



Multi-sector energy modelling

Outcomes of CSIRO and ClimateWorks Australia modelling

CSIRO | Luke Reedman, Thomas Brinsmead, Lisa Havas

CWA | Mei Shien Chew, Jay Gordon, Wei Sue

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Approach to modelling decarbonisation of Australia's economy



AEMO commissioned CSIRO and ClimateWorks Australia to perform multi-sectoral modelling, considering the energy use in all sectors of Australia's economy.

Insights were produced regarding the potential transformative effect that electrification may have on the NEM to meet economy-wide emissions-reduction targets.



What was modelled...

Net Zero 2050: represents the current transition of the energy industry under current policy settings and technology trajectories, where the transition from fossil fuels to renewable generation is generally led by market forces. Following 2030, additional effort is taken through technology adoption to achieve net zero emissions by 2050.

Step Change: higher decarbonisation ambitions are supported by rapidly falling costs for battery storage and variable renewable energy (VRE), which drive consumers' actions and higher levels of electrification of other sectors consistent with limiting the global temperature rise to 2°C by 2100 over pre-industrial levels. These ambitions are supplemented by strong economic and population growth.

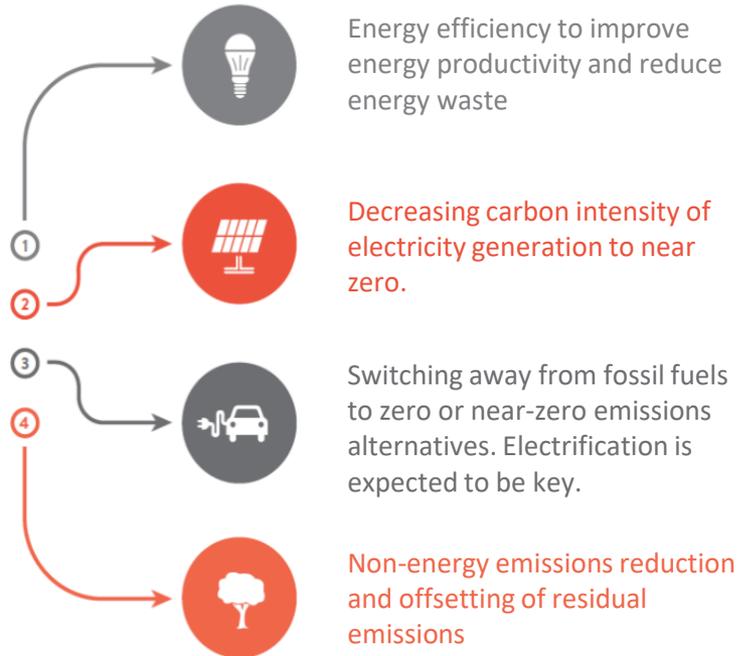
Strong Electrification: features the highest level of international decarbonisation ambition, consistent with a target of limiting the global temperature rise to 1.5°C by 2100 over pre-industrial levels. This is achieved through strong energy efficiency and electrification in all sectors.

Hydrogen Superpower: represents a world with very high levels of electrification and hydrogen production for export, fuelled by strong decarbonisation targets and low-cost abundant renewable energy fuelling strong economic growth.



