

Centre for Urban Research

Connecting people and ideas
for sustainable urban futures



Visit cur.org.au

Talking Transport EV and Beyond



Challenges of EVs and Transport

Jago Dodson

Road transport and climate forcing

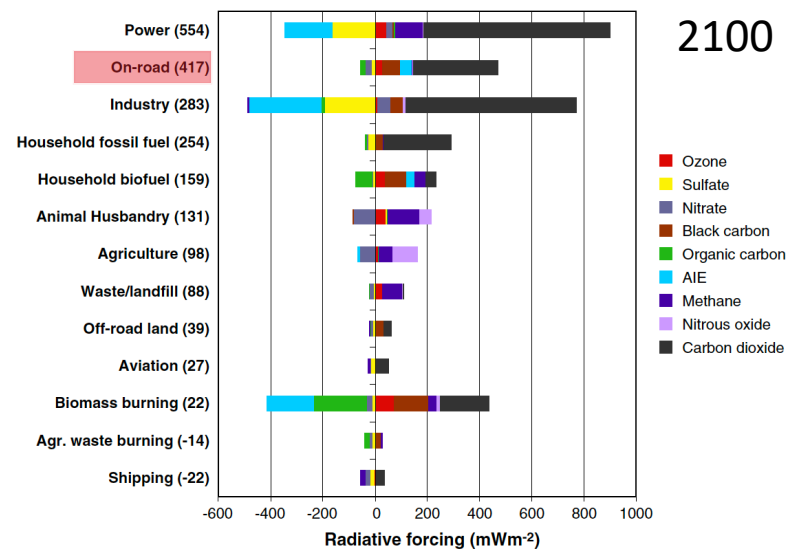
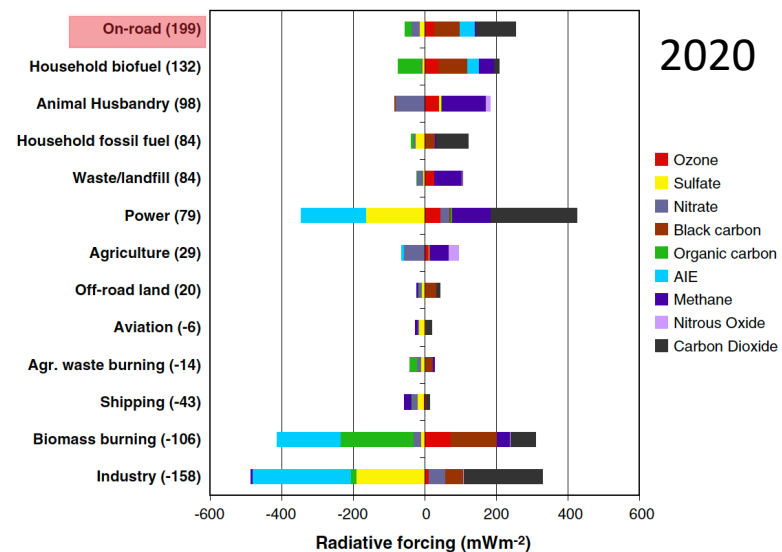
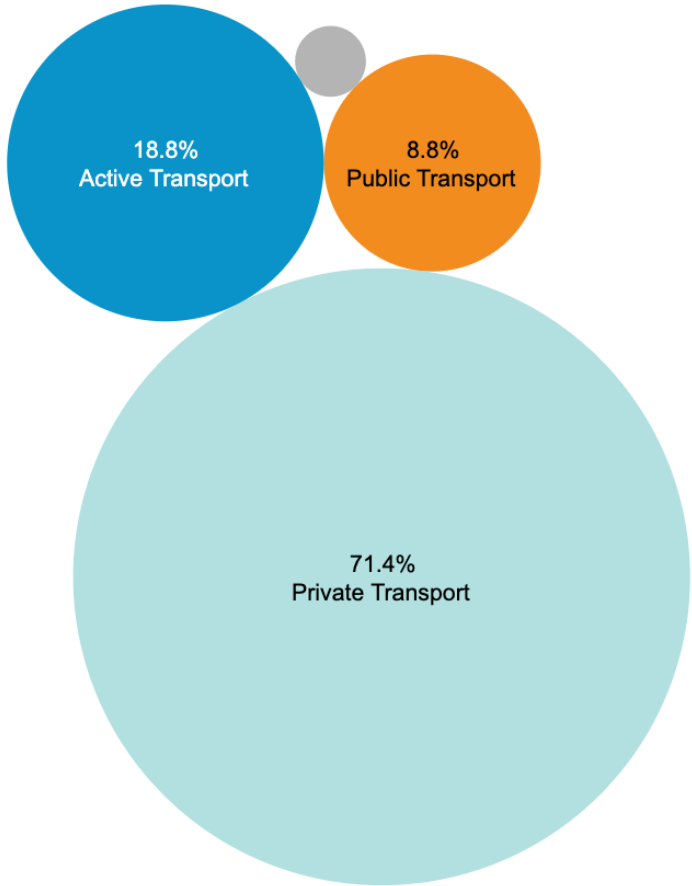


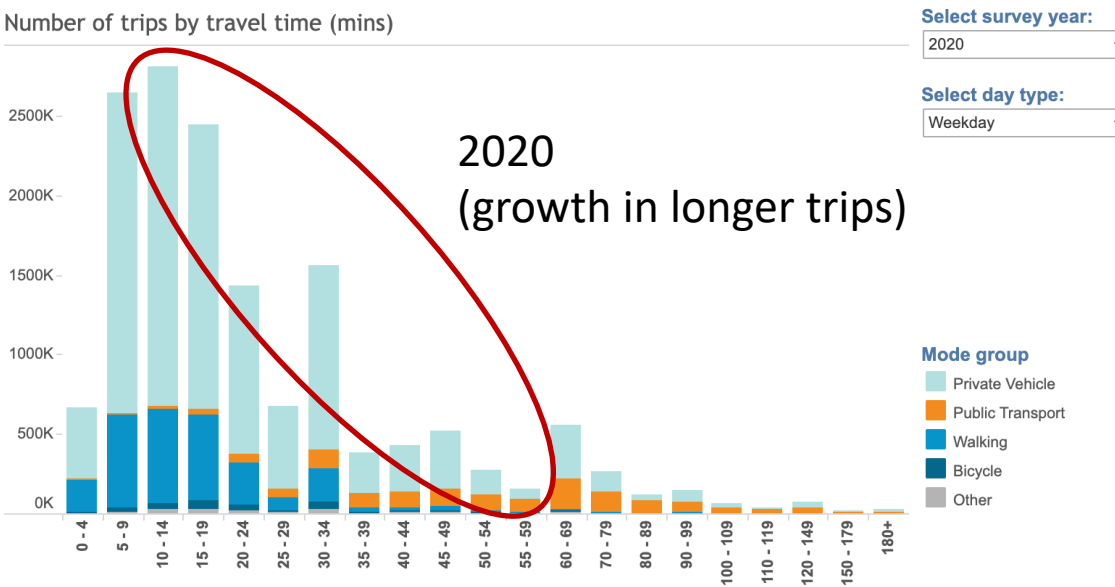
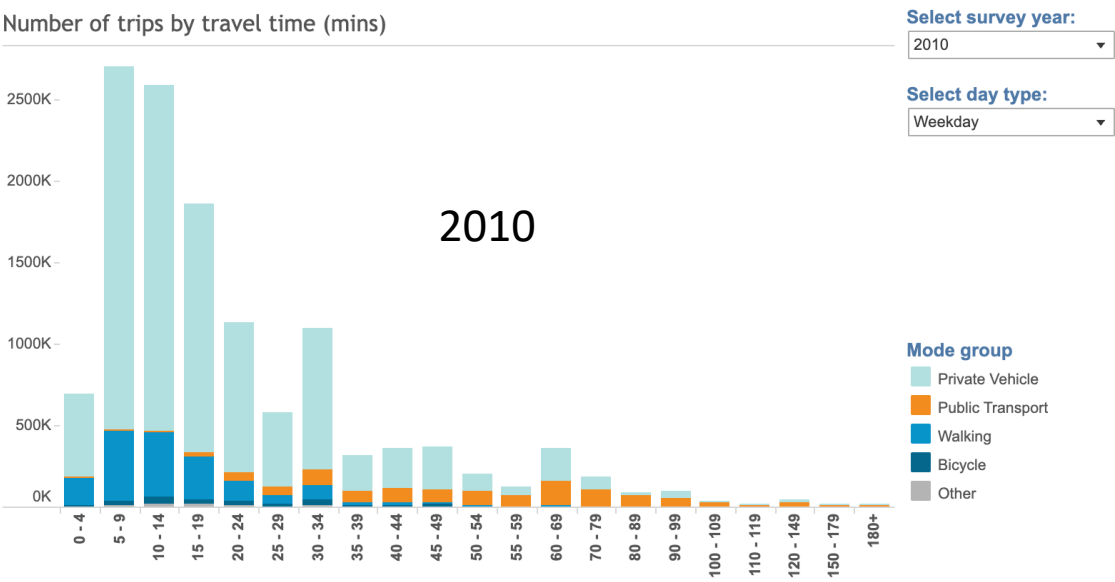
Fig. 1. Radiative forcing due to perpetual constant year 2000 emissions grouped by sector at (a) 2020 (b) 2100 showing the contribution from each species. The net sum of total radiative forcing is indicated by the title of each bar. A positive RF means that removal will result in climate cooling and vice versa.

