NZ2050: 2050

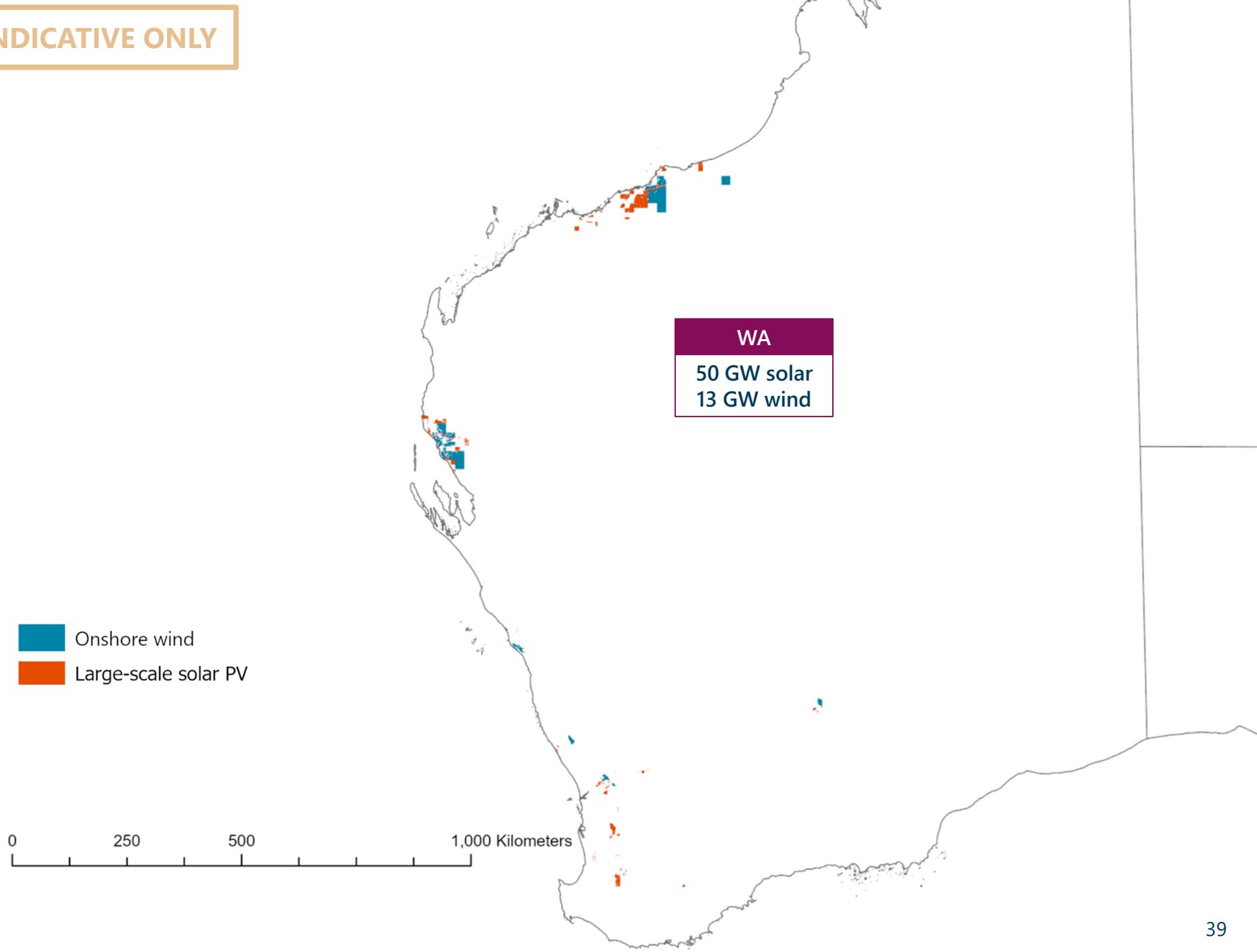
Renewables required in all states, with solar and wind capacities depending on local conditions.



NZ2050: 2050

Renewables required in all states, with solar and wind capacities depending on local conditions.