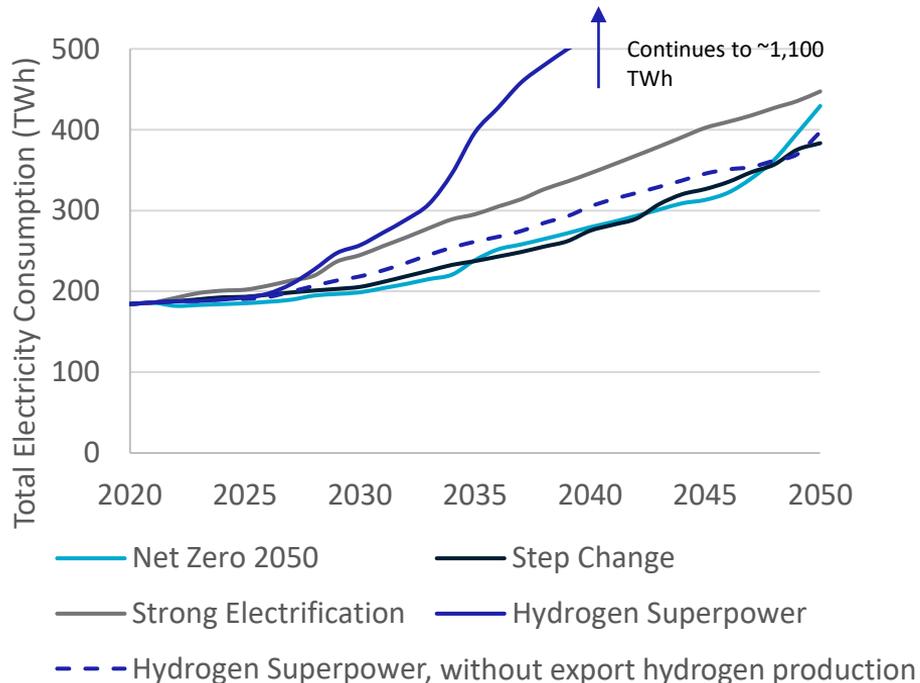
Key outcomes and insights

- Four key levers exist – aligning to the **four pillars of decarbonisation**
- Cost reductions and a strong RD&D focus are required to support technological advancements. **This aligns to the Federal Government’s approach.**
- **Consumers are key to early reductions** in emissions and energy intensity
- Changes in **industry** and **transport** are driving the **biggest impacts from electrification**
- Under all faster-decarbonisation scenarios, the **NEM doubles by 2050**
- **Hydrogen production and green steel** could counter declining emissions-intensive industries, but **will require a significantly larger NEM** (or off-grid production).





Electricity consumption expected to rise in a decarbonised economy resulting in a larger NEM...



Scenario relativities in 2040

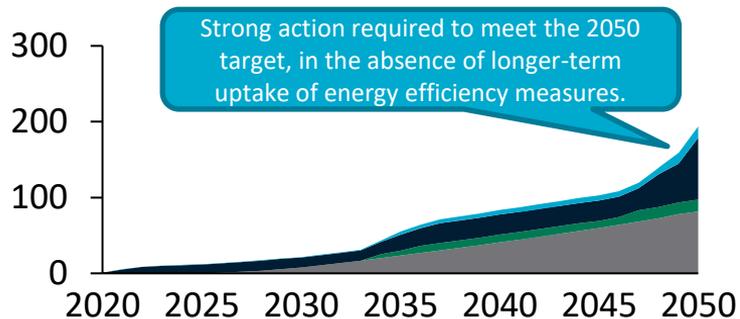
	Electricity consumption (relative to current NEM)	Natural gas consumption (relative to current use)
Net Zero 2050	152%	94%
Step Change	144%	65%
Hydrogen Superpower	165% (excl. H ₂ export)	36%
	282% (incl. H ₂ export)	
Strong Electrification	188%	33%



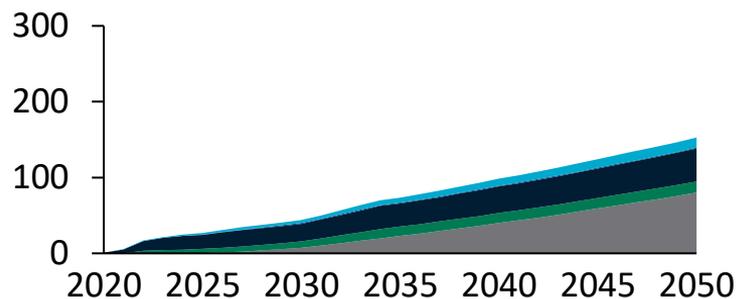
Driven by electrification in all sectors, especially transport and industry...

Electrification

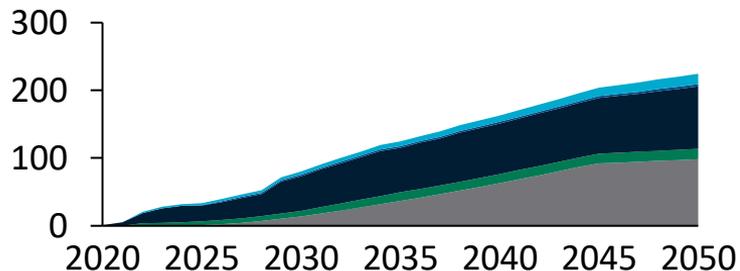
Net Zero 2050 (TWh)



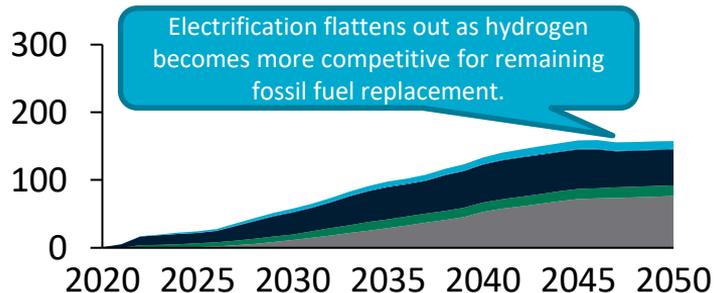
Step Change (TWh)



