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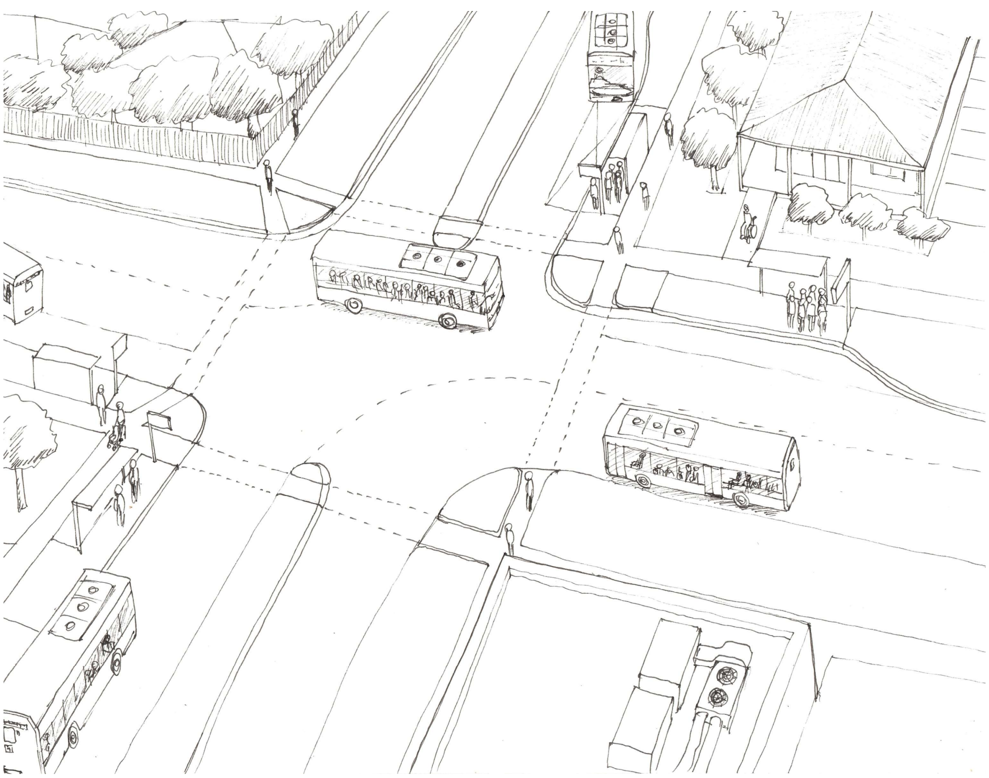
Dr John Stone, Adam Bain, Nathan Pittman, Dr Paraic Carroll

June 2026



THE UNIVERSITY OF MELBOURNE

Melbourne Centre for Cities

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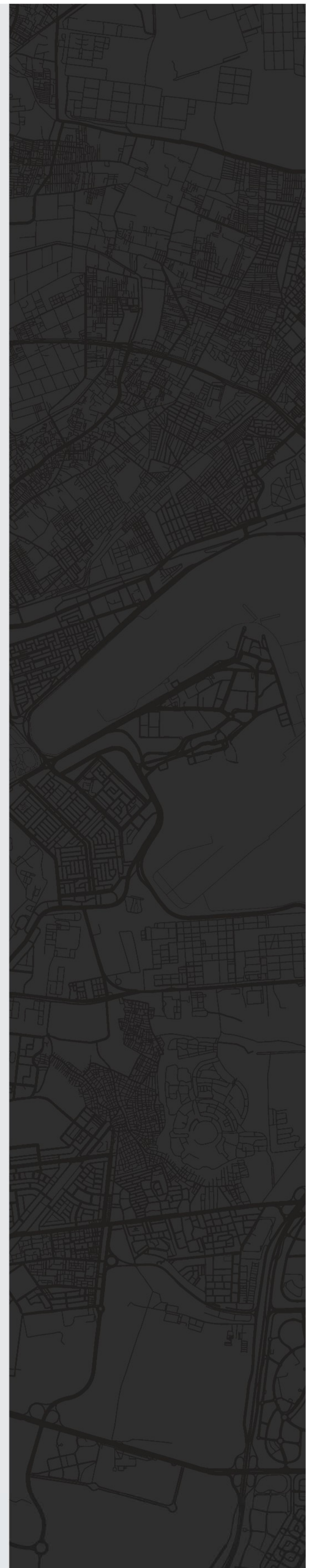

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INTRODUCTION & SUMMARY

Victoria's climate targets require a cut to transport emissions of around 22 Mt CO_2-e by 2036[1], but the pathway to this goal is unclear. Transport emissions in Victoria and nationally are continuing to grow in both absolute terms and in their proportional contribution as domestic renewable energy generation increases.