INDICATIVE ONLY



NZ2050: 2050

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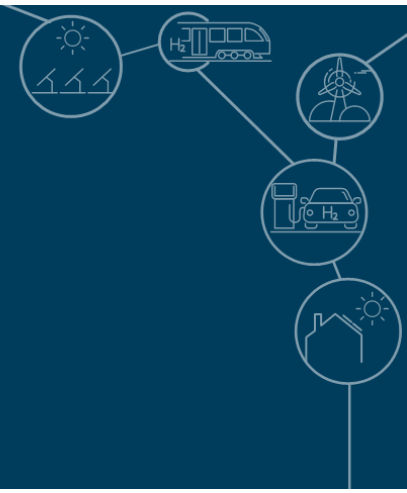
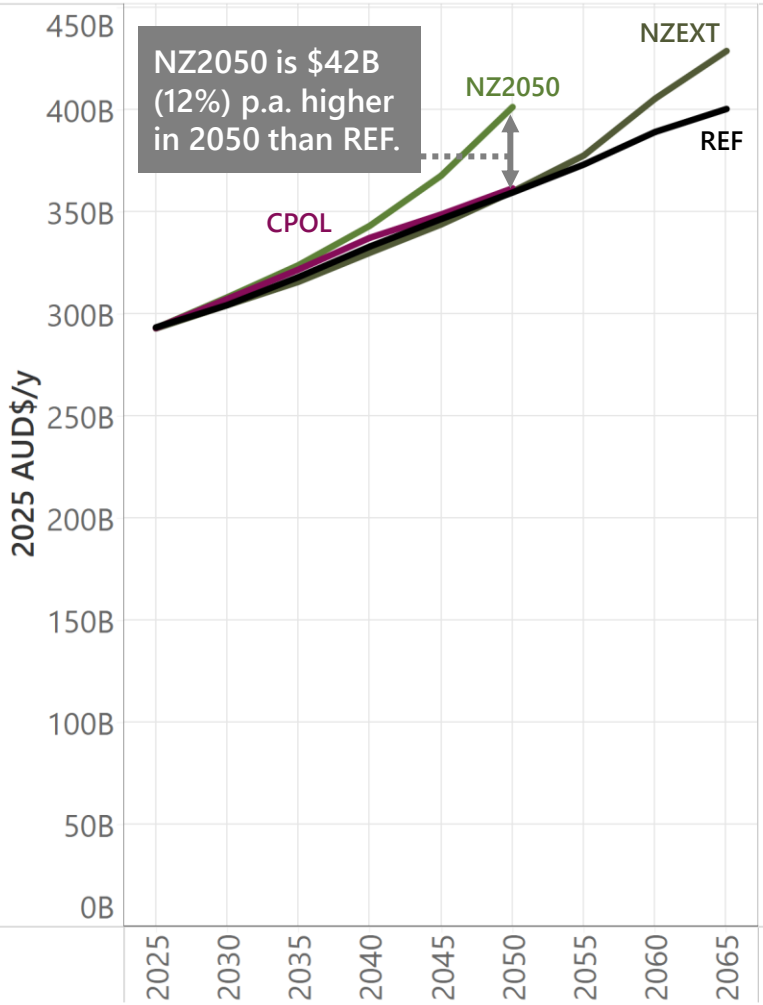
3.4 Costs and investment