Strong Electrification (TWh)



Hydrogen Superpower (TWh)



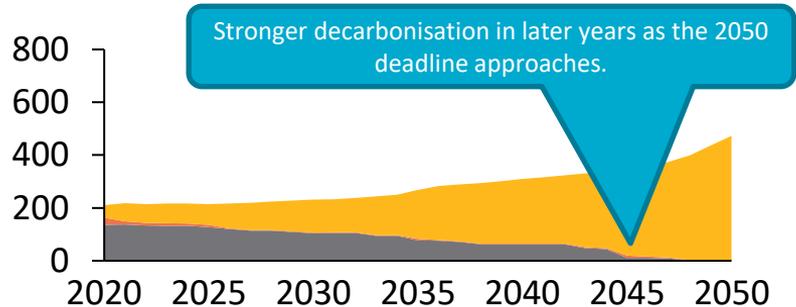
- Residential buildings
- Commercial buildings
- Industry
- Agriculture
- Transport



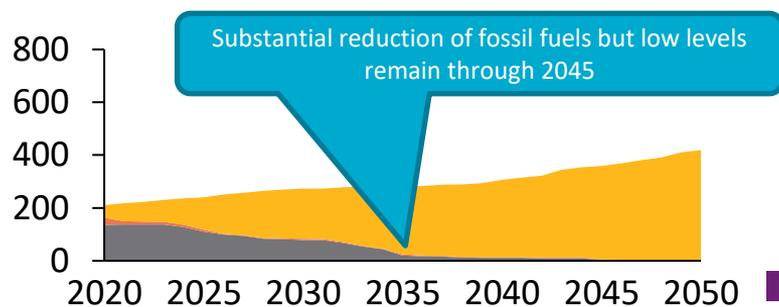
Growth in the NEM and electrification is supported by a system with high variable renewable energy (VRE)...

Fuel share of electricity generation

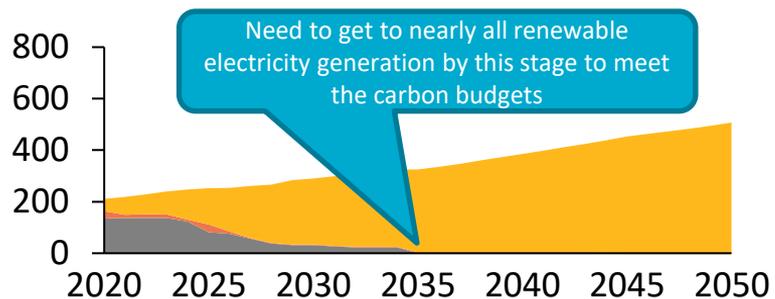
Net Zero 2050 (TWh)



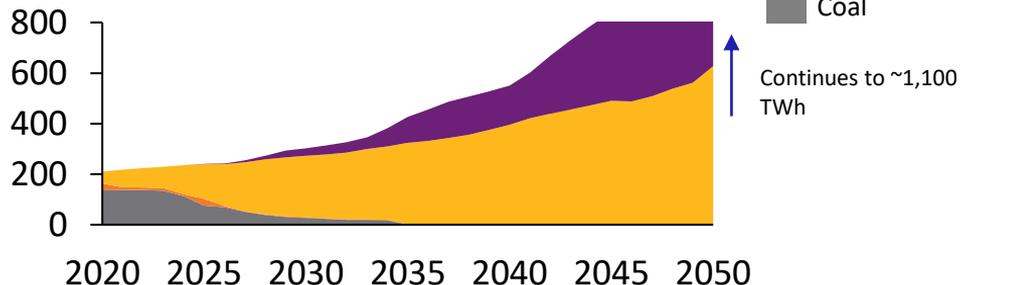
Step Change (TWh)



Strong Electrification (TWh)



Hydrogen Superpower (TWh)



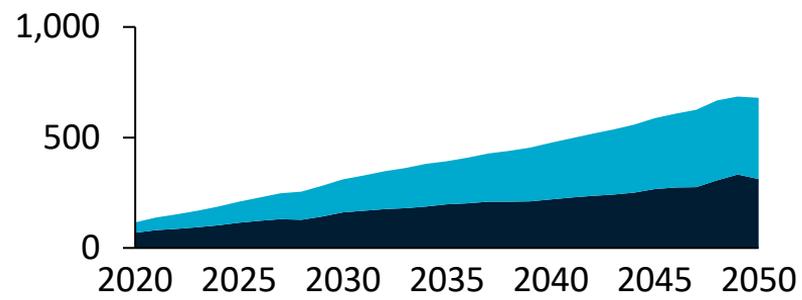
- Hydrogen Export
- Renewables
- Gas
- Coal