Travel in Melbourne

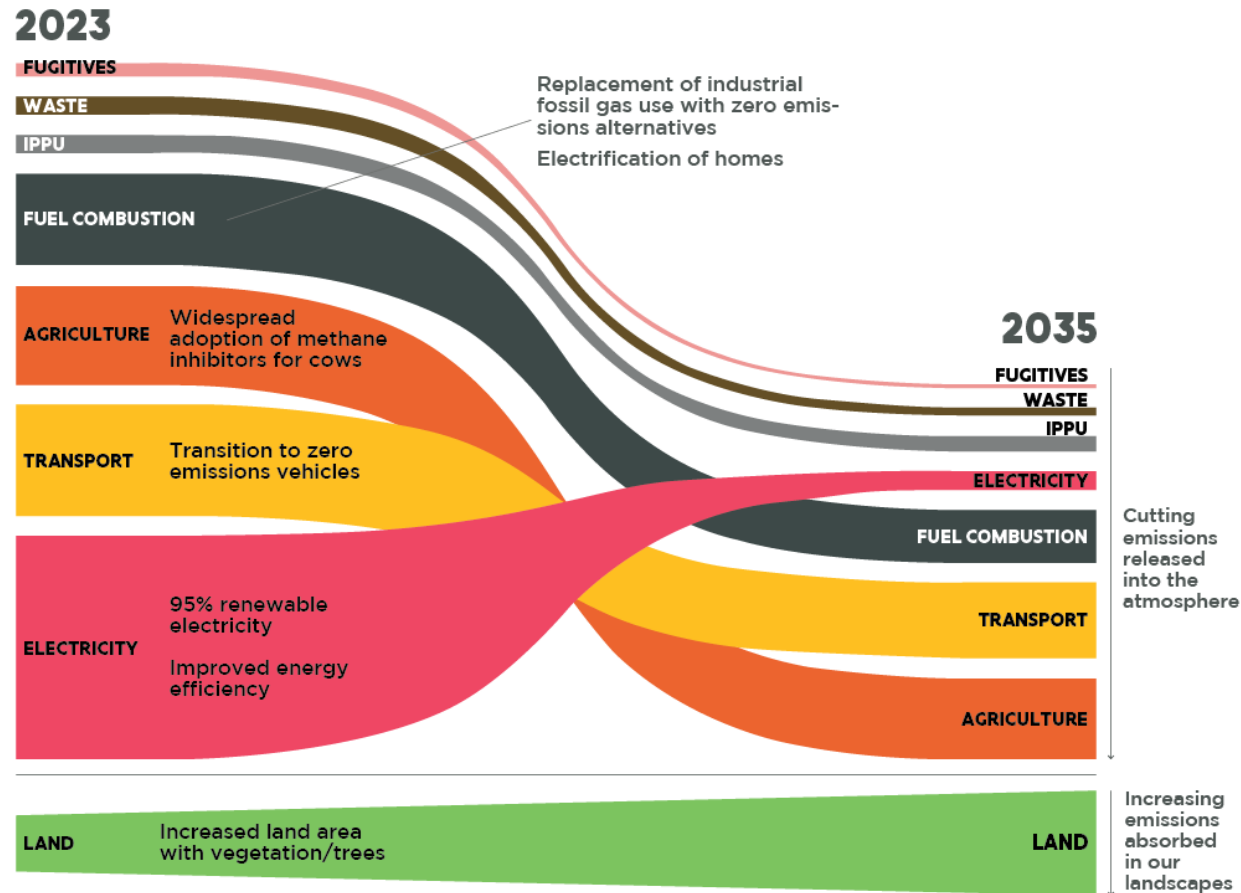
Share of trips by mode group



Trips by travel time

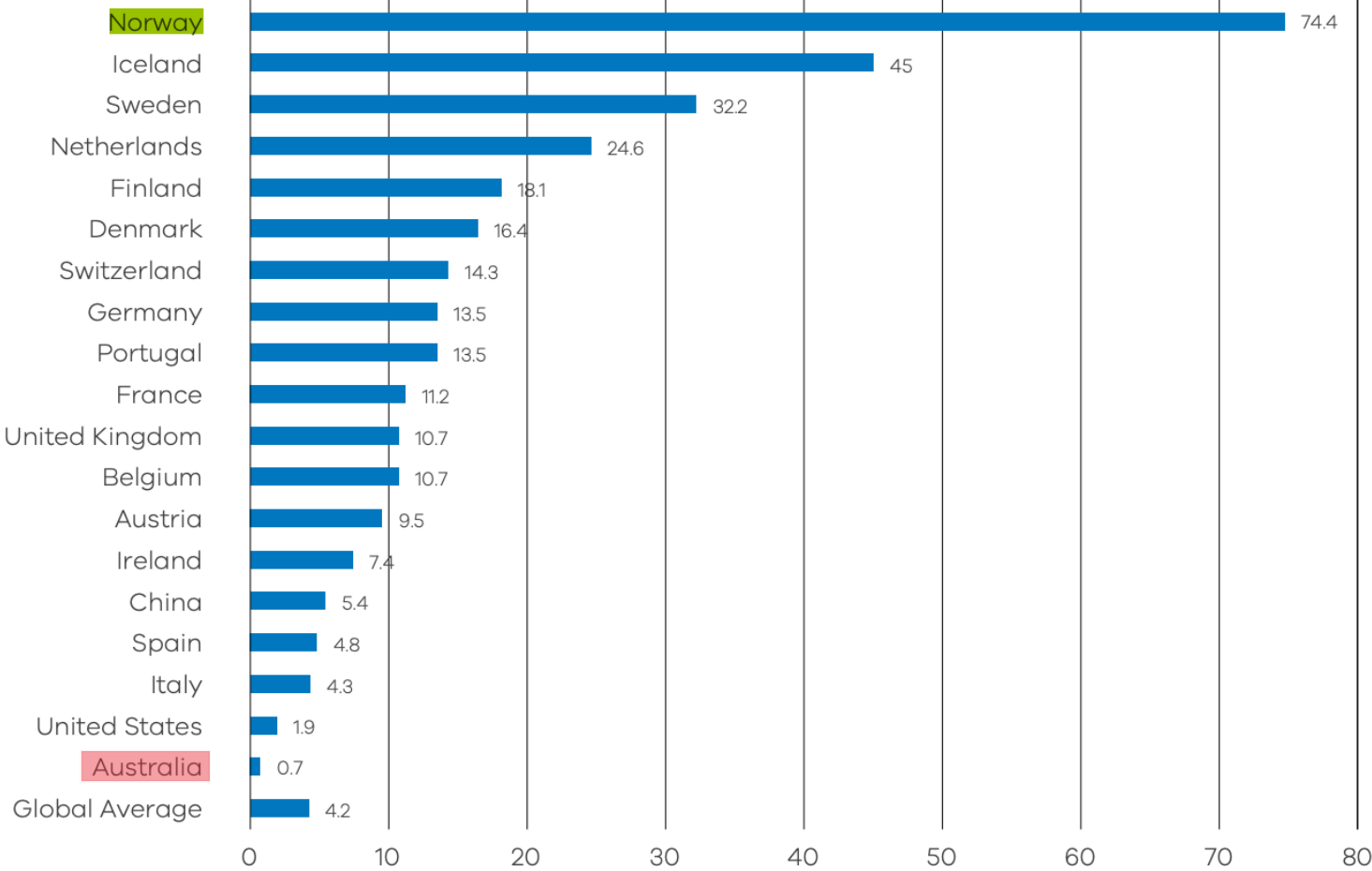


Victorian emissions targets to 2035



Australia in context

Figure 12. Plug-in electric vehicles - percentage of new sales by country, 2020



Comparator cities

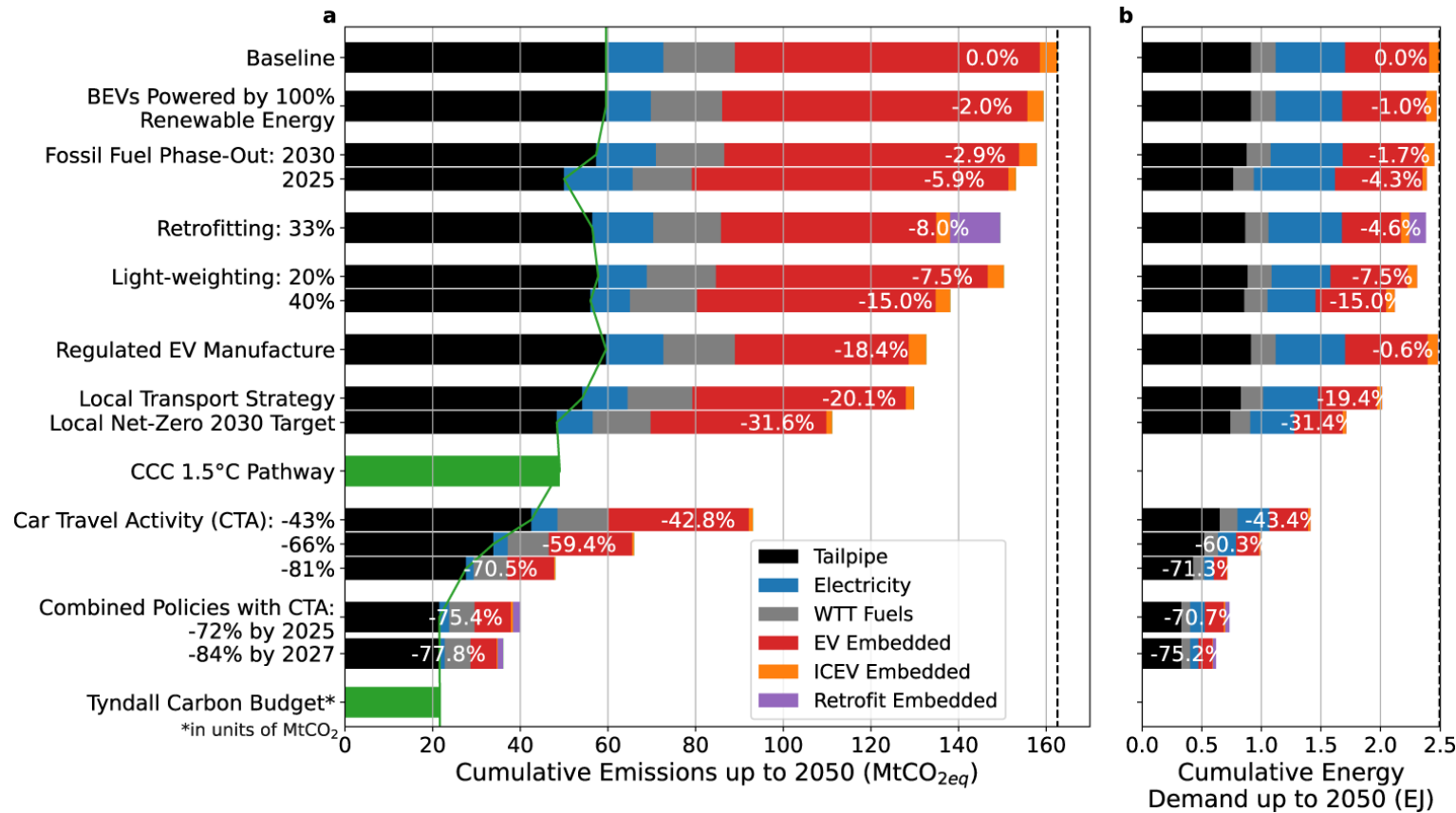
Mode share (%)	Oslo ¹	London ²	Melbourne ³
Private Car	35	38	71
Public transport	30	31	9
Walking & Cycling	35	31	19

1 Deloitte City Mobility Index

2 TFL Travel in London 2023

3 DTP VISTA data, 2020

Decarbonising London



“[P]olicies solely focusing on reducing the carbon footprint of new cars cannot be sufficient in achieving climate targets without introducing regulations that target the existing fleet.”

“Applying modal shift policies result in the most substantial emission reductions due to less car travel activity overall.”

Uptake patterns

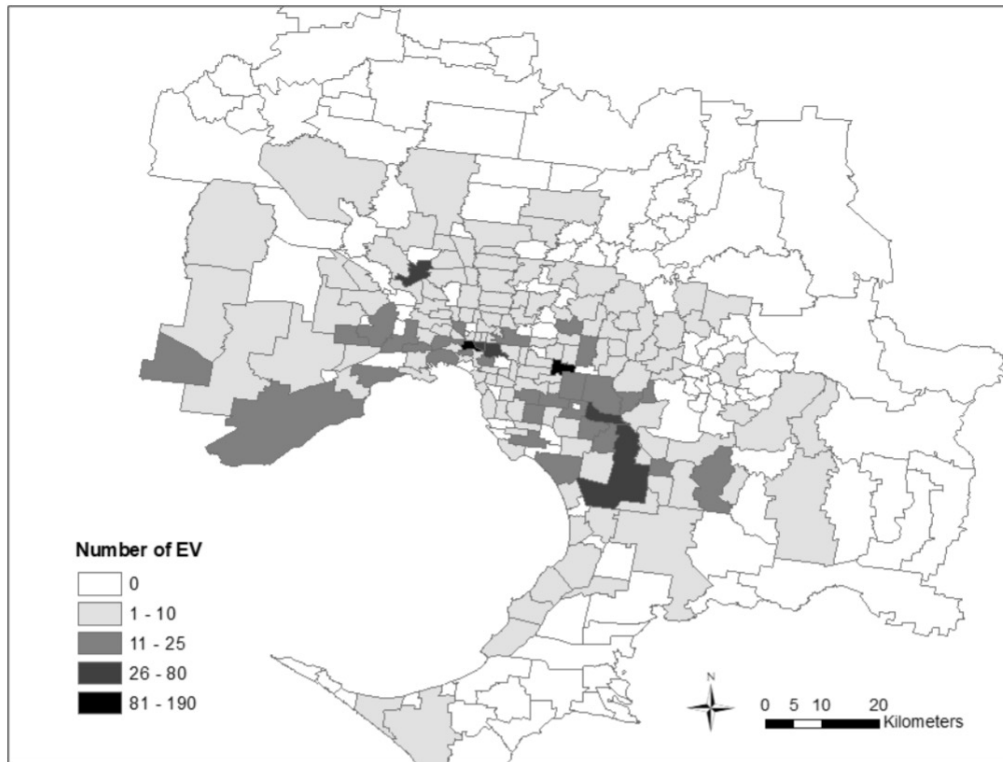


Figure 3: Spatial distribution of EVs (count) at postcode level, Melbourne, 2013 (Source: ABS)

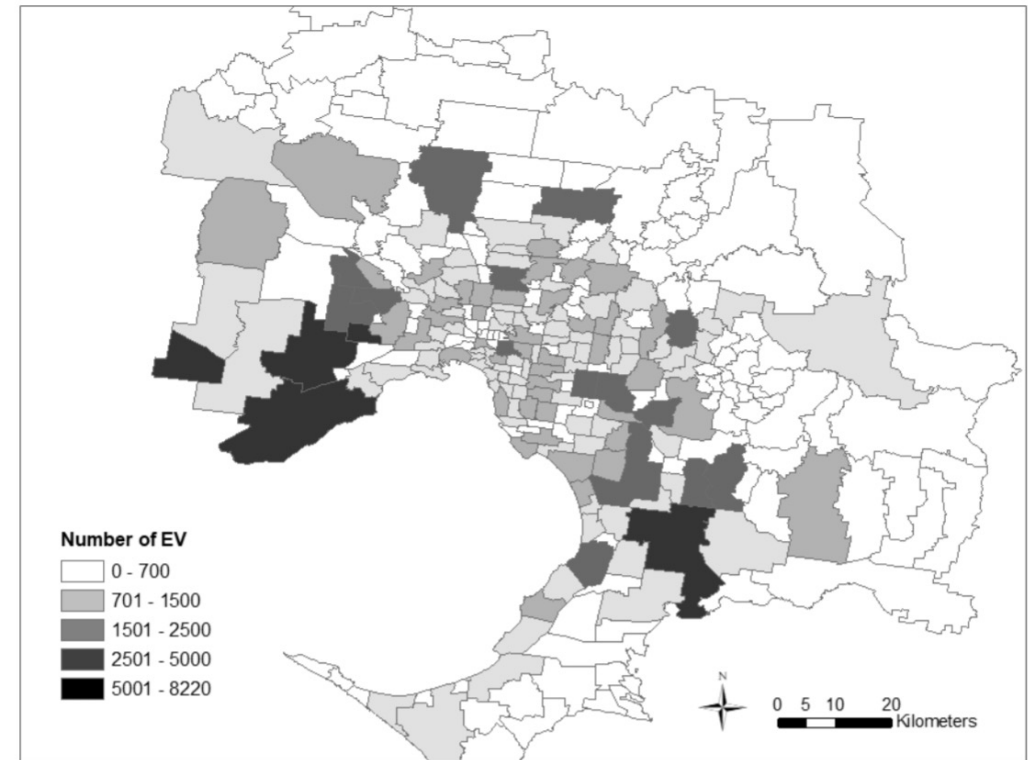


Figure 7: Projected spatial count of EVs at 10 per cent of motor vehicle fleet, postcode level, Melbourne.

Fuel savings



Figure 8: Journey to work fuel savings from 10 per cent replacement of vehicle fleet with EVs, SA2 level, Melbourne.