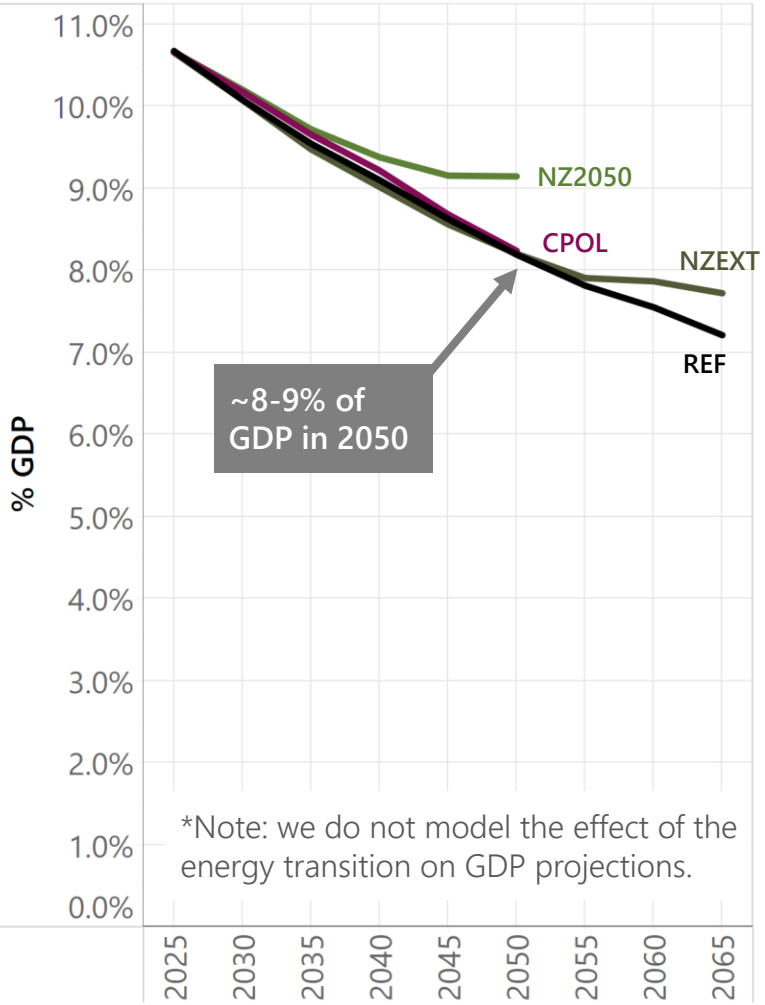


Achieving net zero by 2050 will cost up to ~12% more p.a. than doing nothing about climate change, but these costs reduce as a share of GDP today.

Levelised domestic energy system costs (2025 AUD billions p.a.).



Levelised domestic energy total costs as share of GDP* (% Australian GDP).



- Domestic energy total costs reduce as a share of GDP today in all Scenarios.
- Domestic total costs include the costs of electricity, gas and oil derivatives delivered to the customer, the cost of end-use appliances (e.g. new vehicles, heating, etc.), and the costs of feedstocks to certain industries.
- Net present value to 2050:

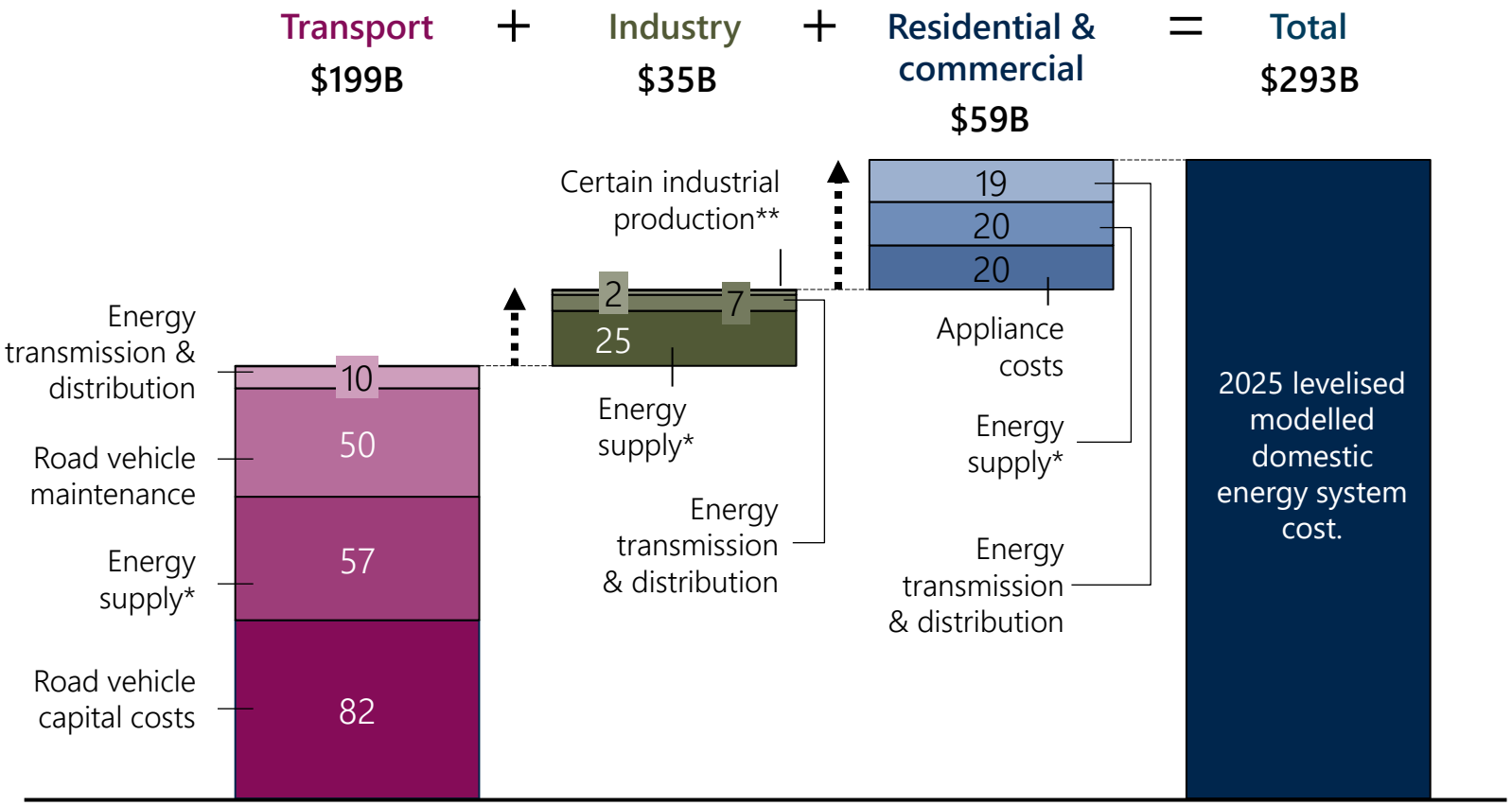
  REF = ~$8,150B

  NZ2050 = ~$8,459B

  Difference = ~$309B
- **These costs don't include investments required for adaptation and climate damage.**

Roughly 2/3 of modelled 2025 costs are transport, with costs in other sectors primarily associated with energy supply.

2025 levelised modelled domestic energy system costs by source,
2025 $AU billion, NZ2050 Scenario.



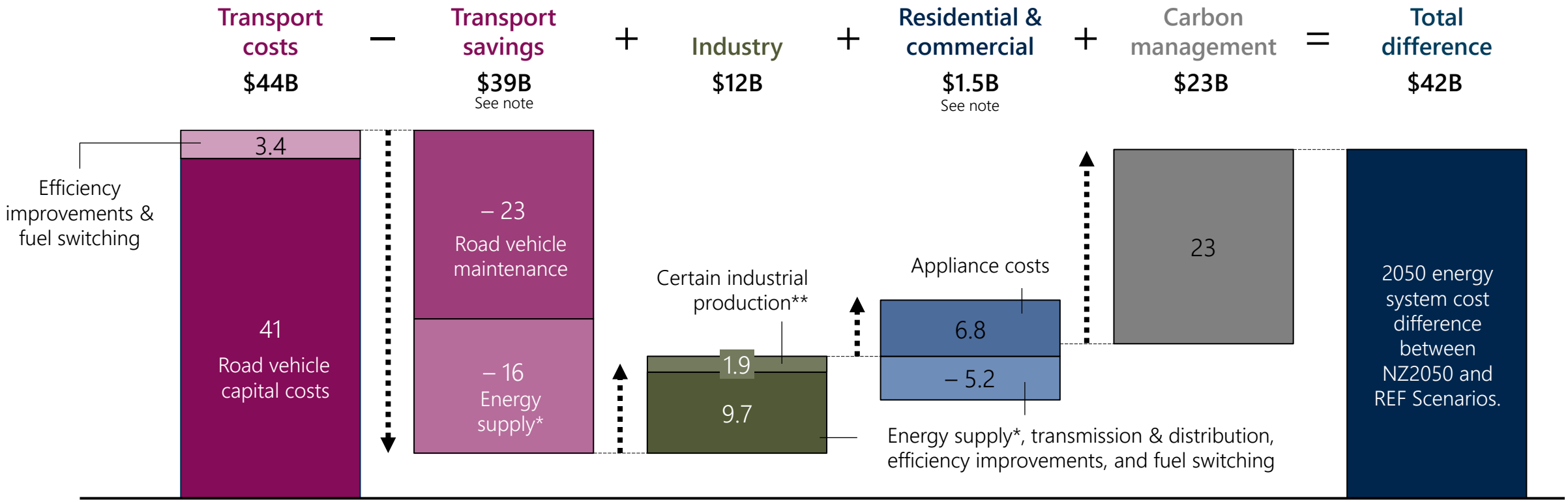
*__Energy supply__ costs include capital, fuel inputs, operating and maintenance costs of all plant supplying energy to the sector.
**__Certain industrial production__ includes the capital, feedstock, and operation and maintenance costs of the iron and steel, alumina and aluminium, and cement industries.