Climateworks modelling shows that the pathway to even modest targets requires both electrification of vehicle fleets and an increased mode share for public and/active travel[2]. Replacing the car fleet is not sufficient, even at the most optimistic rates. But, despite this, most policy responses focus on the transition to EVs, and progress is slow. Turning this around through increased incentives is unlikely to be politically palatable, partly because of the predicted high cost of such policies[3].

Even when studies do identify the need for mode shift, the policy levers required to achieve it are seldom explored with any enthusiasm or confidence. This report explores the potential for emission reductions if mode shift to public transport was vigorously pursued in Melbourne's West.

In transport planning theory, the policy requirements for achieving mode shift in settlement patterns comparable to the middle and outer suburbs of Australian cities are well-understood. The key to this approach is to build services into an effective network which challenges the traditional assumption that rate of growth in new patronage will always be slower than the rate of growth in services (technically speaking, the 'elasticity of demand' will always be less than 1). Instead, network theory and practice demonstrate that new services can be "added in ways that increase demand at faster rates than those as which resources are added"[4].

Researchers and practitioners have identified the common elements of public transport systems that have successfully embodied the 'network effect'. In short, these are stable multimodal systems that use frequency, speed and connections to allow residents to: "set off from a place of (their) own choosing, travel quickly, comfortably, cheaply and in safety to (their) destination, and arrive there at a time set by (themselves); nothing else will do"[5].

Guides to the details of these practices can be found in the HiTrans manual Planning the Networks and Paul Mees' seminal work, Transport for Suburbia: Beyond the Automobile Age.

Practical success in the application of the theory of the 'network effect' to bus networks in otherwise typical western 'automobile cities' is demonstrated in the performance of suburban buses in Toronto, Vancouver and Auckland.

This practical and theoretical knowledge underpinned initial testing of the potential benefits of bus network re-design in Melbourne's West published in 2022 (Lawrie & Stone, Better Buses for Melbourne's West). This work, using Remix (a planning and modelling tool used by many transport agencies) demonstrated the significant accessibility benefits that would

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[1] https://www.climatechange.vic.gov.au/climate-action-targets
[2] Climateworks Centre, 2024, *Decarbonising Australia's transport sector: Diverse solutions for a credible emissions reduction plan*.

[3] Productivity Commission 2023, *5-year Productivity Inquiry: Managing the climate transition, Vol. 6, Inquiry Report No. 100*, Canberra. p. 39-44. This report calculated that the Commonwealth Fringe Benefit Tax exemption would reduce emissions at a cost between $987 and $20,084 per tonne CO_2-e depending on the proportion of EVs obtained through the policy that would not otherwise have been demanded; the number of years that an EV leased under the policy would have been brought forward from 2035 when it is assumed that EVs will dominate the market; and on the rate of decarbonization of the electricity grid. They also estimated that Victoria's EV subsidy policy would reduce emissions at a cost between $287 and $4,807 per tonne CO_2-e.

See also: Productivity Commission, 2025: https://assets.pc.gov.au/2025-12/net-zero.pdf?VersionId=24kY9x7Ou_YqHvzl0z25kQO11I298byU; and Commonwealth DCCEEW, 2025, https://www.infrastructure.gov.au/sites/default/files/documents/transport-and-infrastructure-net-zero-roadmap-and-action-plan.pdf

[4] Mees, et al., 2010, Transport Network Planning: A Guide to Best Practice in NZ Cites, NZ Agency research report 396, p. 18.
[5] Brändli, H. (1990) 'Measures to increase the demand for public transport: The case of Zurich', in Council of Europe (ed.), Conference on improving traffic and quality of life in metropolitan areas: Working documents and conclusions, Strasbourg, pp130–146.

follow from a change in the DTP's current internal service objective of providing a bus stop within 400m of every dwelling (ref) to a more meaningful target of a frequent and connected service with 800m of all dwellings (as is the case in Vienna and many other jurisdictions (ref)). Public acceptance of such a change in Melbourne has been demonstrated through surveys undertaken by the DTP.