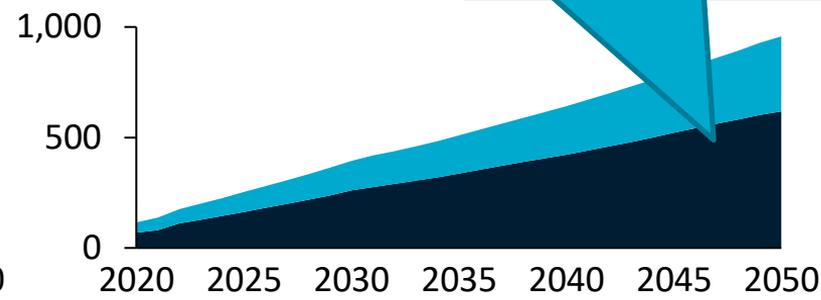
Growth in electricity demand despite strong energy efficiency improvements...

Energy efficiency improvements

Net Zero 2050 (PJ)

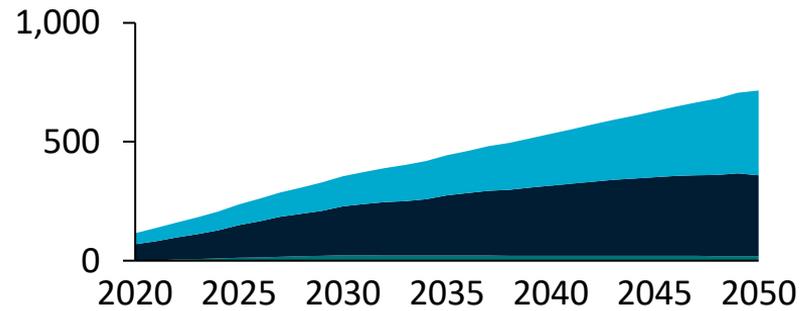


Step Change (PJ)

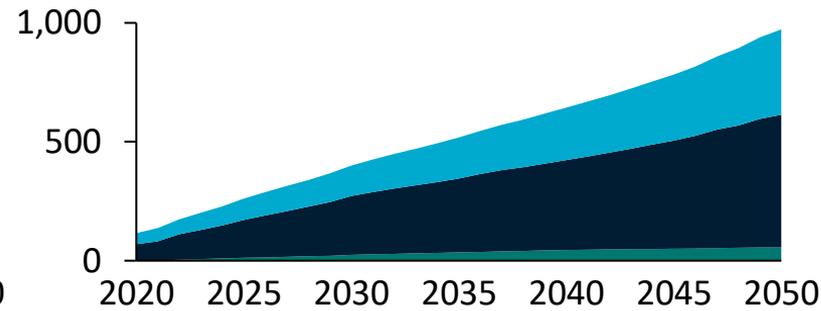


Step Change has the strongest energy efficiency assumptions

Strong Electrification (PJ)



Hydrogen Superpower (PJ)



- Autonomous
- Endogenous
- Exogenous

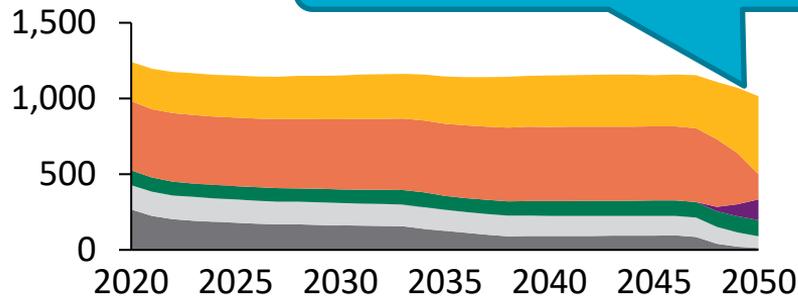


Industry can continue to grow in a decarbonised economy through low emission fuels...

Industry fuel use

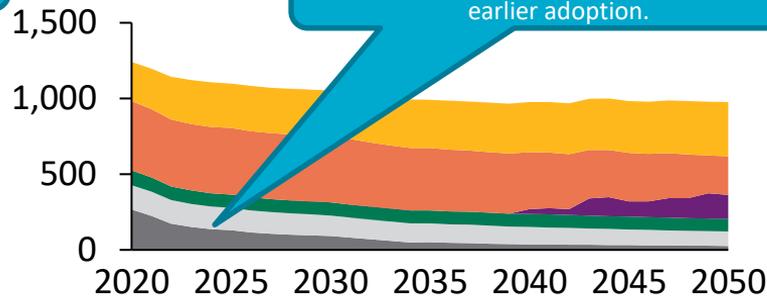
Net Zero 2050 (PJ)

Fuel switching accelerates given the more stringent emission reduction target.