- Of the $293 billion cost of the modelled domestic energy system in 2025, ~$200 billion (68%) is associated with running and maintaining the transport system.
- The bulk of costs for the industrial, residential, and commercial sectors are associated with energy supply.

Note: modelled costs only include energy costs attributed based on domestic consumption. Capital and maintenance costs for water, rail, and aviation vehicles are not included.

The net cost to decarbonise is primarily carbon management, industrial fuel switching, and energy efficiency upgrades.

Difference in 2050 between NZ2050 and REF Scenario levelised domestic energy system costs by sector, 2025 $AU billion.



*__Energy supply__ costs include capital, fuel inputs, operating and maintenance costs of all plant supplying energy to the sector.
**__Certain industrial production__ includes the capital, feedstock, and operation and maintenance costs of the iron and steel, alumina and aluminium, and cement industries.
***__Carbon management__ includes carbon capture and storage capital, operating, and associated transmission costs..

Note: electrification costs in residential & commercial and transport sectors are offset by more efficient energy use.

Decarbonisation by 2050 sees industrial energy system costs increase the most, while per capita costs for other sectors remain similar to 2025 levels.

Per capita levelised cost of modelled domestic energy system by sector and cumulative emissions by sector, NZ2050 Scenario, 2025 $AU per capita per annum.

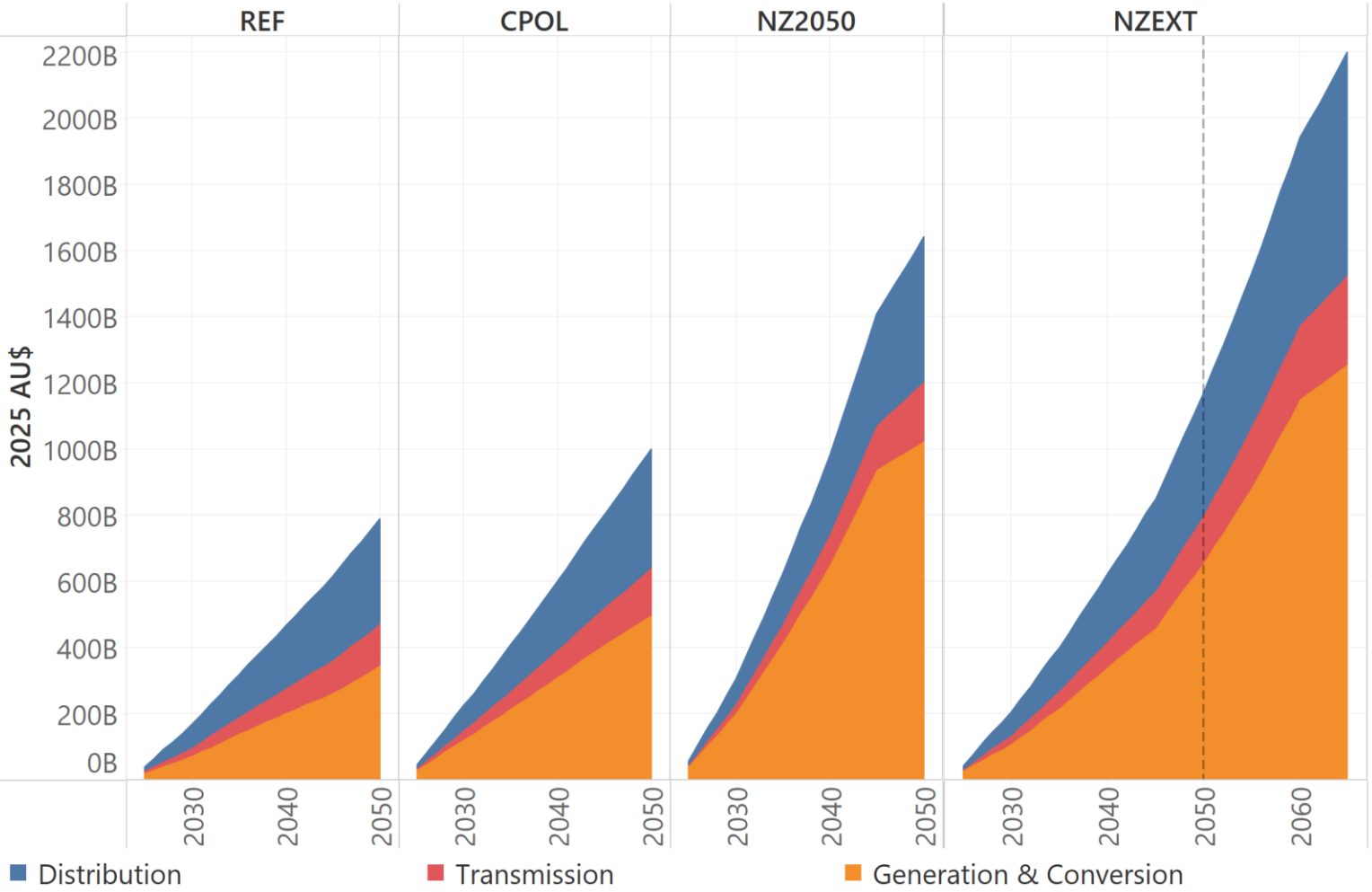
Sector [1]	Levelised system cost per capita ($/person/year)			% of cumulative GHG emissions 2025-50
	2025	2050	Change	
Residential	1,441	1,566	9%	5%
Commercial	734	640	– 13%	5%
Industrial [2]	1,281	2,109	65%	56% [3]
Transport	7,256	7,200	– 1%	34%
Cars	5,553	5,330	– 4%	-
Other domestic transport	1,418	1,530	8%	-
Intl. aviation and shipping	285	340	19%	-
Total [4]	**10,711**	**11,515**	**8%**	**100%**