Future charging demand (work related)

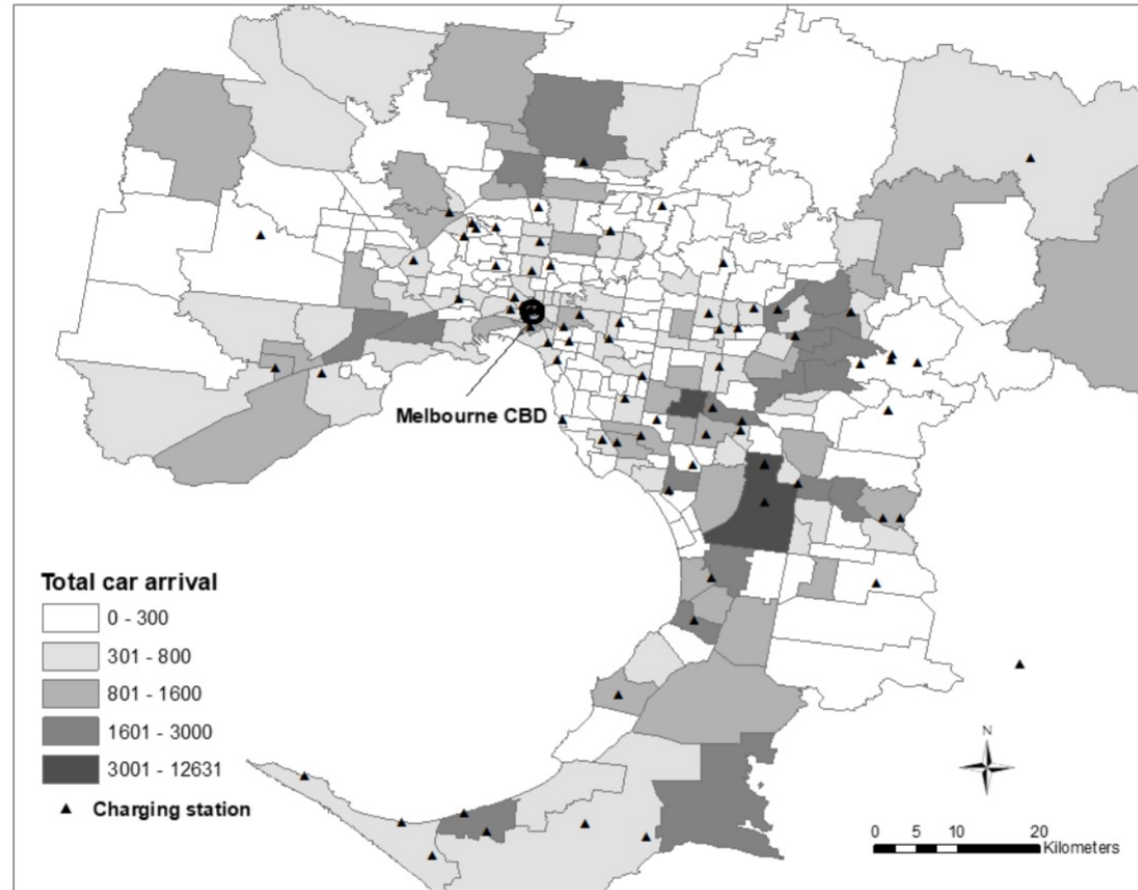
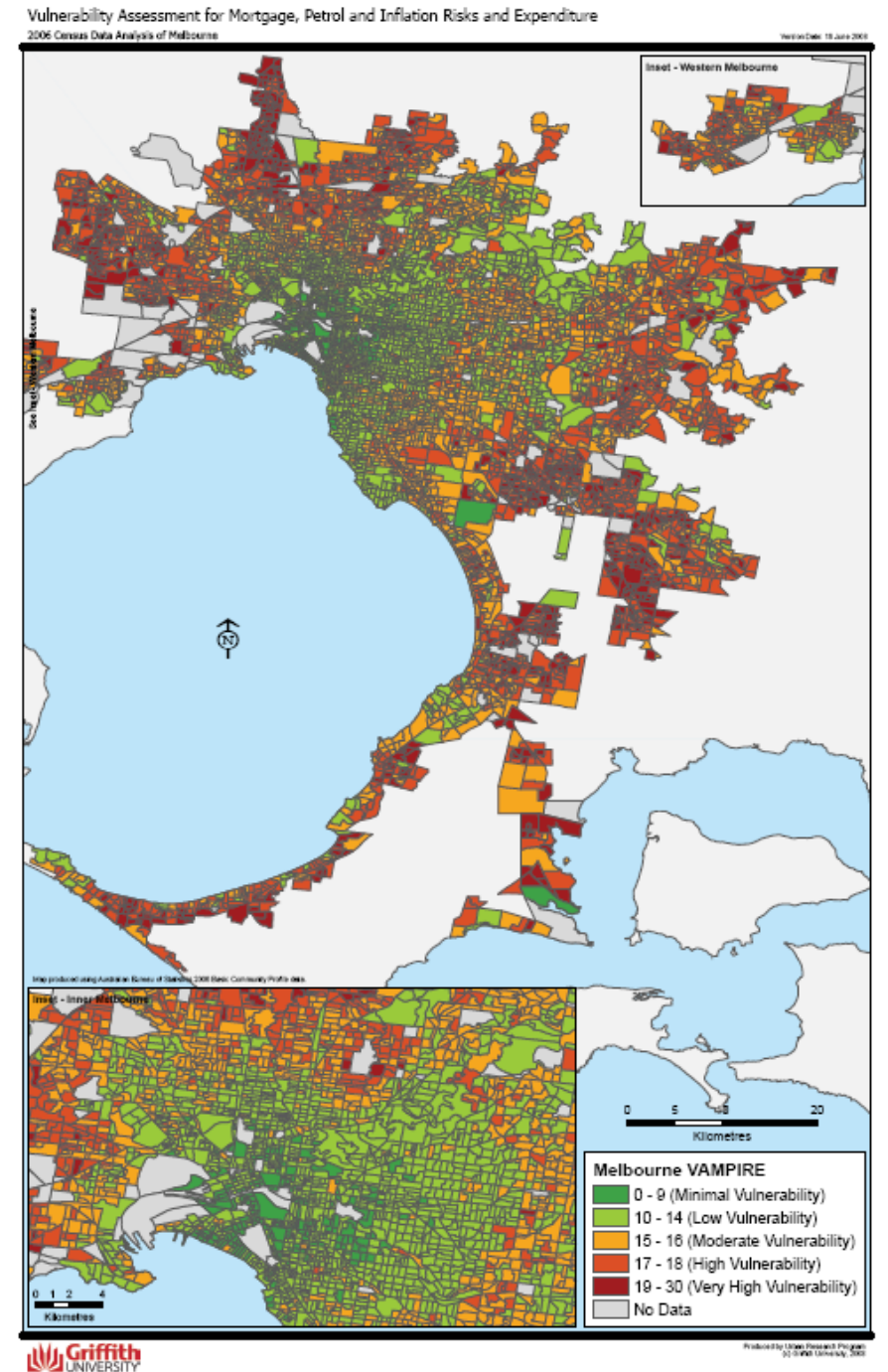


Figure 10: Total journey to work trip arrivals by locality weighted by extent of EV uptake growth in originating locality, with charging facility locations indicated, SA2 level, Melbourne, 2016.