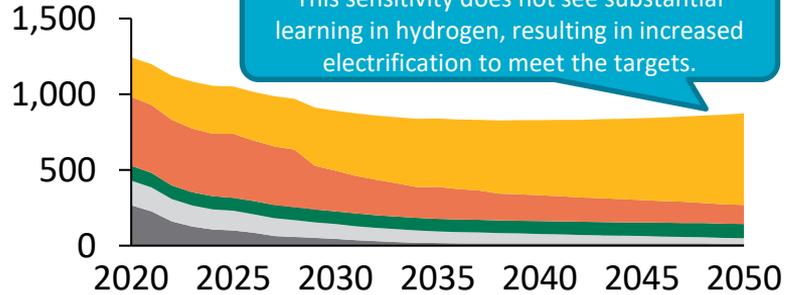
Step Change (PJ)

Fuel switching away from oil is one of the most cost-effective options, resulting in earlier adoption.



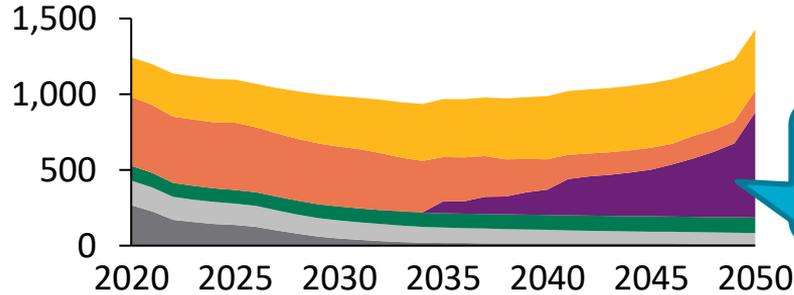
Strong Electrification (PJ)

This sensitivity does not see substantial learning in hydrogen, resulting in increased electrification to meet the targets.



Hydrogen Superpower (PJ)

Includes substantial growth of a new green steel industry.



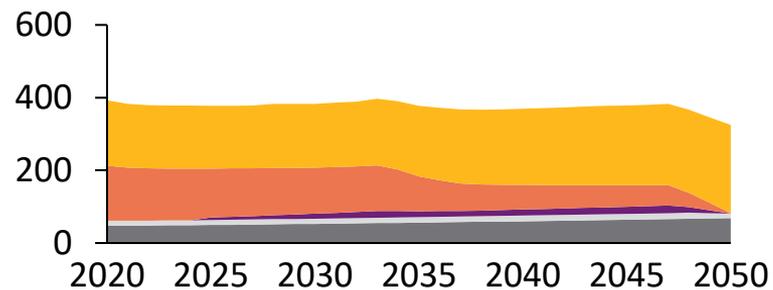
- Electricity
- Natural gas
- Hydrogen
- Bioenergy
- Coal
- Oil



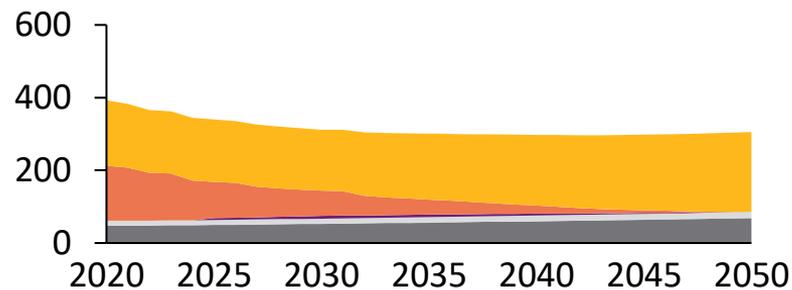
Fuel switching from natural gas to electricity expected in residential buildings...

Residential fuel use

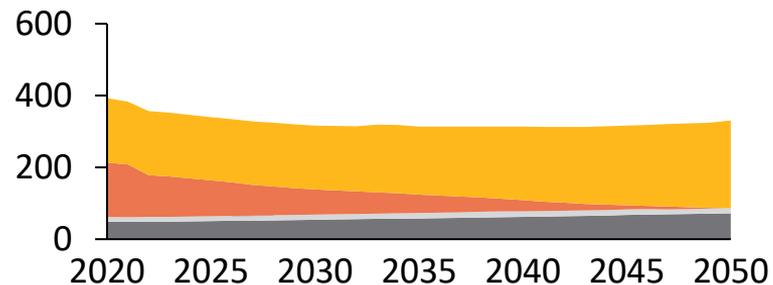
Net Zero 2050 (PJ)