1. Cost of negative emissions sources (e.g. direct air capture) are attributed based on 2050 absolute emissions by sector.
2. Note that costs associated with agriculture, waste, and LULUCF GHG mitigation are not incorporated into the model and so would be additional to the industrial values reported here. These also do not include the costs associated with energy exports. CCS costs not associated with negative emissions (e.g. clinker retrofits) are allocated to industry.
3. Includes fugitive emissions, emissions from the land sector, and negative emissions from carbon sequestration.
4. Totals may not align with sum of individual values due to rounding.

- **Average** residential, commercial and transport costs per person experience more modest changes.
- **Average** industrial energy costs rise more significantly than the other sectors, in significant part due to its required carbon management.
- The importance of the industrial abatement task for net zero, combined with their significantly higher energy costs, suggests material risks for this sector.
- Car costs per person remain relatively flat, while heavy-duty and international transport experience larger cost rises.
- Allocating reasonable car costs to residential consumers largely cancels residential cost impacts.

Achieving net zero is capital intensive, with significant investment required in renewables and networks.

Cumulative capital investment, by type (2025 AUD) for each scenario. Note the difference in x-axis, with 2050 highlighted in NZEXT for Scenario comparison.



Note: estimates include a 6% markup to account for pre-FID costs.

- **~$1.6 trillion capital investment** must be unlocked to achieve net zero by 2050. Note this is not a direct cost to consumers.
- The primary difference between Scenarios is additional investment in generation and conversion technologies to achieve net zero.
- Higher capital investment in NZEXT is primarily due to annual distribution upgrades, alongside replacement of retired fleet.

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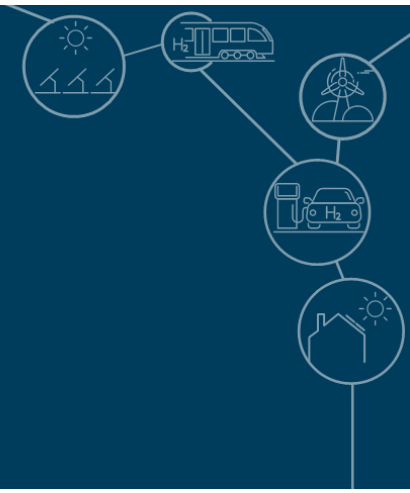
4 Implications of results