Oil Vulnerability



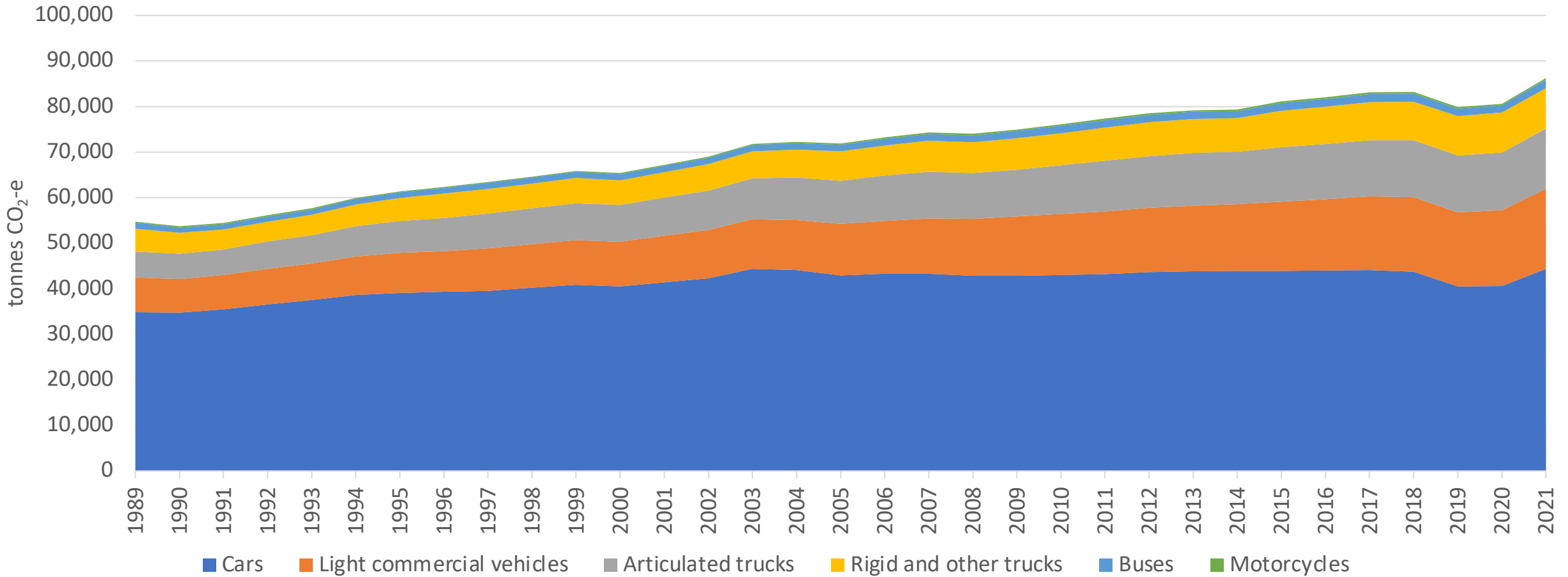
The state of EVs in Australia

Liam Davies

Institute for Sensible Transport

RMIT University Centre for Urban Research

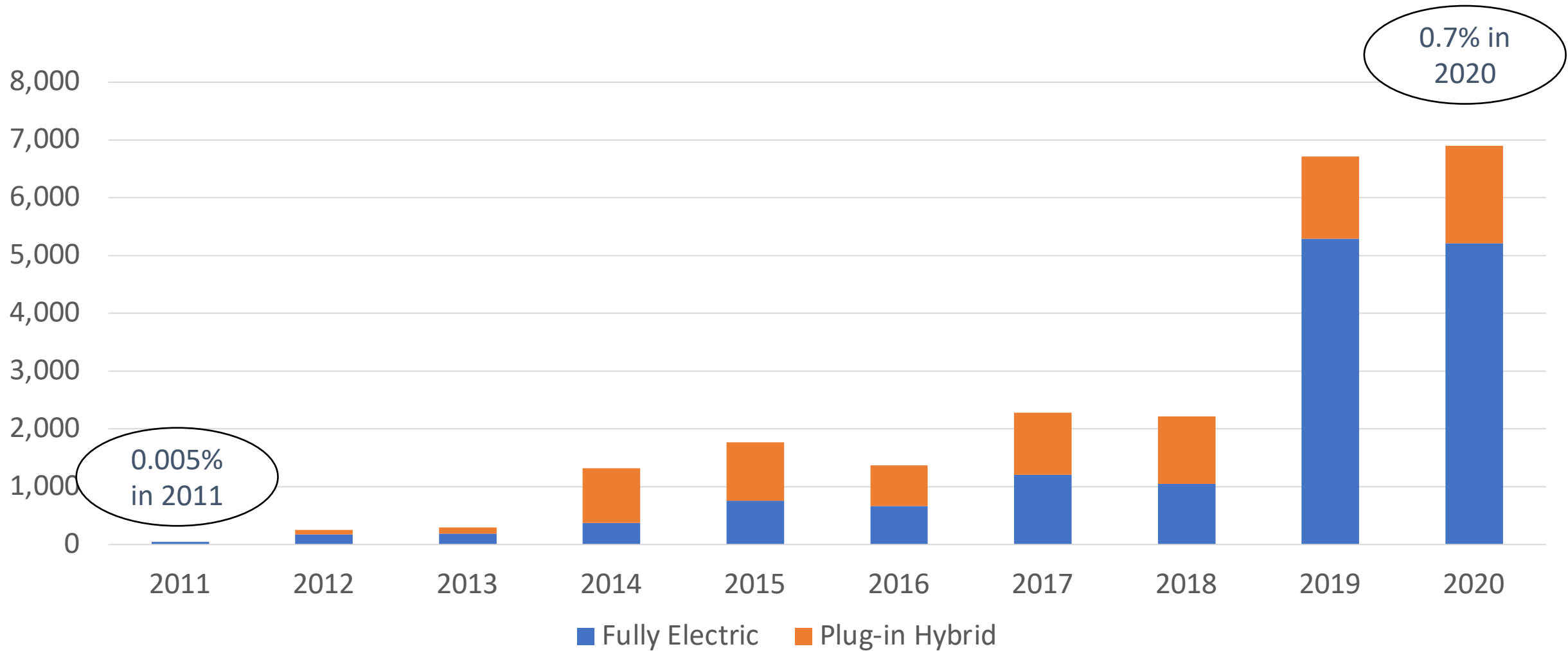
Road transport emissions in Australia



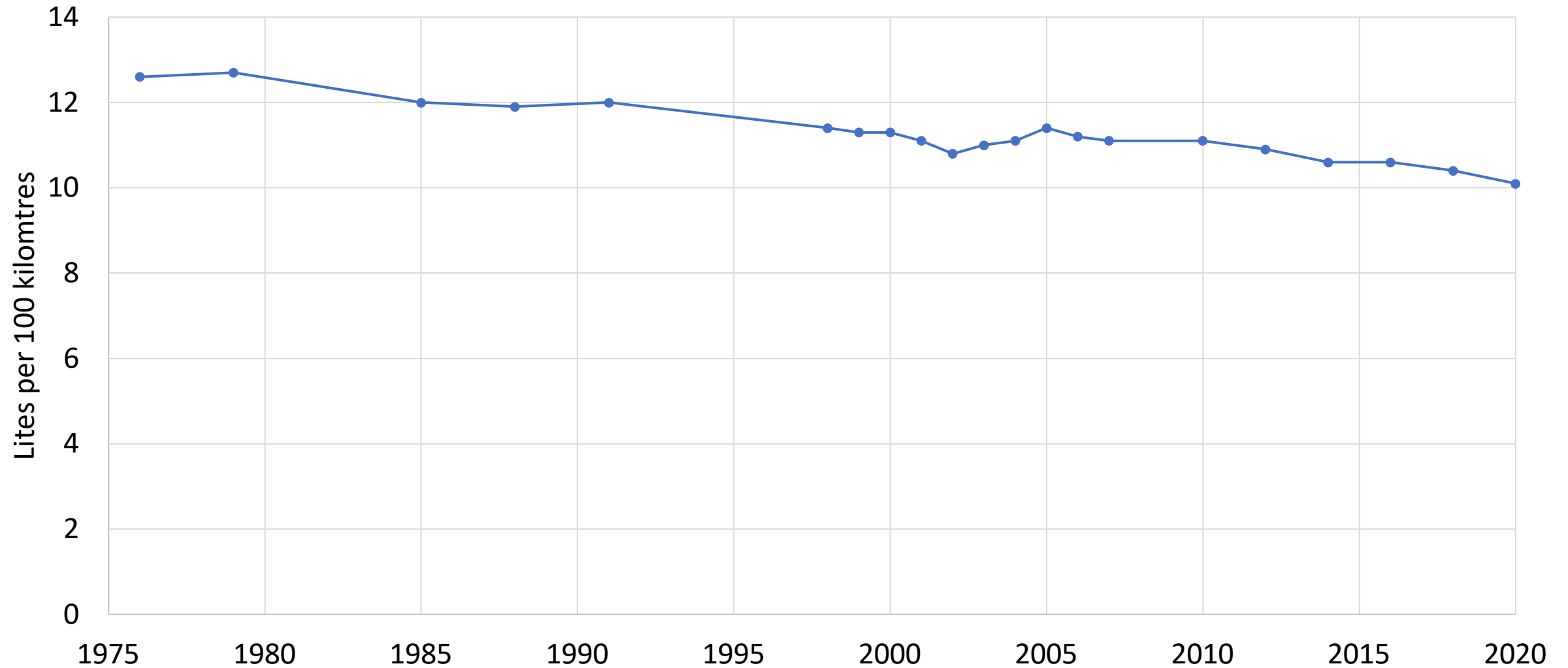
Overview of transport emissions

- 95,921 kt CO₂-e in 2005
- Over 110,000 kt CO₂-e today
- Road vehicles account for 80% to 85% of transport emissions
- COVID-19 restrictions reduced road emissions by 3% to 4%
- Emissions are already back to pre-pandemic levels

EV Vehicle Sales



Australia's average fuel consumption



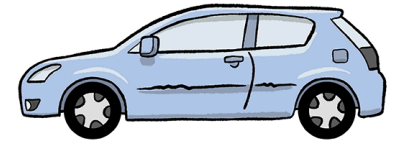
Source: ABS 2021

Australia's fleet

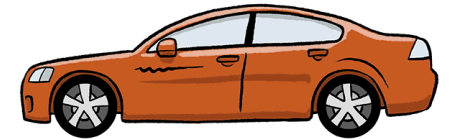
- Efficiency gains have been reinvested into more powerful engines
- Cars became more powerful
- Cars became bigger and heavier
- Consumer demand has shifted
- Fuel consumption failed to meaningfully decrease

Back in 2010, four of New Zealand's top five bestselling vehicles were cars. By 2020 they were all utes and SUVs.

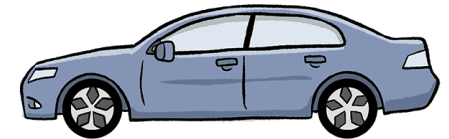
2010



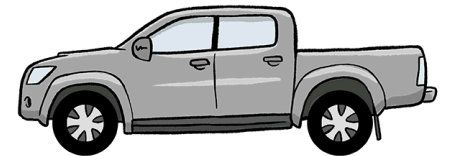
1. Toyota Corolla



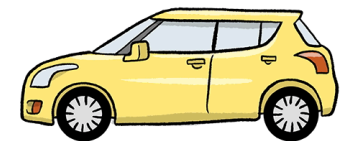
2. Holden Commodore



3. Ford Falcon



4. Toyota Hilux

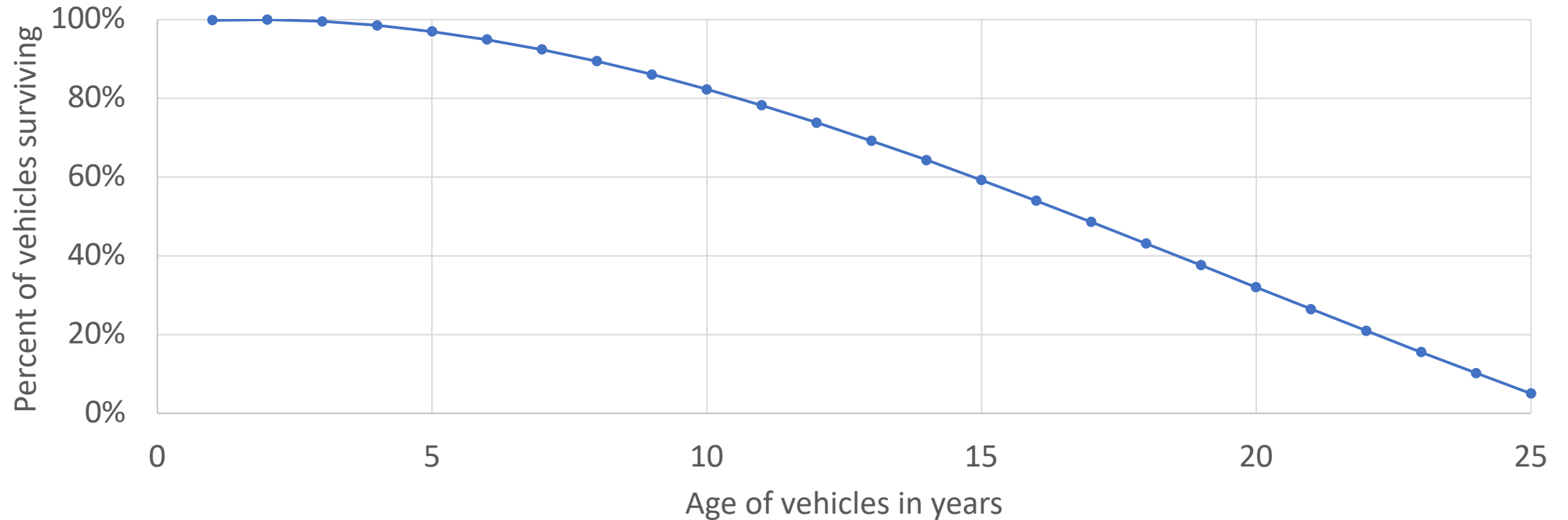


5. Suzuki Swift

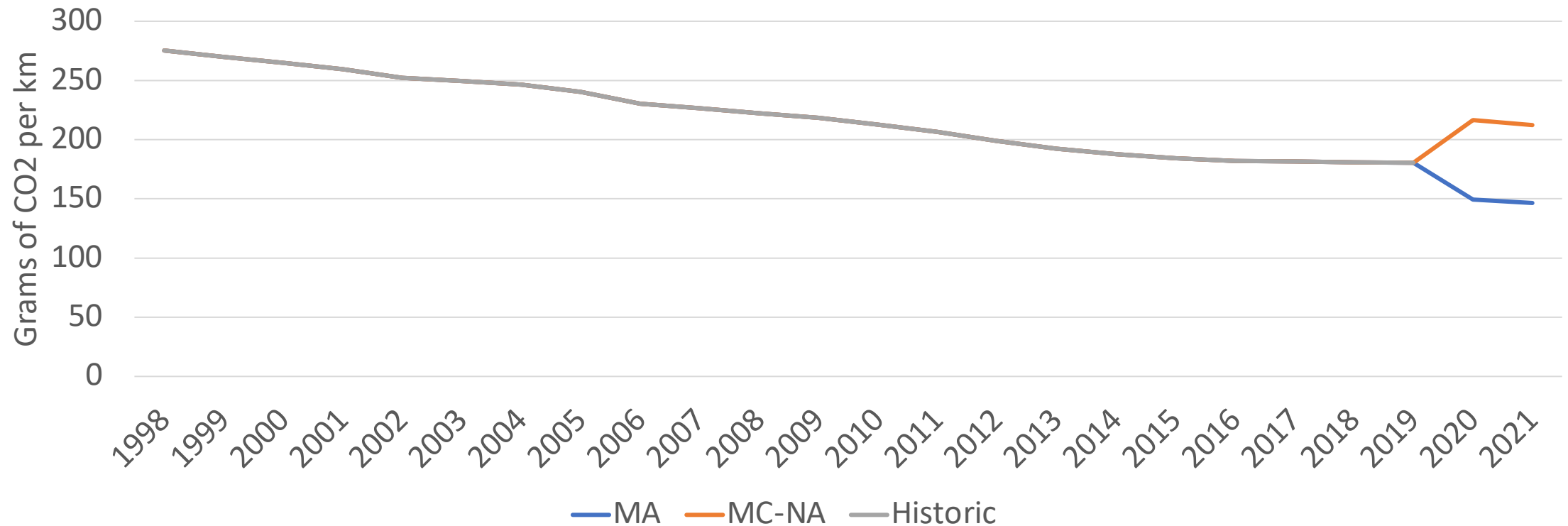
Fuel Efficiency Standards

- A fleet average emissions intensity target
- The average emissions of all vehicles a manufacturer sells must be below the standard
- Manufacturers balance their sales
- Credits can be traded
- Penalties are paid for manufacturers who fail to meet the standard
- Offer a pathway to net zero emissions vehicles