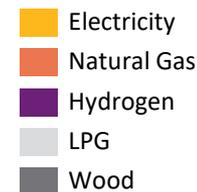
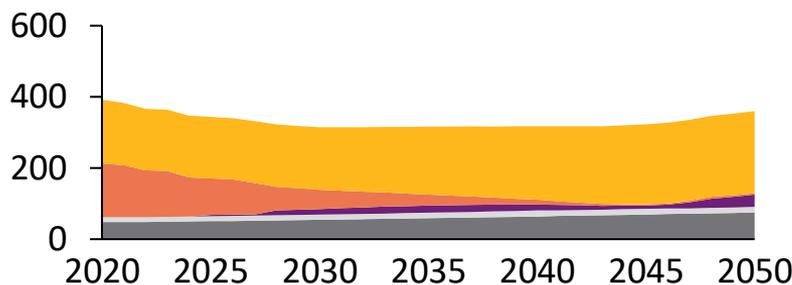
Step Change (PJ)



Strong Electrification (PJ)



Hydrogen Superpower (PJ)

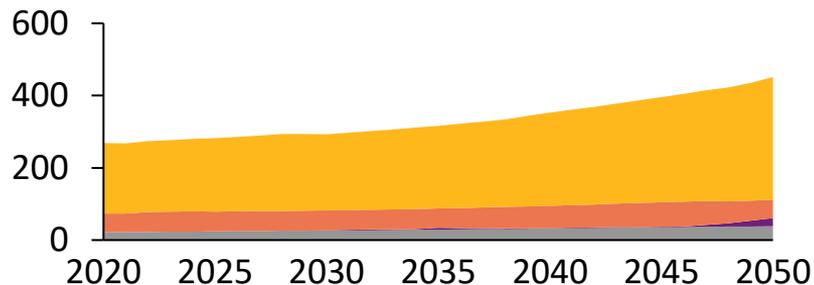




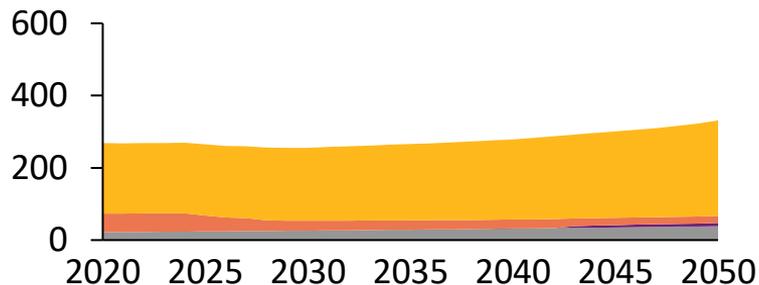
Electricity use remains dominant in commercial buildings...

Commercial fuel use

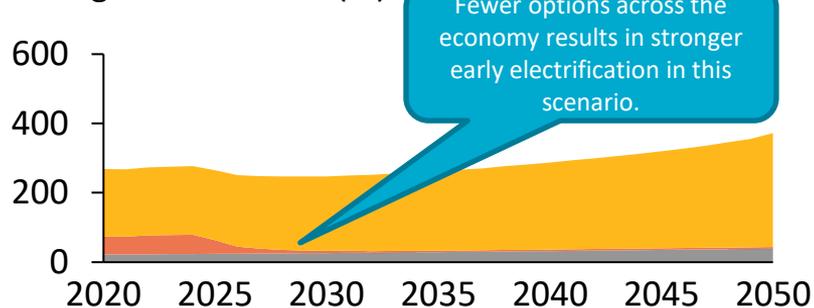
Net Zero 2050 (PJ)



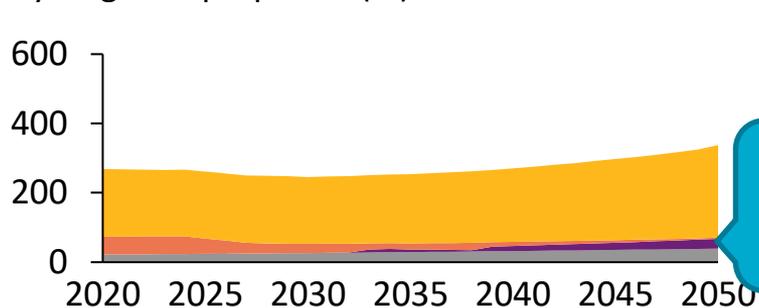
Step Change (PJ)



Strong Electrification (PJ)



Hydrogen Superpower (PJ)