To refine this initial proof-of-concept, we have developed a more concrete bus network re-design appropriate to the specific geographies of Melbourne's West. Details of this transformational network reform proposal can be found on p. 10 and 11. The proposal is for a new frequent grid network and includes the retention of around 65% of existing services. The existing service pattern is reduced largely where it is duplicated by new grid network. These retained services would reduce potential for objections from people who use the existing system. Over time, these resources can be transferred to feeder and other secondary network functions.

In this report, we have made estimates of the carbon emissions savings from avoided private vehicle travel under this transformational network-reform proposal. This requires a series of assumptions which we have made explicit below.

Our method is not that which is typically used in conventional transport modelling. That is, we have not simply extrapolated from the current extremely low mode share. Such a method would inevitably underestimate potential patronage growth because the current service patterns are so clearly inadequate to meet current or future travel demands. Our method recognises that the proposed network re-design offers a vastly improved service, and so significant patronage growth can be expected. This method extrapolates from the occupancy rates (passengers per service-km) of today's best performing lines. In the West These are the lines with coverage hours and frequencies much closer to our network reform proposal.

Using this method, we estimate that carbon emission reductions of up to 1.3 Mt CO2-e can be achieved over 10 years in this one region of metropolitan Melbourne. This is a significant contribution to Victoria's emissions targets and shows that mode shift should be given much greater attention in abatement policy development. If this approach to network reform were to be repeated in the growth corridors of Melbourne's north and south-east and in the regional cities, then emission reductions of a further 3 to 4 M Mt CO2-e could be achieved

A further important conclusion from our analysis is that a greater proportion of the emission reduction from a mode shift to buses is achieved through restricting the future growth in car trips powered by fossil fuels rather than from a shift from diesel to zero-emission buses.

CALCULATIONS & ASSUMPTIONS

Anticipated emission reduction from western suburbs bus reform (E_R) can be expressed as:

$E_R = (T_{Car} * C_{CarKm}) – (T_{Bus} * C_{BusKm})$

Where:

T_{Car} = kms of car travel avoided through new bus patronage.

T_{Bus} = kms of additional bus services required to operate the bus reform package.

C_{CarKm} = average CO_2-e per km for private car and bus respectively.

We have used the following constants:

C_{CarKm} = 0.00019 tonnes per car-km[6]

C_{BusKm} = 0.00084 (0.0033 tonnes CO_2-e per litre of diesel[7] x 0.26 litres per bus-km[8])

Assumptions

Patronage

Current bus patronage is taken from the DTP's 2024 estimates for touch-on rates released under FoI. While there are doubts about the accuracy of this data, the DTP have asserted that corrections have been made to account for users who travel without touching on. We have taken this assertion at face value.

If the current service pattern was not upgraded, we can assume that patronage might increase at the same rate as population growth. So, our estimate of patronage in 2036 is 30% higher than 2024 levels.

For transformational network reform, our patronage estimates are based on a range of occupancy rates for the new grid network (2.5, 3.0, and 3.5 passengers/bus-km) and a slight decrease in occupancy for the retained 'legacy' services (see table below). The occupancy rates used for the new network are conservative as they represent only a small improvement on existing occupancy rates for four of the most popular routes in the West (see tables below), which have better service quality than many other routes, but are still well below what is proposed for routed in the new grid: a user of one of these routes calls it the "mystery bus" for its erratic adherence to the published timetable.

We have also assumed that patronage growth would take time. For simplicity, we have assumed linear growth over 10 years from 2027 to 2036. Over this time, as the new network gains popularity, the government and the operators may be able to improve elements of the system such as on-road priority for buses, pedestrian access to and amenity at bus stops, and re-locate stops at key connection points. Completion of the Airport Rail line and the electrification of V-Line services to Melton and Tarneit, and the appropriate development of new employment precincts can also be anticipated over the next decade. Together, such changes would make our assumed occupancy rates even more achievable.

Another factor that is likely to lead to patronage growth is the increasing number of young people. Birth rates in the West have been high for some years and over the next 10 years many of these children will reach high-school age and will be seeking ways to move independently around their neighbourhoods.