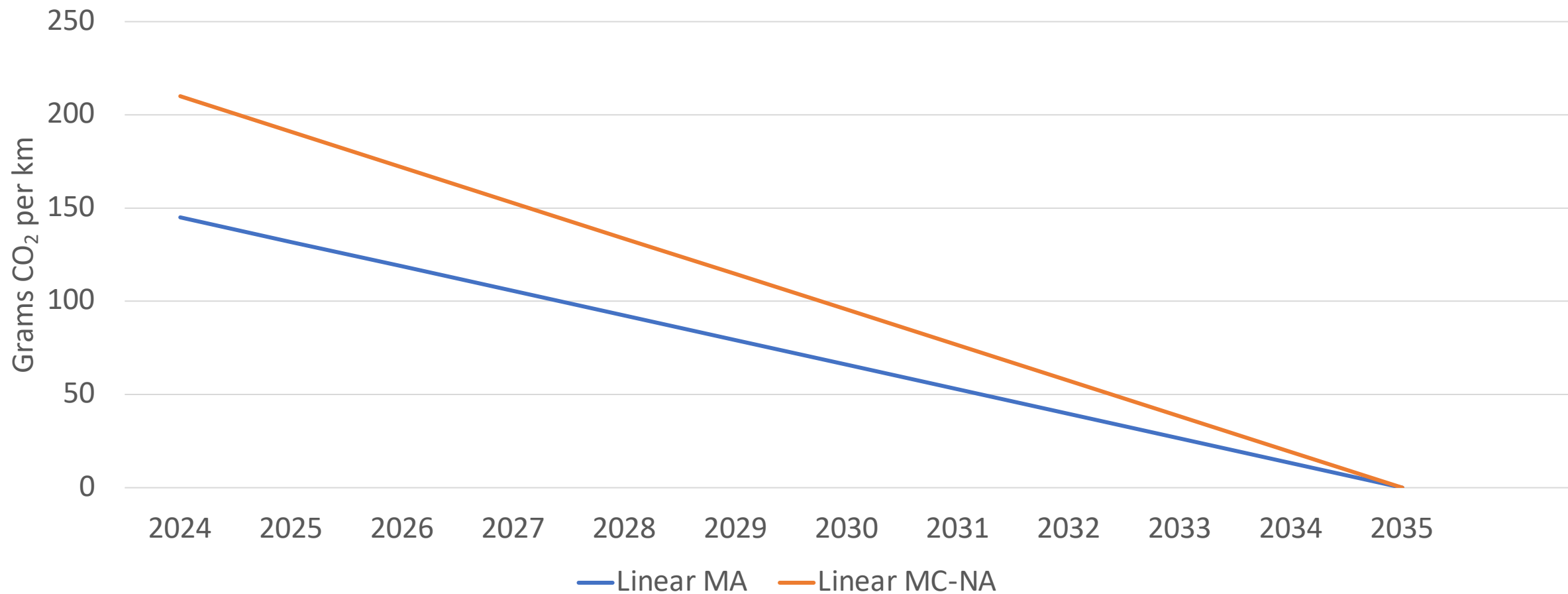
Survival rate, by year of manufacture



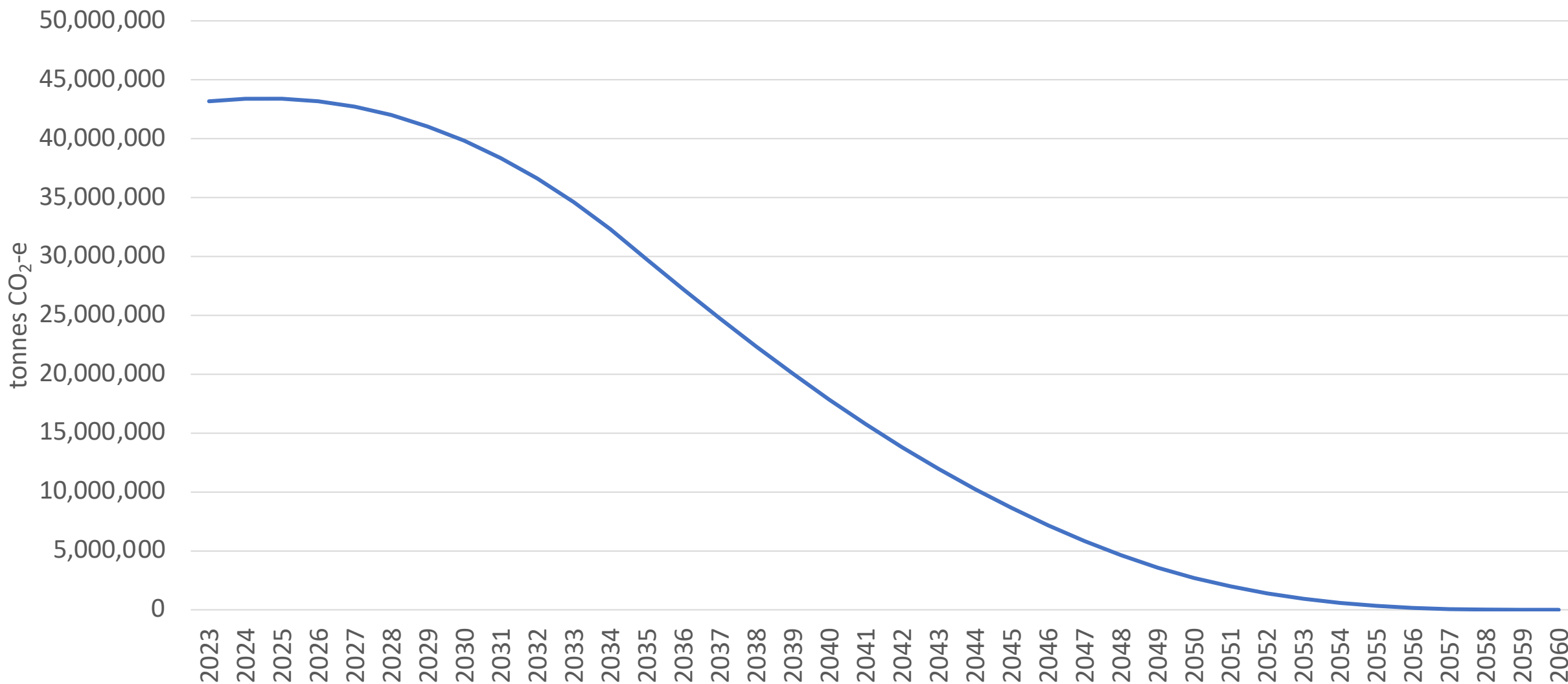
Australian new vehicle emissions



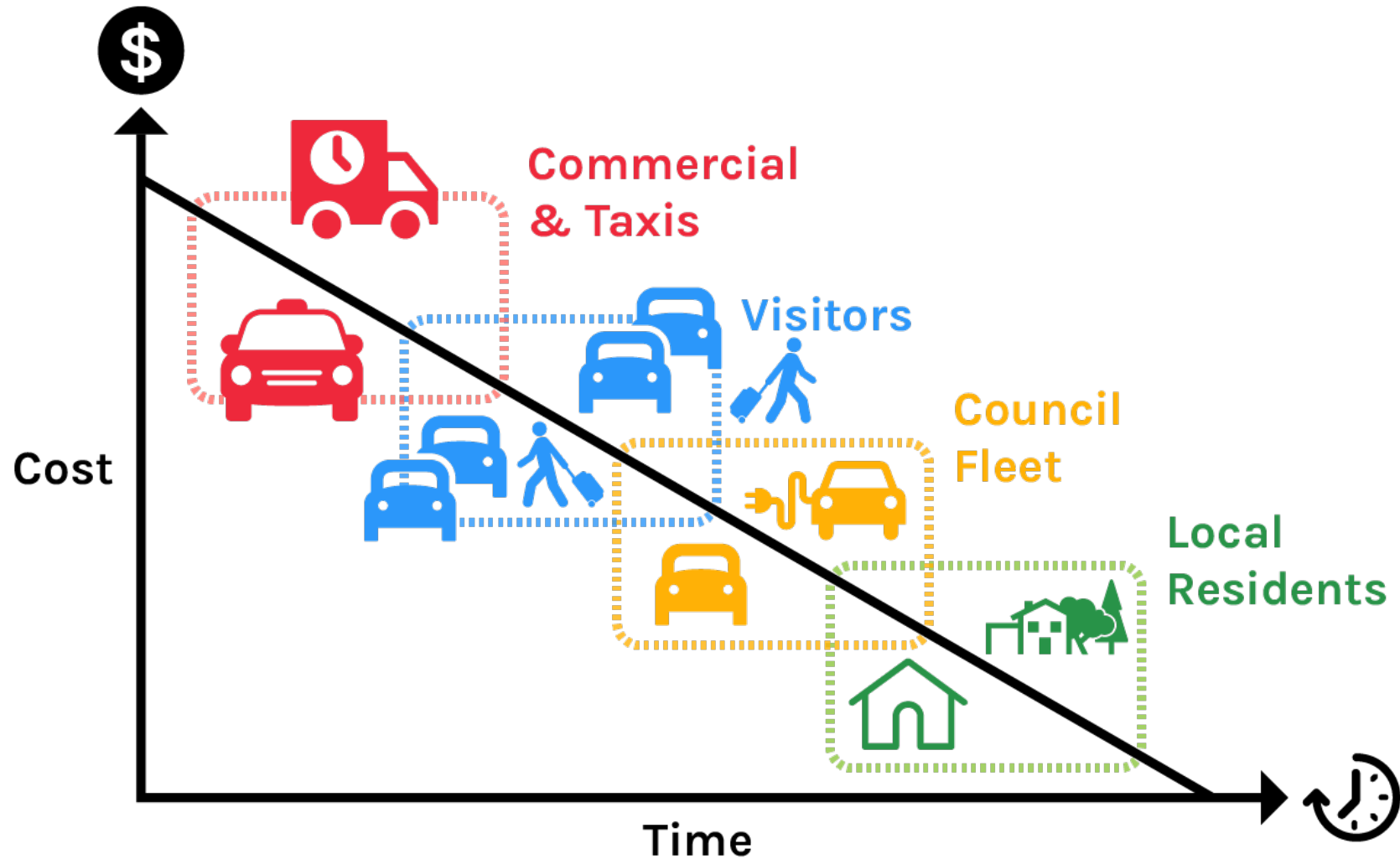
A linear FES



Emissions trajectory of an FES



EV Charging



Matching charging with time of use

1 Passing Through Motorist

Daniel, needs a recharge to get to his destination



150kW - 350kW
DC charger



2 Opportunistic

Sam, goes to the shops and tops up while parked



25kW - 50kW
DC charger



3 Local Resident

Cassie, does not have a garage for charging



7kW
charger



The role of neighbourhood charging



Summary

- EVs will be key to reducing road emissions
- Australian take-up of EVs is behind other nations
- ICE fuel consumption has flat-lined
- FES are a key way to drive technological change
- Charging infrastructure is another driver of change
- Australia needs to increase neighbourhood charging opportunities

Transport electrification and EV-grid integration – RMIT EV Living Lab

Mahdi Jalili

School of Engineering, RMIT University

July 2023



Charging requirement and infrastructure

- There are around 20M motor vehicles in Australia
- If only 25% are electrified with average battery size of 80KWh, the charging requirement will be 400GWh!
- Australia's average electricity consumption is ~250GWh!
- Some vehicles (e.g. taxis, public transport buses, trucks) may require double daily charge!



EVs and the grid

- EVs will have significant consequences to the energy market
- We are in the midst of *Energy Crisis*!
- If not properly managed, EV fleet will put even more pressure on the grid
- Investments required to upgrade the grid
- The same has happened for solar PVs
 - Overvoltage issues due to export of excess generation
 - Energy distributors should invest to update the network
 - Cost will be passed to customers!
 - Export limits introduced!



EVs and the grid – PT bus electrification example

- There are ~ 4,000 Public Transport (PT) buses in Victoria alone
- Each e-bus will consume ~500KWh of electricity daily
 - 2GWh daily consumption
- Victoria's peak electricity consumption is ~ 9GW in summer and ~7.5GW in winter
- If all PT e-buses are charge during peak hours, there would be enormous pressure on the grid
- Pushes the wholesale prices up
- Disadvantages vulnerable customers



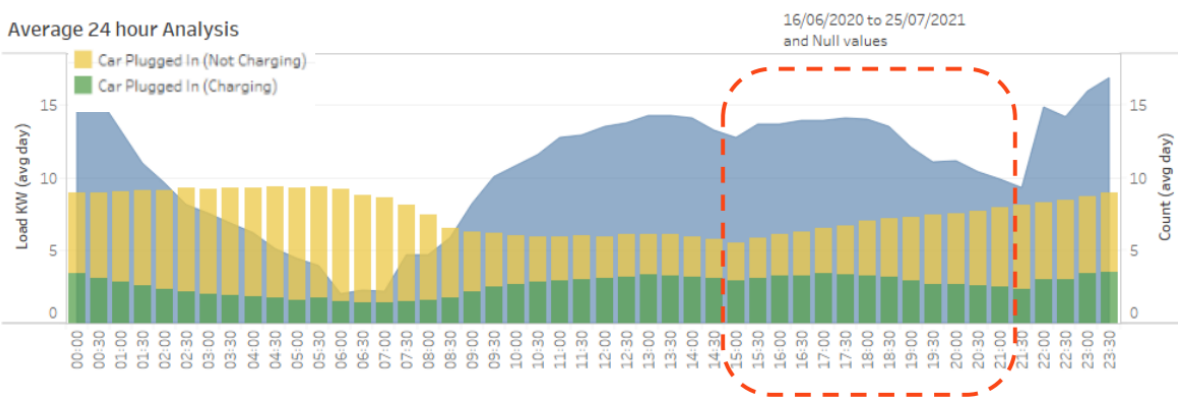
EVs and the grid – private and corporate EVs

- Most private EVs are charged at home
- Charging is often during peak hours (e.g. afternoon)
- Pushes up the demand! (and the prices)
- May lead to voltage drops in the neighbourhood
- May impact consumer satisfaction
- ...



EVs and the grid – Origin smart charging trial

- Smart charging (managed by retailer/distributor) could be solution
- Consumers will lose their comfort (to some extent)!
- Trial showed that consumers responded favourably to monetary incentive-based approach to smart charging
 - 10c per KWh to charge in off-peak periods



		Early Morning	Solar Sponge	Peak	Overnight
		5am to 10am	10am to 3pm	3pm to 9pm	9pm to 5am
Baseline	No incentives	7%	25%	30%	38%
Experiment 1	Incentives	4%	31%	10%	55%

<https://arena.gov.au/assets/2022/05/origin-energy-electric-vehicles-smart-charging-trial-lessons-learnt-2.pdf>



EVs and the grid – Origin smart charging trial

- In another experiment, Origin asked customers to give Origin full control to manage their charging
 - The fixed component consisted of a 25c per day reward if participants allowed Origin to curtail their charging between 3pm and 9pm.
 - Participants would also receive a variable component of 10c per kWh reward for charging between the times of 10am – 3pm and 9pm – 5am to further shape charging habits.

		Early Morning	Solar Sponge	Peak	Overnight
		5am to 10am	10am to 3pm	3pm to 9pm	9pm to 5am
Baseline	No incentives	7%	25%	30%	38%
Experiment 1	Incentives	4%	31%	10%	55%
Experiment 2	Incentives with control	9%	30%	6%	55%

<https://arena.gov.au/assets/2022/05/origin-energy-electric-vehicles-smart-charging-trial-lessons-learnt-2.pdf>



Challenges of high EV penetration

- Charging infrastructures
- Long-time required for charging at stations
- Impacts on the grid
- Lack of enough data to study charging behaviour
- EVs are much more cost-effective when renewables make up a greater proportion of the energy mix (but we are not there yet!)
- Lack of policies
- ...