Summary of modelling results

Energy production, storage, and build	• Renewables dominate, with 5-10%+ annual growth for many technologies in the net zero Scenarios. • Solar and battery storage are prioritised. • Firming will mainly be provided by batteries and gas, with investment primarily in batteries. • Many different energy systems achieve essentially the same emissions and total transition costs. • Net Zero Scenarios need ~2+ times existing electricity transmission, and new CO_2 and H_2 pipelines.
Energy use, emissions, and targets	• Emissions reduction is fastest in electricity; transport and heavy industry are slower. • The agriculture and land sector is not expected to be a source of offsets for other sectors. • CCS has an important role in all decarbonised futures. • Cth 2030 and 2035 targets are achieved in 2031+ and 2038+ respectively, depending on Scenario. • Additional action is needed to achieve 82% renewables by 2030, with 2033+ projected.
Maps	• New build electricity, hydrogen, CO_2 and water transmission connects major centres.
Costs and investment	• Decarbonisation tasks and costs vary widely across end-use sectors, with industry most impacted. • Achieving net zero is capital intensive across supply-side and demand-side sectors.

Implications of results

Energy production, storage, and build

Energy use, emissions, and targets

Maps

Costs and investment

Results

- Renewables dominate, with 5-10%+ annual growth for many technologies in the net zero Scenarios.
- Solar and battery storage are prioritised.
- Firming will mainly be provided by batteries and gas, with investment primarily in batteries.
- Many different energy systems achieve essentially the same GHGs and total transition costs.
- Net Zero Scenarios need ~2+ times existing electricity transmission, and new CO_2 and H_2 pipelines.

Implications

1. To reach net zero by 2050-2065, the model builds **all of** renewables, storage, electrification, natural gas generation and CCS **at 5-10%+ annual growth rates.** If any of these cannot be built at these rates, the **other, unprecedented builds must do more**.
2. The large **optionality** in different fleets with essentially the same emissions and total transition costs suggests:
   - net zero isn't technologically pre-determined; and
   - system planning might accommodate **reasonable social and environmental objectives**, e.g. offshore wind and pumped hydro might displace onshore wind and solar and reduce land use.
3. Numerous factors (e.g. social, economic, political, geopolitical, and supply chains) will **constrain this optionality** in the real world.

Implications of results

Energy production, storage, and build

Energy use, emissions, and targets

Maps

Costs and investment

Results

- Emissions reduction is fastest in electricity; transport and heavy industry are slower.
- The agriculture and land sector is not expected to be a source of offsets for other sectors.
- CCS has an important role in all decarbonised futures.
- Commonwealth 2030 and 2035 targets are achieved in 2031+ and 2038+ respectively, depending on Scenario.
- Additional action is needed to achieve 82% renewables by 2030, with 2033+ projected.

Implications

1. A straight-line from today to net zero in 2050 is **~50% abatement** in 2035 cf. 2005 levels. This is less ambitious than the Commonwealth's 2035 target range but still requires **annual investment** and **technology deployment** at **unprecedented rates**.
2. The many existing decarbonisation and energy policies should be rationalised and reprioritised. Those that remain should **have a scale consistent with the net zero task,** with **mechanisms** to drive adoption.
3. CCS and land sector abatement **both** have major roles in net zero futures and **so should both be prioritised.**
4. The net zero Scenarios' ~2-3°C warming suggest that **adaptation should be a priority** alongside mitigation. These significant costs of mitigation and adaptation are separate to those from climate damages.

Implications of results

Energy production, storage, and build

Energy use, emissions, and targets

Maps

Costs and investment

Results

- New build electricity, hydrogen, CO_2 and water transmission connects major centres.
- Decarbonisation tasks and costs vary widely across end-use sectors, with industry most impacted.
- Achieving net zero is capital intensive across supply-side and demand-side sectors.

Implications

1. The residential and commercial sectors are each ~5% of the decarbonisation task, suggesting we should **plan a more gradual transition for these sectors** while we target greater decarbonisation elsewhere.
2. The immense scale of the transport sector, and differences in **decarbonisation costs by vehicle class and end-user,** both suggest carefully tailored policy responses by vehicle class are required.
3. Given the current industrial environment, the added costs of decarbonisation risk further closures. Decarbonisation policy should therefore consider **significant and tailored industrial support**.
4. Transitioning from primarily fossil fuel use to more electrified and more capital intense systems presents **significant and different financing challenges** across all end-use sectors.

Thank you

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