[6] National Transport Commission, 2024, Light vehicle emissions intensity in Australia: trends over time. Research Report, December 2024

[7] DCCEEW, 2023, National Greenhouse Accounts Factors: 2023 - DCCEEW

[8] Bus industry Confederation, 2020, 2020 bus fleet stats - Bus Industry Confederation

	Occupancy rates (pass/bus-km)
Current (average of 4 best routes)	2.4
Current (all routes)	0.6
New grid in 2036 (low)	2.5
New grid in 2036 (mid)	3.0
New grid in 2036 (high)	3.5
New 'legacy' in 2036	0.5

Current best-performing bus services in the West	Services per year (both ways)	Passengers per bus- km
Tarneit to Werribee (Route 170)	36,088	1.7
Tarneit to Williams Landing (Route 152)	17,992	3.3
Tarneit to Werribee (Route 182)	21,528	2.4
Keilor East-Footscray (Route 406)	37,128	2.1

Bus service-kms

Current bus service-kms (36. 9 million km/year) are derived from Remix modelling in Lawrie & Stone (2022). Calculations for new grid network bus service-kms (29.3 million km/year) are shown on p. 11. Retained legacy services (23. 4 million km/year) are designed to maintain services that are not duplicated by new grid network. Retaining these services demonstrates to existing users that the changes represent an improvement in the overall system. Over time these services can be adjusted to feeder and other secondary network functions.

Avoided car trips

We have made two important assumptions about the anticipated mode shift away from car trips.

First, the proportion of new bus trips that replace car trips. The new bus grid is likely to be competitive for many necessary trips that are currently done by car. For example, in Brimbank, less than 1% of work trips include a bus; and chauffeuring trips make up a staggering 42% of car trips in Brimbank, Melton, and Wyndham (compared with only 16% in Boroondara, Stonnington, and Whitehorse[9]. In addition, the scale of relief to household budgets offered by the opportunity to relinquish a formerly essential second or third car is a considerable incentive for mode shift.

Second, the average length of avoided car trips. VISTA and other data suggest that average car trips in the West are around 10- 11 kms, but this is skewed by the large proportion of trips that are in the 0 – 2 km range. These are not likely to be competitive by bus. Instead, the bus will be more attractive for longer trips.

[9] VISTA, (https://public.tableau.com/app/profile/vista/viz/VISTA-LGAProfiler/LocalGovernmentAreaprofiles)

Costs

Our estimates of the emission reduction costs are necessarily simplistic. Our intention is to explore the potential environmental benefits of network reform. We have not included the capital and other costs associated with implementation of the new network, nor have we included a premium for the ZEB transition, as this cost is already built into government commitments. Nor have we attempted to quantify the many savings to households and government that would accrue from improved transport accessibility. These include improvements in health and well-being, reduced interactions with the criminal justice system for young people, and greater participation in the work force and further education. Substantial household savings can be expected from reductions in the number of cars currently required by many households in the West.[10]

In short, while the emission reduction cost may be high in comparison to other abatement strategies, the extent of the likely social benefits makes a compelling case for action.

Other emission-reduction opportunities

We have not factored in the rate of transition of the car fleet to EVs powered by renewables. This is partly due to complexity, but also, it is likely, given the high levels of car ownership per household in the West, that bus trips will likely replace trips by these second or third cars (fuelled by petrol and diesel). EVs will slowly replace the principal cars in some households, but the cost of EVs means that ICE vehicles will remain prominent in the fleet in our forecast period.

For simplicity, we have not included any estimate of emission reductions that might accrue from changes in congestion patterns

[10] https://web.archive.org/web/20240327023114/https://cur.org.au/cms/wp-content/uploads/2018/03/top-final-report_november-2021.pdf The tables on pages 32 and 34 are most relevant.