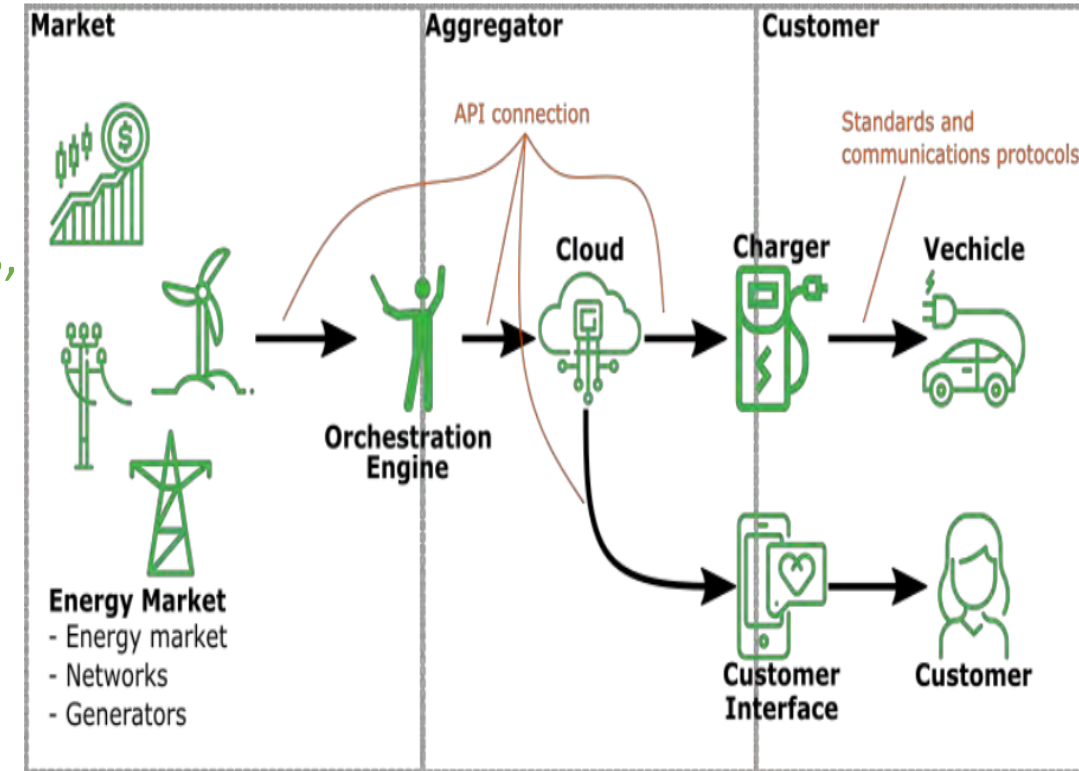
Opportunities

- Australia needs energy storage (e.g. battery) to support increased share of renewables in the energy mix
- It is estimated that ~10GWh home battery is required to accommodate excess generation from rooftop solar
- Much larger capacity for grid-scale batteries
- EVs can be mobile batteries
- V2X
 - Vehicle to Grid (V2G)
 - Vehicle to Home (V2H)
 - Vehicle to Load (V2L)
- But, is V2X economic?



V2X

- **Grid Integration:** poses challenges in terms of compatibility, communication protocols, and grid management systems.
- **Infrastructure Requirements:** A robust charging infrastructure with bi-directional power flow capabilities, including smart charging stations and grid connection points.
- **Battery Management:** Managing battery performance, degradation, and optimising battery lifespan while enabling bi-directional power flow.
- **Standardisation and Interoperability:** Ensuring standardisation and interoperability among different EV models, charging infrastructure providers, aggregators, and grid operators is a key challenge for seamless V2G integration and operation.

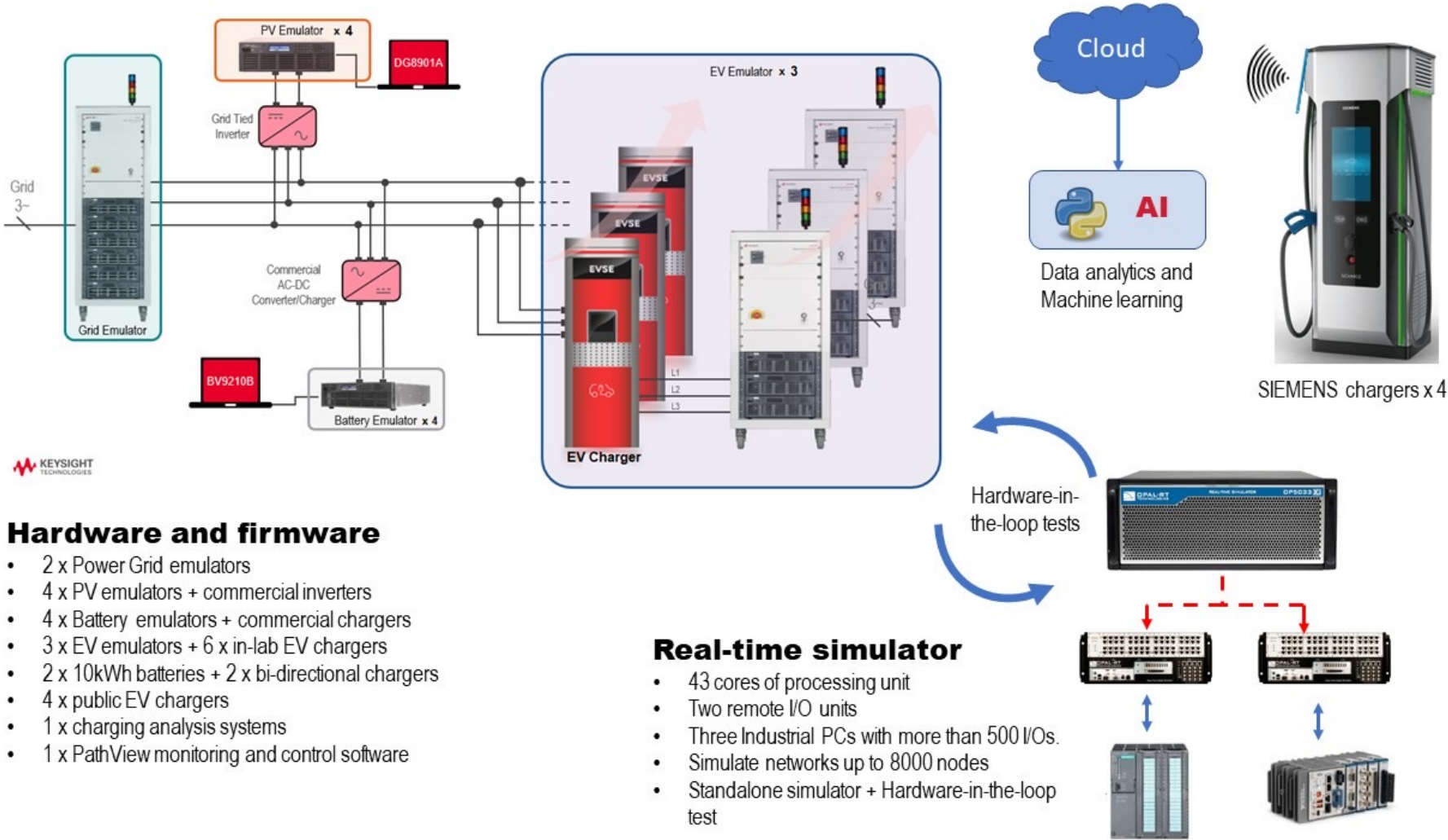


V2G implementation architecture

A to Z of V2G A comprehensive analysis of vehicle-to-grid technology worldwide, L. Jones, K. Lucas-Healey, B. Sturmberg, H. Temby and M. Islam. January 2021

RMIT EV Living Lab

To study interactions of EVs and the grid



Premier of Victoria
The Hon Daniel Andrews

Home > Developing Clean, Green Transport Options For Victoria

Developing Clean, Green Transport Options For Victoria

EV Living lab Team



Dr Samaneh Sajjadi
Smart algorithms



Dr Ali Moradiamani
Control of complex systems



Dr Syed Ali
Power electronics,
control engineering



Dr Parham Moradi
Machine learning



Dr Saman Ahmadi
AI and Optimisation, mobility
analytics



Dr Ammar Kamoona
Deep learning and its
Applications



Helen Rowe

Transport Program Impact
Manager

Thinking beyond EVs to decarbonise Australia's transport sector

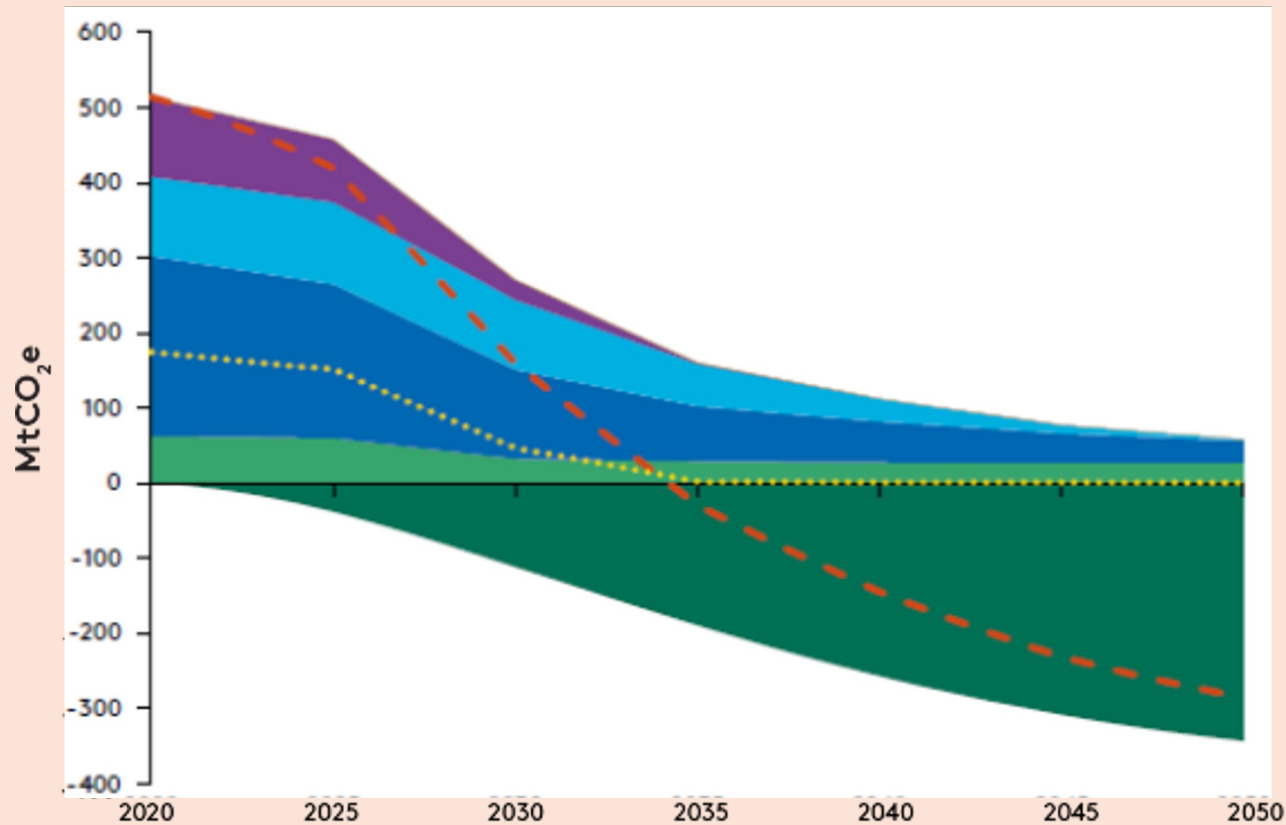


July 2023

-
1. Can EVs get us to net zero in time?
 2. How effective are they in reducing all emissions?
 3. What other factors are important in selecting a transport decarb pathway?

To reduce transport emissions *in time*, all available solutions are needed

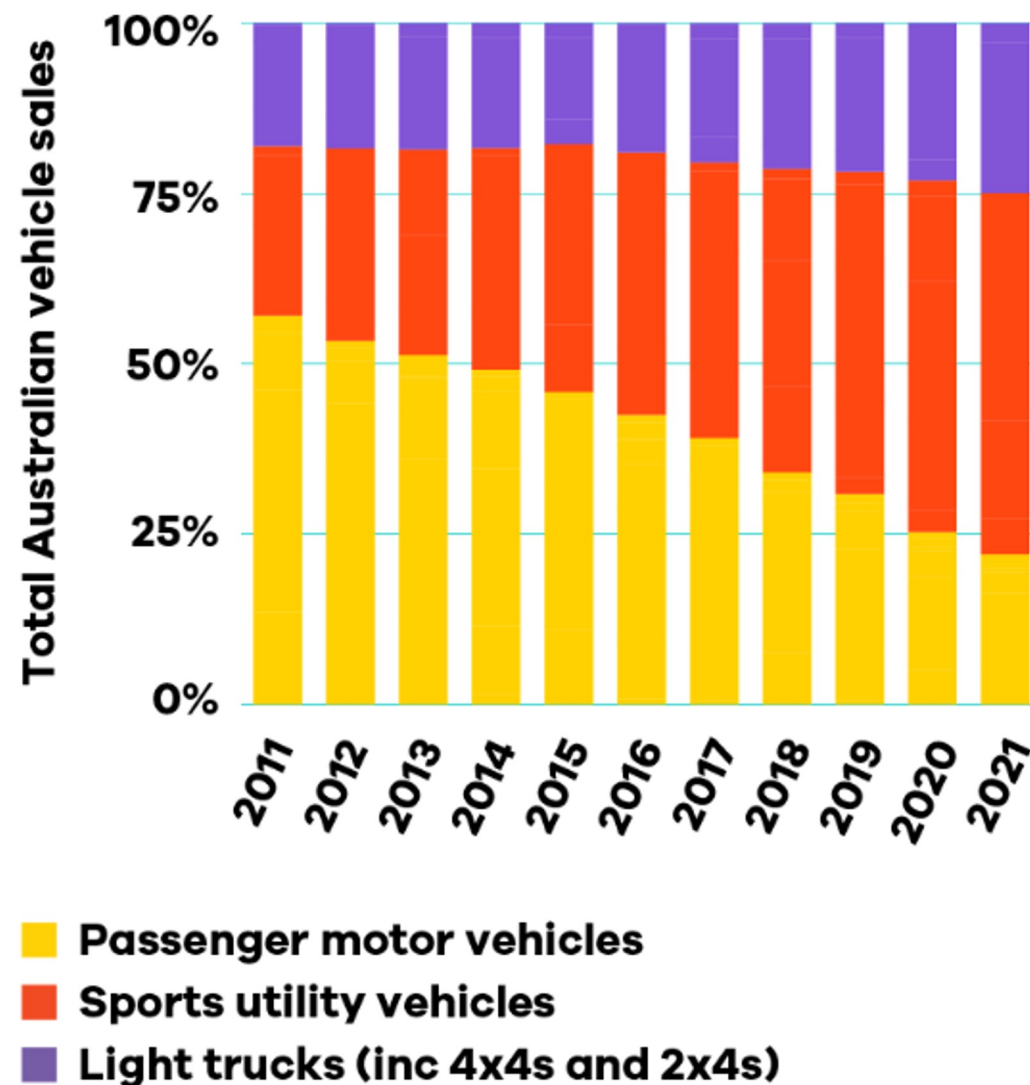
Sector emissions, MtCO₂e, '1.5C A-in Scenario'