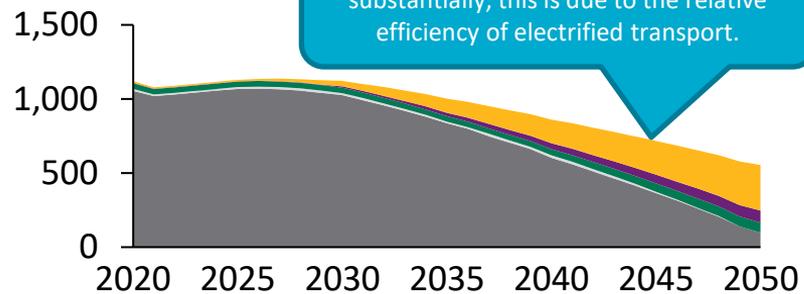
- Electricity
- Natural gas
- Hydrogen
- Oil



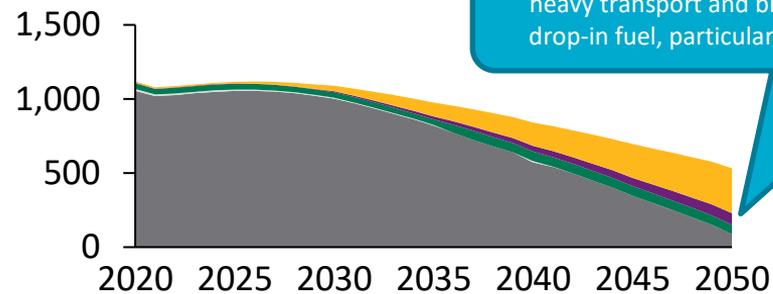
Electrification of road transport is a significant part of decarbonisation...

Transport fuel use

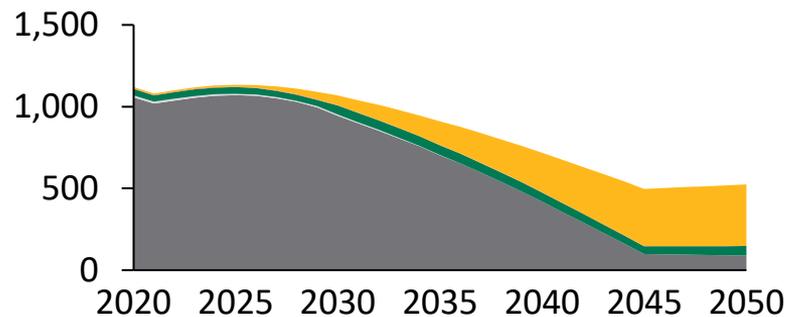
Net Zero 2050 (PJ)



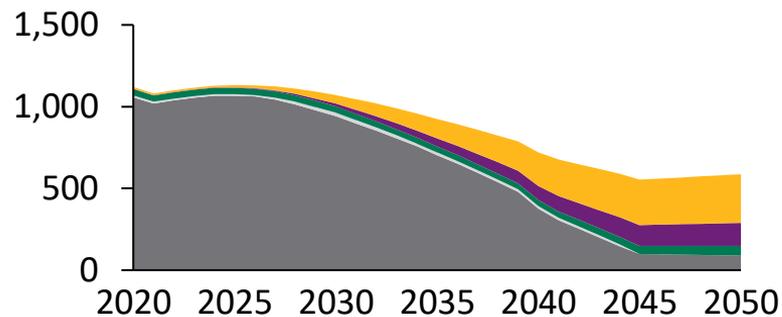
Step Change (PJ)



Strong Electrification (PJ)



Hydrogen Superpower (PJ)