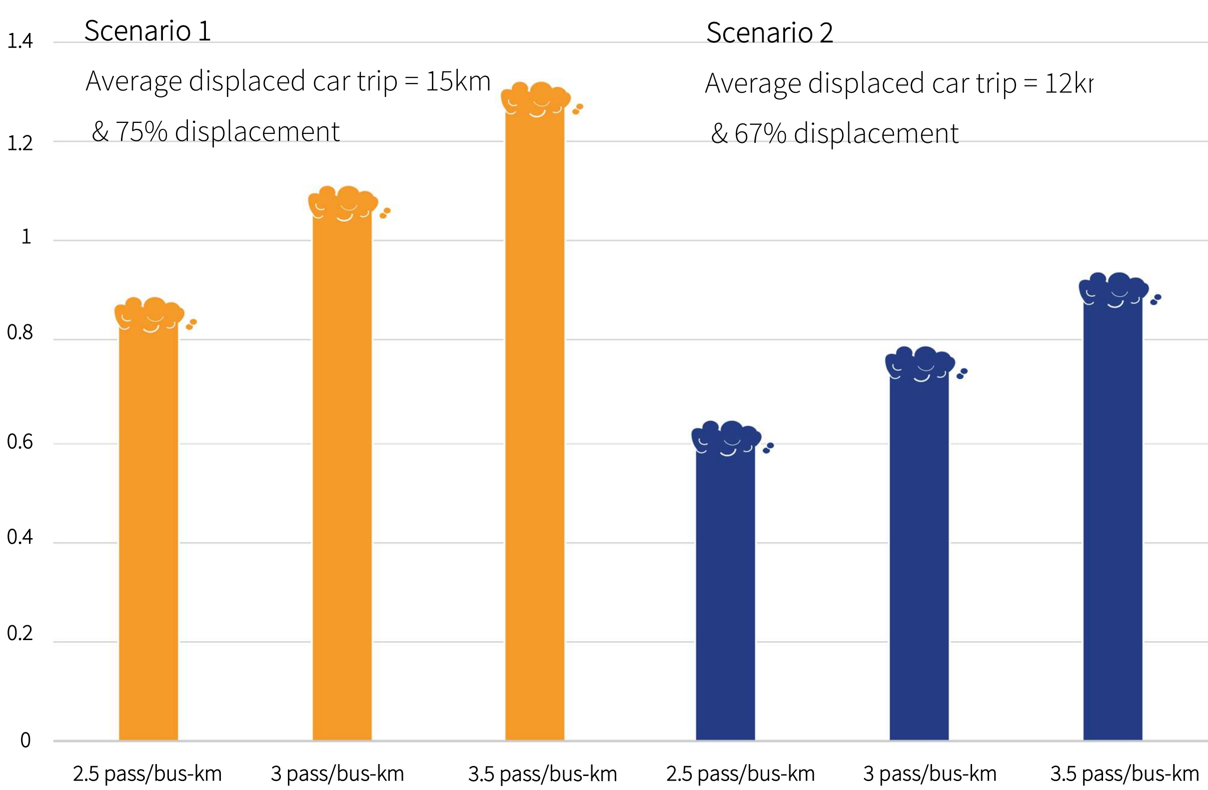
ESTIMATED EMISSION REDUCTIONS –TABLE

	Emission reduction – Scenario 1 (Average displaced car trip = 15km & 75% displacement[11])			Emission reduction – Scenario 2 (Average displaced car trip = 12km & 67% displacement)		
	Occupancy rate for new grid			Occupancy rate for new grid		
	2.5 pass/bus-km	*3 pass/bus-km*	*3.5 pass/bus-km*	2.5 pass/bus-km	3 pass/bus-km	3.5 pass/bus-km
Annual patronage in 2036 (million)	112.4	131.8	151.3	112.4	131.8	151.3
Displaced annual car trips (million)	61.5	76.1	90.7	55.0	68.0	81.0
Car-km displaced (million)	922.7	1141.3	1360.0	659.4	815.7	971.9
Carbon avoided in 2036 if 50% ZEB transition (Mt)	0.16	0.20	0.24	0.11	0.14	0.17
Carbon avoided in 2036 if full ZEB transition (Mt)	0.18	0.23	0.27	0.13	0.16	0.19
Carbon avoided 2027 – 2036 (full ZEB transition) (Mt)	0.89	1.11	1.32	0.64	0.79	0.94
Cost/tonne over 10 years (full ZEB transition)	$1,052	$850	$714	$ 1,472	$1,190	$999
Proportion of 2036 transport emissions target for the West[12]	13%	17%	20%	10%	12%	14%