Source: ClimateWorks Australia (2020)

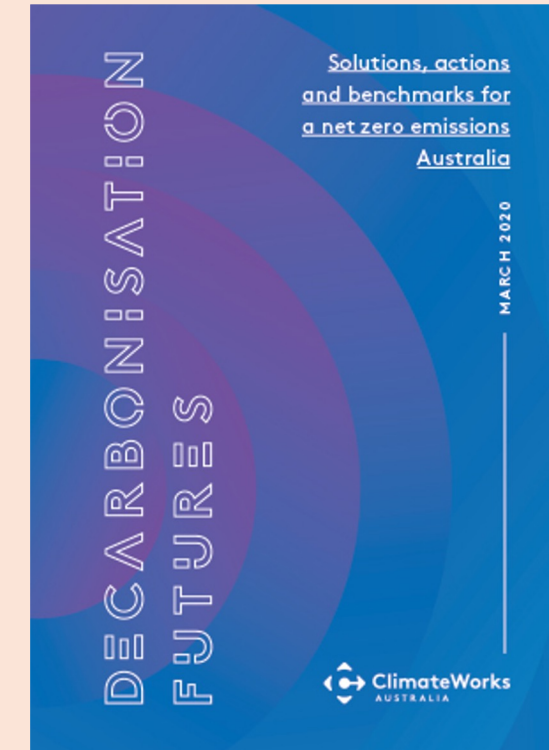
	Emissions reductions	
	2030 vs 2005	2050 vs 2005
Electricity	-65%	-100%
Buildings	-67%	-100%
Transport	+1%	-93%
Industry	-41%	-79%
Land	-44%	-37%
Carbon forestry		
Net emissions		

Growth in larger vehicles is eating away at Australia's transport emissions savings



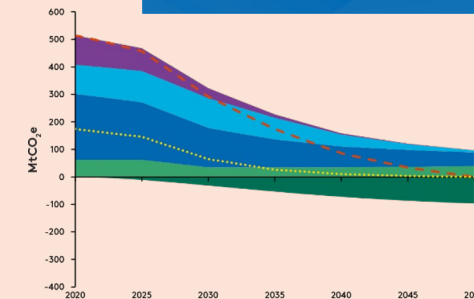
Looking to other solutions can add complementary early actions that lighted the load

	2030 ZEVs share in scenarios aligned to:	
	2 °C pathways	1.5 °C pathway
New car sales	50%	76%
Total car fleet	15%	28%
New truck sales	25-39%	59%
Total truck fleet	8-13%	24%

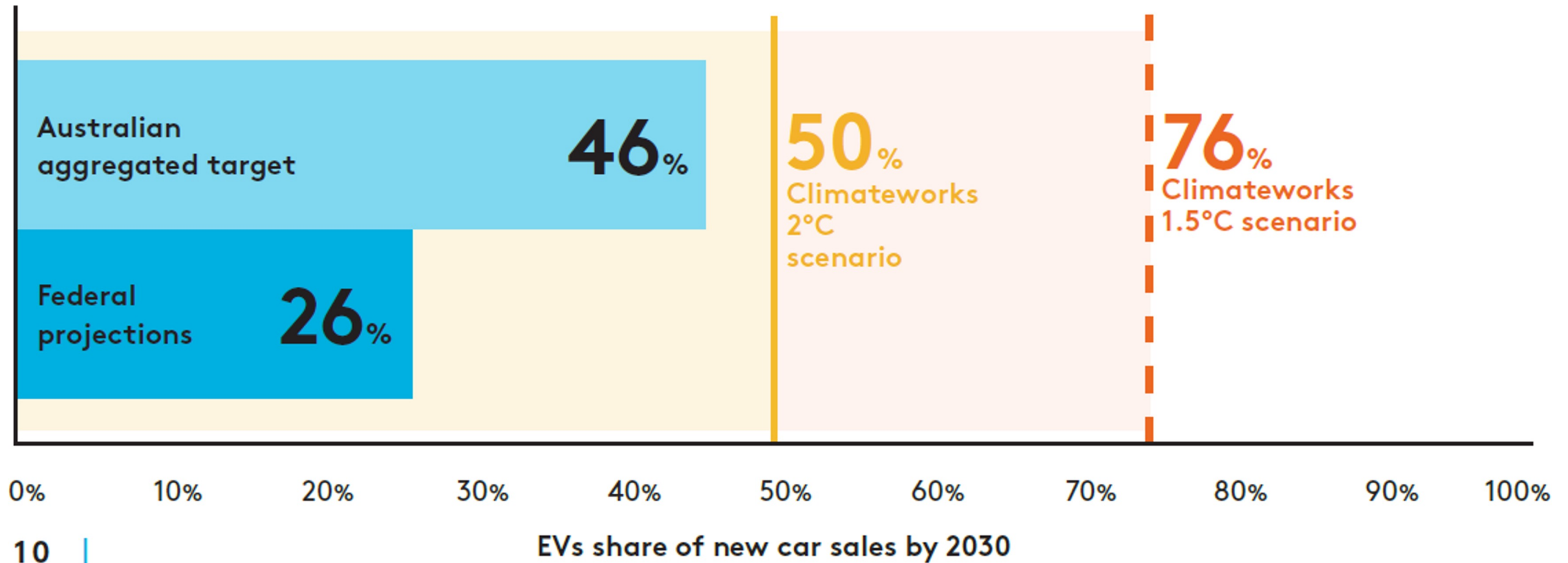


Truck sales: Minimal data/ trials
EV sales: 3.8% (2022)

Source: EV Council Australian Electric Vehicle Industry Recap 2022



Uptake aligned with 2C and 1.5C scenarios vs uptake targets and projections (2030)



Climateworks Centre, 2022, *Accelerating EV uptake*

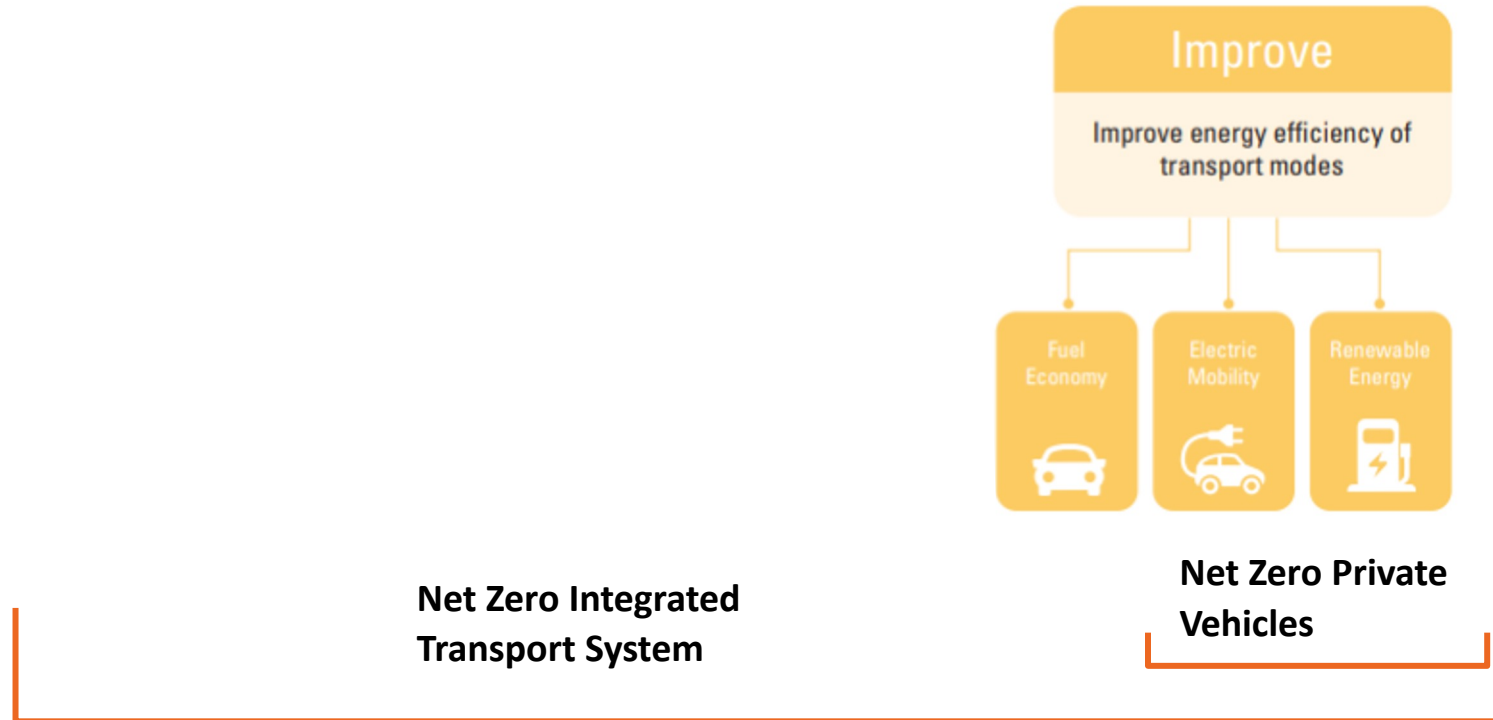
**Risky
enterprise to
rely on EVs
as the only
solution**

**...more EVs
and more
than EVs**



"Blue Eggs in Nest Box" by U. S. Fish and Wildlife Service - Northeast Region

Improving outcomes by moving from Improve...to Avoid, Shift & Improve scenarios



EVs remain critical to net zero transport. However, diversification can optimise emissions reduction *and* transport outcomes, while managing risk.

The current focus:

- Under-estimates broader interventions
- Over-relies on 'improve' solutions
- Risks decarbonisation leading to poor transport outcomes
- Risks emissions target not being met in time

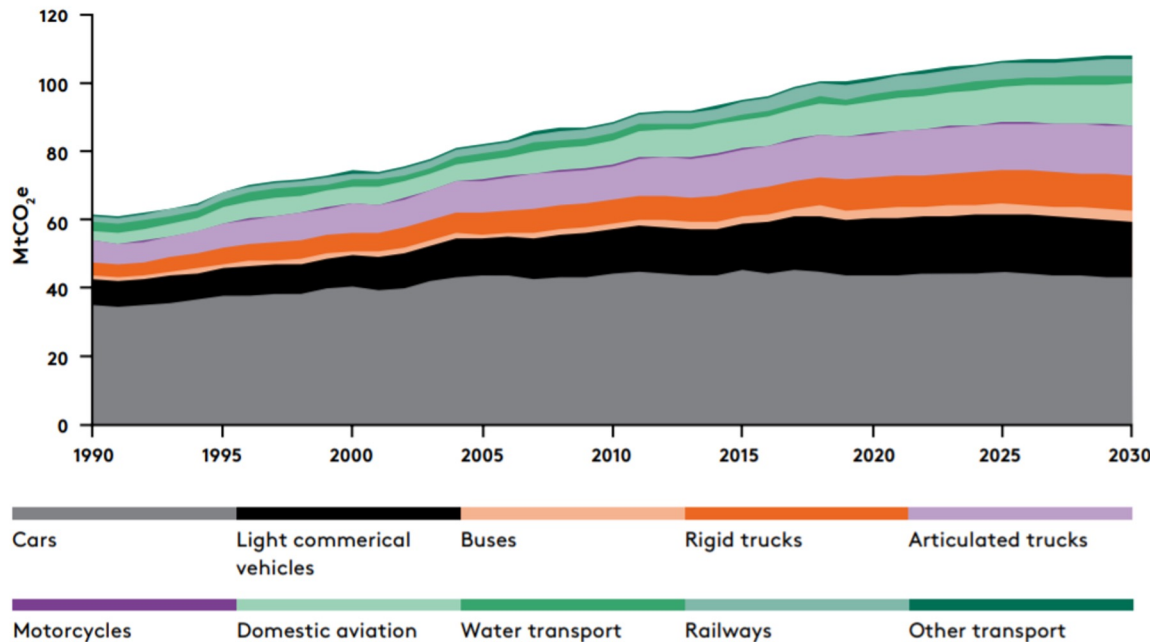
Optimal approach -

- A range of complementary, integrated solutions, reducing more emissions, more quickly as well as embodied emissions
- Creating more efficient, equitable, accessible and livable outcomes with potential cost savings for govts and consumers.

Current focus - Reduces scope 1 /2 emissions
Relying on one solution.

Freight makes up a significant proportion of all transport emissions, the majority in road freight

Australia's projected transport emissions by subsector, 1990 to 2030



Source: ClimateWorks Australia (2020)

Approx. 44% of transport emissions are from Trucks, Light Commercial Vehicles, Domestic Shipping, Rail

Urban/Shorter Haul:

- Technology available (electric vans, cargo bikes, trucks)
- Barriers - width and mass limits impacting on supply and operating on network

Long Haul:

- Technology de-risking electric / hydrogen options
- Mode shift to rail, coastal shipping potential

Opportunity to expand the ambition in 2023

Federal Budget:

- \$20.9 million dollars over five years to decarbonise transport and infrastructure,
- This includes \$7.8 million to develop a ***Transport and Infrastructure Net Zero Roadmap and Action Plan***.