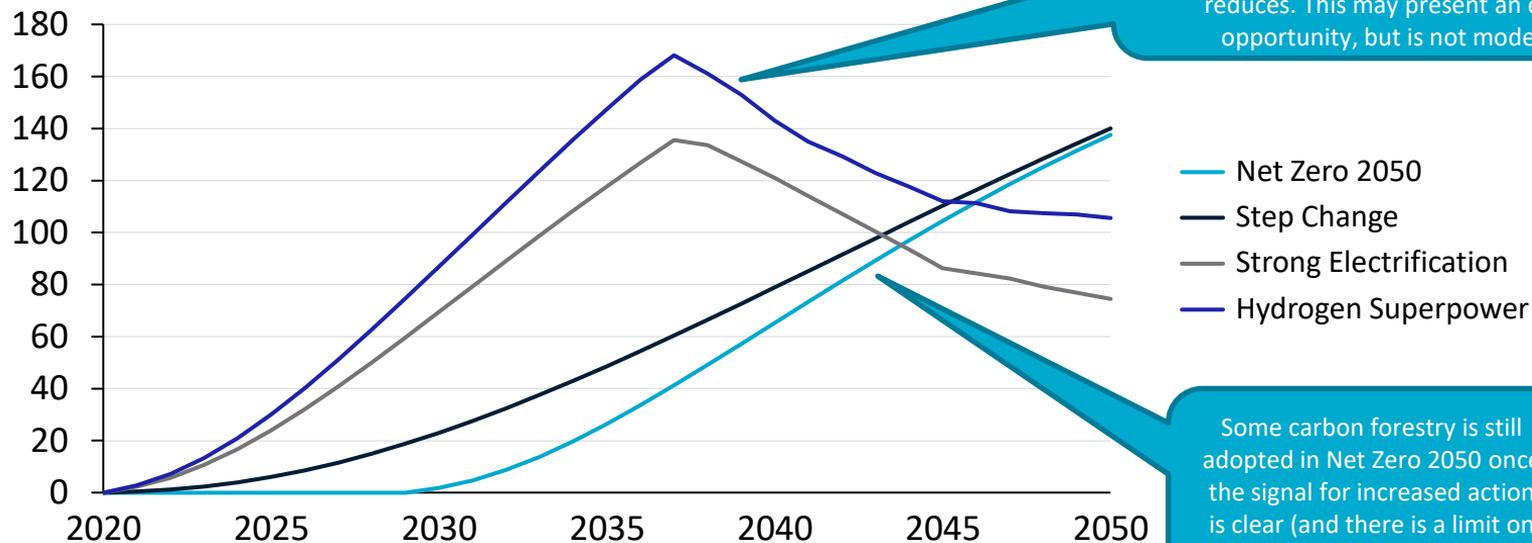


- Electricity
- Natural gas
- Hydrogen
- Biofuel
- LPG
- Oil



Carbon sequestration through forestry is needed to meet decarbonisation targets...

Emissions sequestered through carbon forestry (Mt CO₂-e)



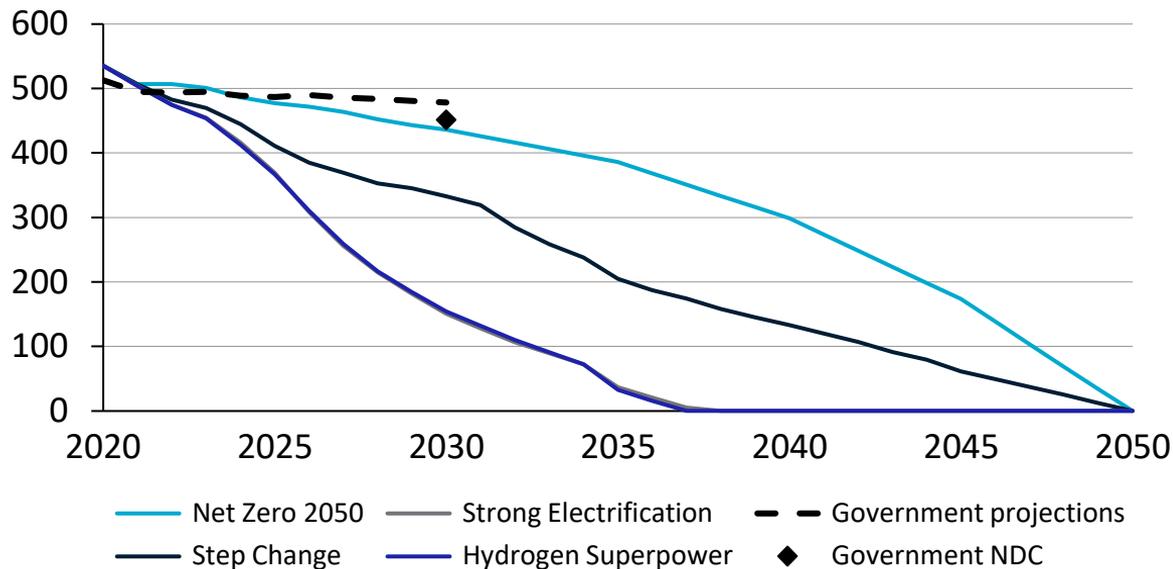
In these fastest decarbonisation scenarios, net zero is reached in the late 2030s and as the economy continues to adopt the lower cost forms of energy, the need for carbon forestry reduces. This may present an export opportunity, but is not modelled.

Some carbon forestry is still adopted in Net Zero 2050 once the signal for increased action is clear (and there is a limit on annual uptake).



Australia can meet net zero emissions on or before 2050...

National emissions (Mt CO₂-e)



Scenario	Carbon budget (2021-2050) (Mt CO ₂ -e)	Actual cumulative emissions (until net zero reached) (Mt CO ₂ -e)
Net Zero 2050	NA	9,650
Step Change	6,531	6,531
Strong Electrification	3,521	3,521
Hydrogen Superpower	3,521	3,521



Thank you