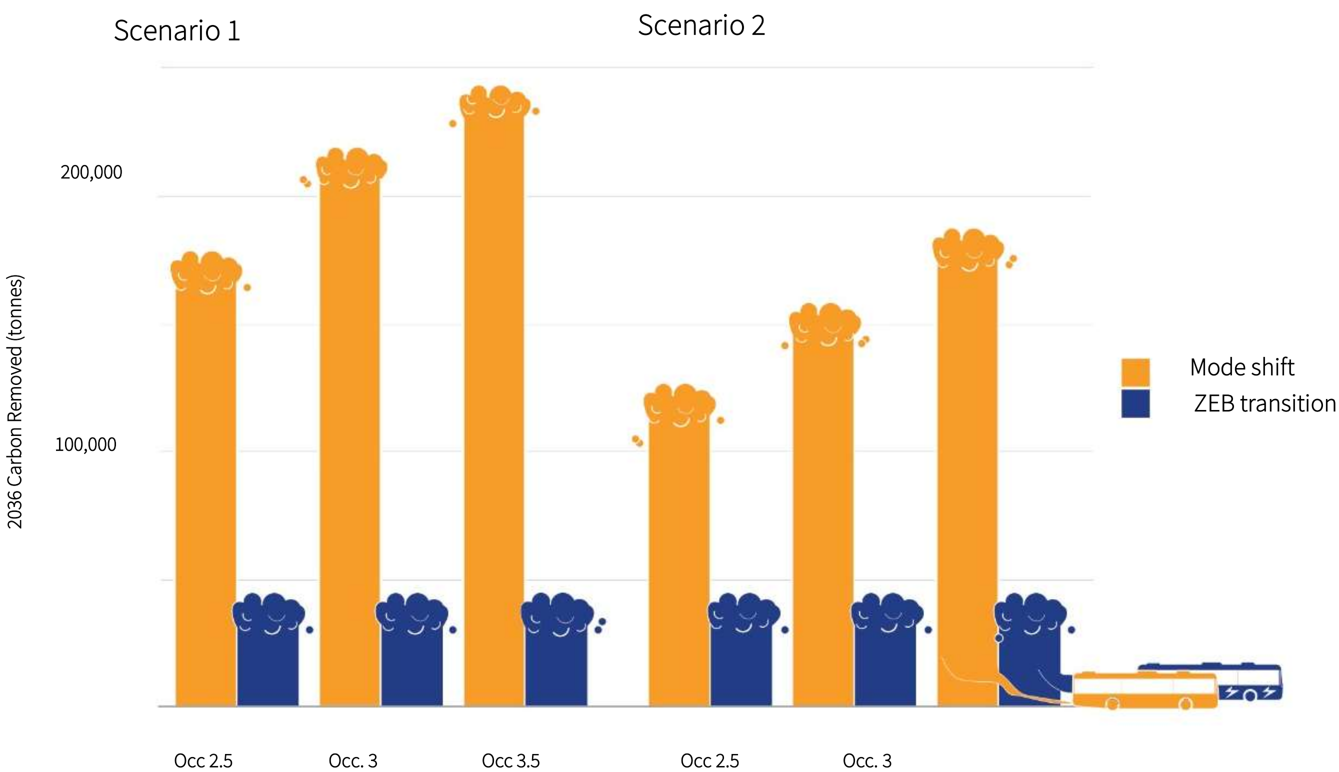
[11] Proportion of new trips that replace a car trip. This is an achievable target noting the current high proportion of car trips with a 'chauffeuring' purpose.

[12] This is estimated from the Victorian target on a per capita basis.