Leading net zero transport practice: integrating transport outcomes with net zero ambitions

UK Decarbonising Transport: A Better, Greener Britain

- + Prioritises actions to shift to lowest emissions modes of transport (walking, cycling, public transport)
- + 10.7% EV sales in 2020
- + Co-benefits defined for each strategic theme
- + Acknowledge of more work needed for freight, aviation and maritime emissions



Accelerating modal shift to public and active transport



Decarbonisation of road vehicles



Decarbonising how we get our goods



Place-based solutions



UK as a hub for green transport technology and innovation



Reducing carbon in a global economy



Key actions

- ▶ Reduce reliance on cars and support people to walk, cycle and use public transport including by:
 - improving the reach, frequency and quality of public transport and making it more affordable for low-income New Zealanders
 - increasing support for walking and cycling, including initiatives to increase the use of e-bikes
 - ensuring safer streets and well-planned urban areas.
- ▶ Rapidly adopt low-emissions vehicles including by:
 - continuing to incentivise the uptake of low- and zero-emissions vehicles through the Clean Vehicle Discount scheme and consider the future of the road user charge exemption for light electric vehicles beyond 2024
 - increasing access to low- and zero-emissions vehicles for low-income households by supporting social leasing schemes and trialling an equity-oriented vehicle scrap-and-replace scheme
 - improving EV-charging infrastructure across Aotearoa to ensure that all New Zealanders can charge when they need to.
- ▶ Begin work now to decarbonise heavy transport and freight including by:
 - providing funding to support the freight sector to purchase zero- and low-emissions trucks
 - requiring only zero-emissions public transport buses to be purchased by 2025
 - supporting the uptake of low-carbon liquid fuels by implementing a sustainable aviation fuel mandate and a sustainable biofuels obligation.

The Government has set four transport targets that will support these focus areas and align with achieving the sector sub-targets for transport.² This is approximately equivalent to a 41 per cent reduction in transport emissions by 2035 from 2019 levels.³

- ▶ **Target 1** – Reduce total kilometres⁴ travelled by the light fleet by 20 per cent by 2035 through improved urban form and providing better travel options, particularly in our largest cities.
- ▶ **Target 2** – Increase zero-emissions vehicles to 30 per cent of the light fleet by 2035.
- ▶ **Target 3** – Reduce emissions from freight transport⁵ by 35 per cent by 2035.
- ▶ **Target 4** – Reduce the emissions intensity of transport fuel by 10 per cent by 2035.

Mahere Hohenga kia Whakakorea
te Waro ā-Kawenga 2022-25 |
Decarbonising Transport Action
Plan 2022–25

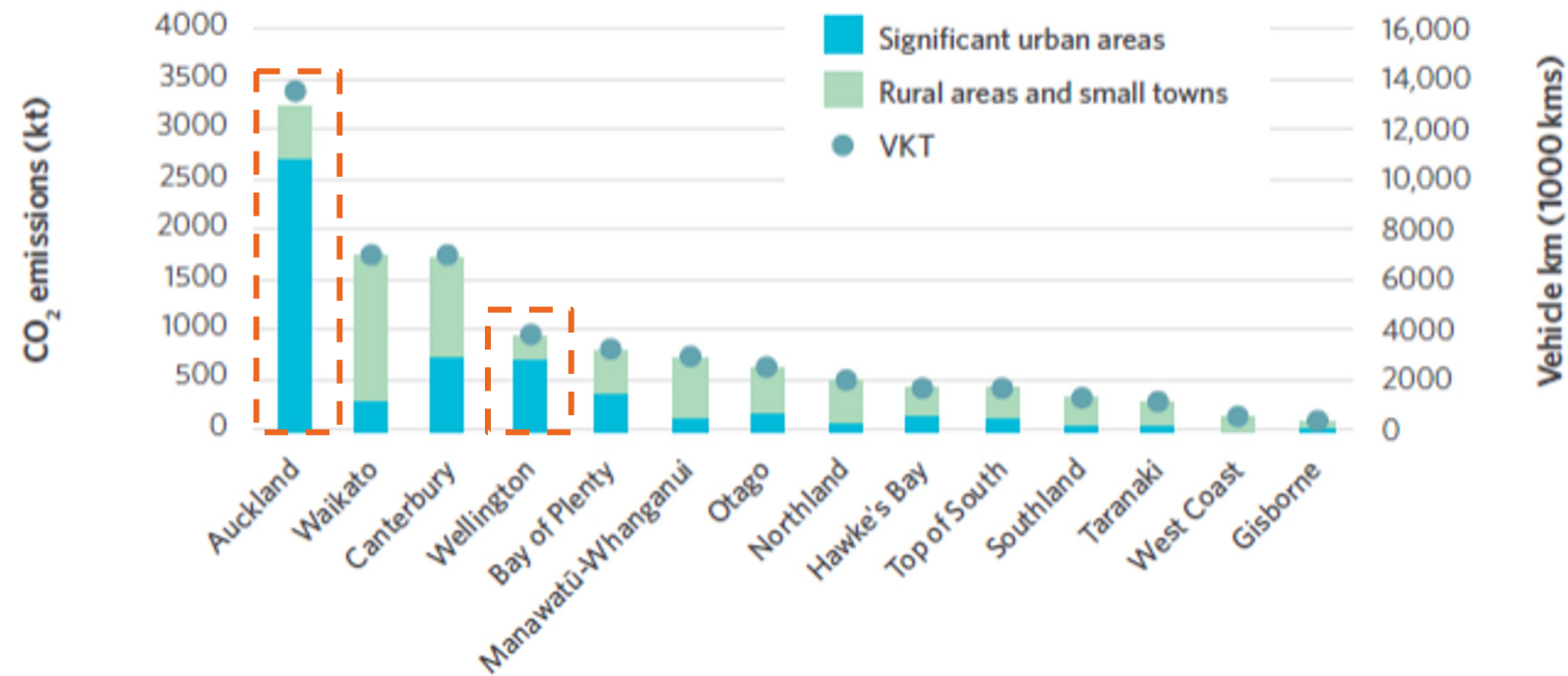
Implementation plan for the actions in the Transport
chapter of Te hau mārohi ki anamata – Towards a productive,
sustainable and inclusive economy: Aotearoa New Zealand's
first emissions reduction plan

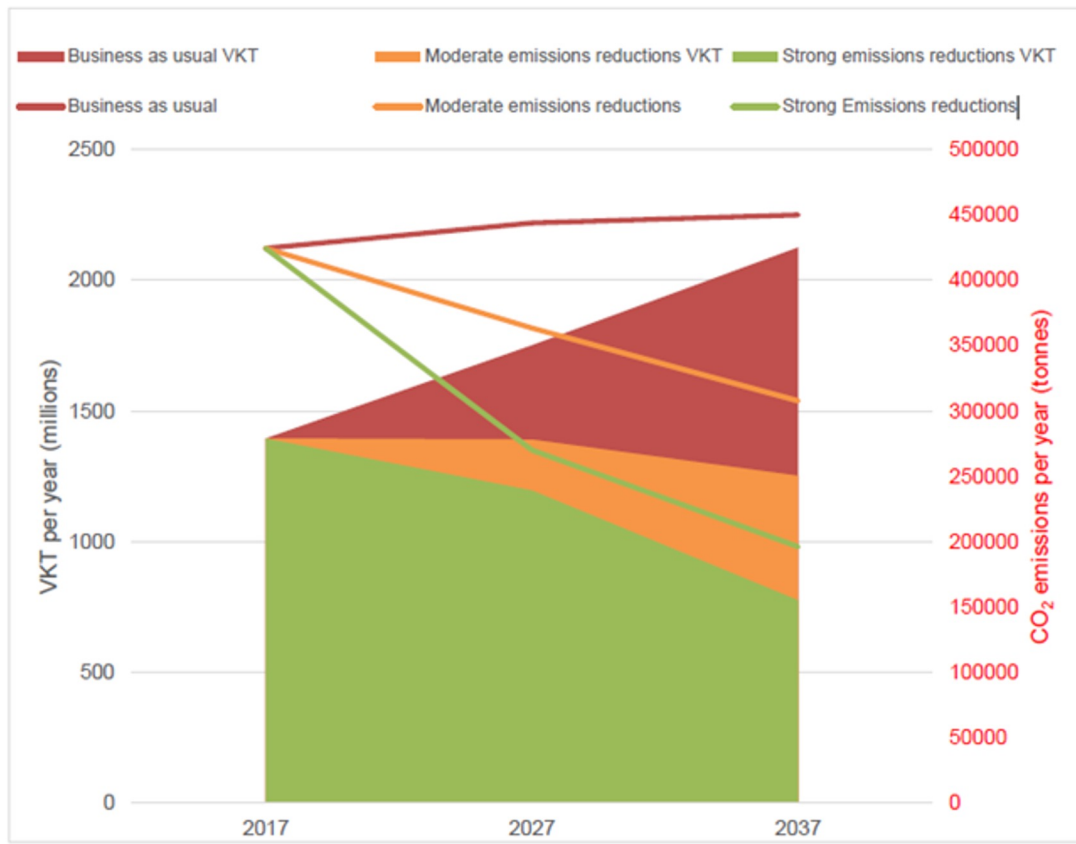
December 2022



Solutions that scale in urban areas

Figure 2: Annual CO₂ emissions (kilotonnes) in rural and urban areas compared to the kilometres travelled by vehicles in each region in 2020 (source: Waka Kotahi)

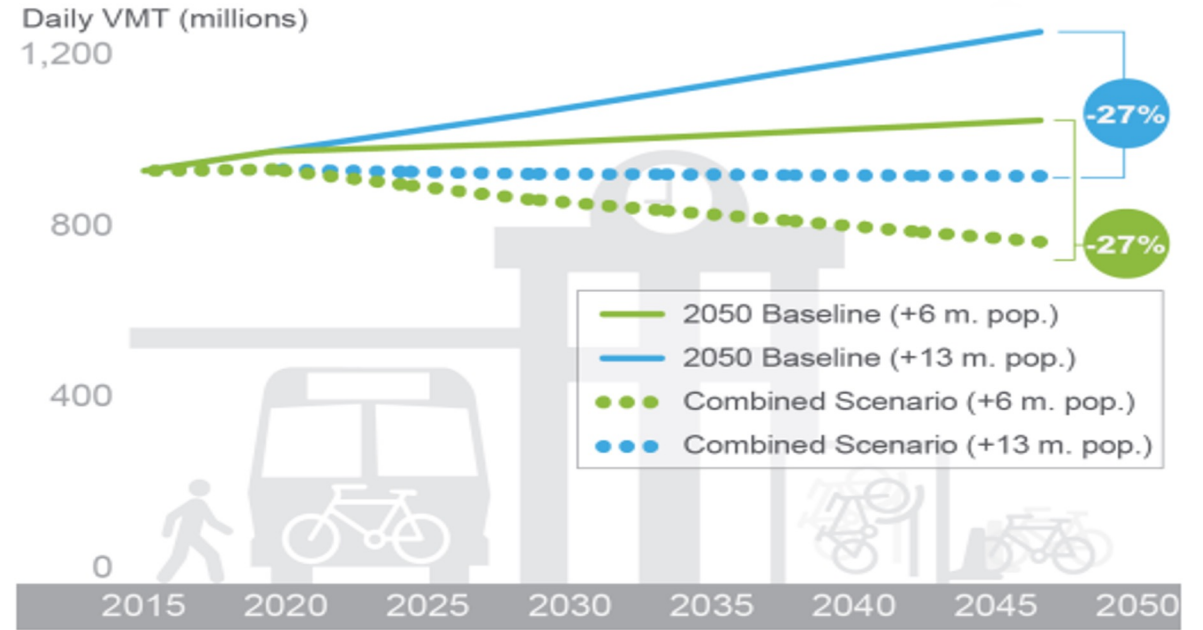




Comparison of projected per capita GHG emissions and transport mode share in 2037

City of Melbourne

FIGURE 36 VMT REDUCTION (MPO VS. DOF POPULATION FORECAST COMPARISON)



Source: CSF2TDM.

[California Transportation Plan 2050](#), Caltrans, 2021

Scope 1 - emissions as a direct result of an activity
(e.g. tailpipe emissions)

Scope 2 - emissions from the indirect consumption of energy
(e.g. electricity used to power trains and vehicles)

Scope 3 - emissions, other than scope 2 emissions, that are generated in the wider economy as a consequence of the activities
(e.g. embodied emissions associated with vehicle production & infrastructure)

-
1. Can EVs get us to net zero in time?
 2. How effective are they in reducing all emissions?
 3. What other factors are important in selecting a transport decarb pathway?

Climateworks updated scenarios - 'Improve' and 'Avoid, Shift, Improve' benign finalised this year:

- Scope 1 & 2 emissions
- Scope 3 emissions
- VKT
- Infrastructure needs

Helen Rowe

Transport Program Impact Lead

CLIMATEWORKS CENTRE

Level 27, 35 Collins Street
Melbourne Victoria 3000

+61 3 9902 0741 // info@climateworkscentre.org

www.climateworkscentre.org



Climateworks Centre was co-founded by Monash University and The Myer Foundation and works within the Monash Sustainable Development Institute



MONASH
University

MONASH
SUSTAINABLE
DEVELOPMENT
INSTITUTE



THE MYER
FOUNDATION

Q & A

Centre for Urban Research

Connecting people and ideas
for sustainable urban futures



Visit cur.org.au