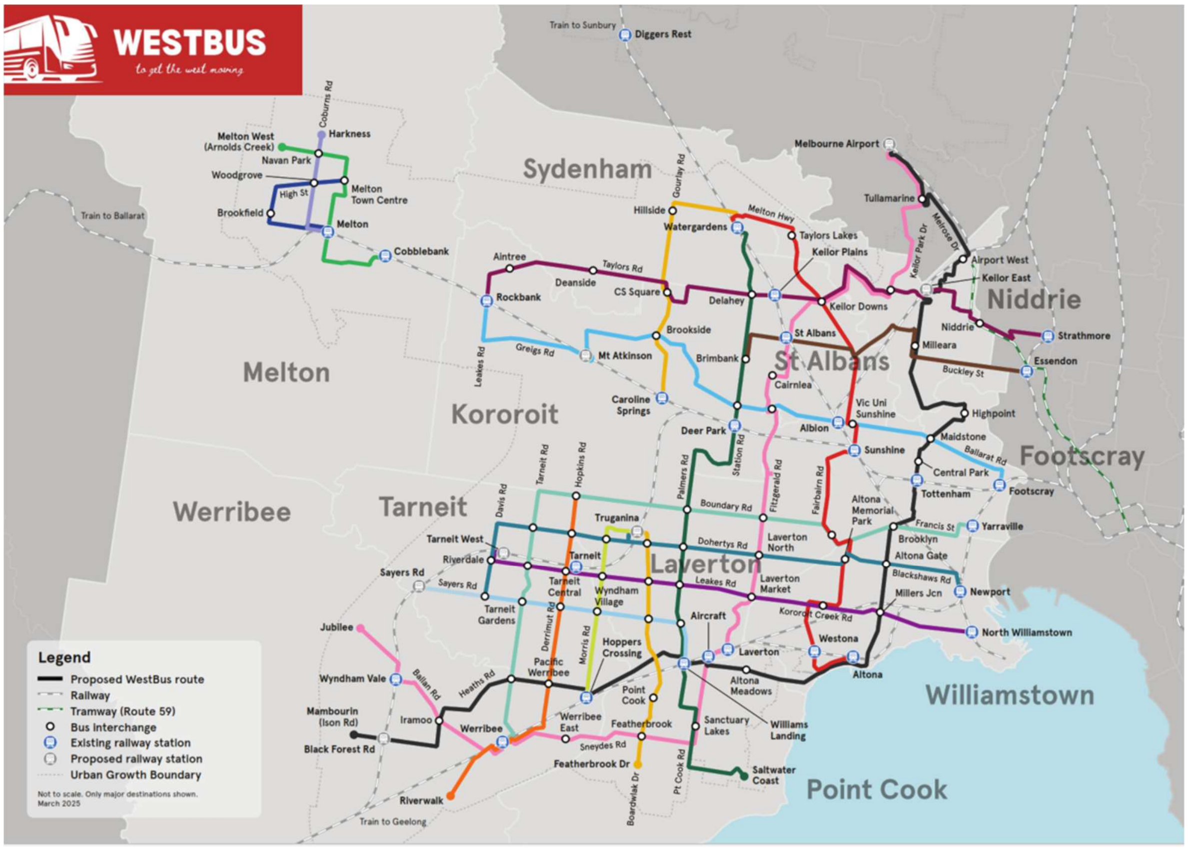
Carbon avoided 2027 – 2036 (full ZEB transition) (Mt)



Emission reduction in 2036 – mode shift vs. ZEB transition



GRID NETWORK MAP & COSTINGS



Proposed grid network for the West

Line	Length	Annual service-kilometres	Annual cost
Melton High Street to Melton Station	8.8	642,400	$3,308,360
Rockbank to Strathmore via Keilor East	32.9	2,401,700	$ 12,368,755
Melton Harkness to Melton Station	5.6	408,800	$ 2,105,320
Melton West to Cobblebank	11.0	803,000	$ 4,135,450
Rockbank to Footscray	31.2	2,277,600	$ 11,729,640
Werribee to Yarraville via Tarneit North	31.1	2,270,300	$ 11,692,045
Werribee Riverwalk to Tarneit North	15.7	1,146,100	$ 5,902,415
Point Cook Boardwalk to Truganina	8.2	599,330	$ 3,086,550
Caroline Springs to Watergardens	12.1	883,300	$ 4,548,995
Point Cook Saltwater to Watergardens	29.4	2,146,200	$ 11,052,930
Altona Beach to Watergardens	28.9	2,109,700	$ 10,864,955
Tarneit West to Williamstown North	22.4	1,635,200	$ 8,421,280
Tarneit Gardens to Newport	24.3	1,773,900	$ 9,135,585
Blackforest to Melbourne Airport via Altona	56.5	4,124,500	$ 21,241,175
Manor Lakes to Melb Airport via St Albans	56.0	4,088,000	$ 21,053,200
Tarneit Gardens to Williams Landing	10.3	751,900	$ 3,872,285
Hoppers Crossing to Truganina	8.2	598,600	$ 3,082,790
Brimbank to Essendon	16.6	1,211,800	$ 6,240,770
	400.4	**29,229,930**	**$ 150,534,140**

100 services per direction per day based on following service level assumption
5:30am - 7:00am - 15 minutes
7:00am - 9:00pm - 10 minutes
9:00pm - 11:30pm - 15 minutes
services run 365 days/year

$5.15/kilometre includes bus acquisition & running costs, dead-running time, maintenance, drivers, and operator's margins.

New grid operating costs per line (using costs as recognised by the industry in 2025)