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# Driving down emissions: accelerating Victoria's zero emission vehicle uptake

Key findings to inform Victoria's infrastructure strategy 2021-2051



## Acknowledgements

Infrastructure Victoria acknowledges the traditional owners of country in Victoria and pays respect to their elders past and present, as well as elders of other Aboriginal communities. We recognise that the state's infrastructure is built on land that has been managed by Aboriginal people for millennia.

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# Executive summary

In Victoria, cars are responsible for over half of the state's transport emissions. Transport is the state's second biggest contributor to greenhouse gases, and while in most sectors emissions are declining, transport emissions are increasing.

Climate change, driven by these rising greenhouse gas emissions, is one of the biggest threats to our future as communities around the world are responding to its current and expected impacts. The Victorian Government has joined the global call-to-action by setting a legislated target of reaching net zero emissions by 2050. This target will not be reached if Victoria's transport emissions continue to rise.

To assist the government in its efforts to plan for and minimise the risks posed by climate change, Infrastructure Victoria has investigated opportunities to drive down emissions in the transport sector. The purpose of this report is to share our research on what will be the most effective way to reduce Victoria's transport emissions - transitioning the current petrol and diesel vehicle fleet to low and zero emissions vehicles (ZEVs). Following extensive research, analysis and consultation, we have outlined priority actions the Victorian Government can take to encourage a greater uptake of ZEVs, including a ban on the sale of new petrol and diesel vehicles from the early 2030s.

Widespread electric car uptake has the potential to not only result in significant emissions reductions in Victoria and help reach the net zero target by 2050, but also deliver hundreds of millions of dollars every year in health and environmental benefits to the community. At the same time, accelerating the uptake of ZEVs will ensure Victoria does not get left behind by the rest of the world in one of the most significant transformations in transport since the emergence of the internal combustion engine.

We recognise there are other ways to reduce transport emissions which must also be pursued, such as getting more people on public transport, walking, and cycling. But for many Victorians, cars are essential and this reliance on private vehicles will likely continue into the future. By transitioning the vehicle fleet – especially cars – to ZEVs, Victorians can reduce their greenhouse gas emissions, enjoy the environmental and health benefits associated with cleaner air, and reduce the cost of driving and maintaining their vehicle. To do this, there are some barriers that need to be overcome.

The priority actions outlined in this report address the main barriers to ZEV uptake, being purchase price, access to charging infrastructure, and driving range anxiety, which are the biggest deterrents for consumers when considering an electric car. Additionally, manufacturers and consumers are caught up in a supply and demand cycle whereby manufacturers may be reluctant to bring zero emissions vehicle models to Australia without further encouragement of their uptake and a clear strategy, while consumers are unlikely to make the switch due to limited options.

To understand how the Victorian Government could overcome these barriers and promote ZEV uptake in Victoria, we sought the views of everyday Victorians through an online deliberative engagement process. The largest of its kind in Victoria, 211 people from a range of age groups, cultural backgrounds, employment status' and postcodes came together to address the question '*How should the Victorian Government support more people to adopt low or zero-emissions vehicles sooner?*' The insights from this process, coupled with a growing body of evidence based on policy approaches taken by governments around the world, point to a series of clear, concrete actions the Victorian Government can take right now, as well as informing a longer-term strategy.

Victoria is already heading in the right direction to overcome the barriers. With the release of *Victoria's zero emissions vehicle roadmap*, the Victorian Government has outlined its approach to boosting uptake in Victoria, but there is more that can be done.

Our recommended actions to increase ZEV uptake in Victoria are:

- In the next two years, **publish a statewide electric vehicle charging network strategy**, produce charging infrastructure design standards and payment principles.
- Over the next five years, **monitor and review the effectiveness of financial incentives** in encouraging early ZEV purchases.
- Within the next five years, **require all new government fleet vehicles to be ZEVs** where available. **Incentivise uptake of zero emissions freight vehicles** by reviewing restrictions on zero emissions freight movements on freight routes
- Commit to **no longer registering new petrol and diesel vehicles in Victoria by 2035 at the latest**, through increasingly stringent vehicle registration emissions standards.

Our recommendations complement and strengthen the actions the Victorian Government is already taking as part of *Victoria's zero emissions vehicle roadmap*. Taken together, these actions will significantly benefit Victorians now and into the future.



# Findings and priority actions

## What we found

- Reducing emissions from passenger vehicles is an essential step in meeting the Victorian Government's legislated target of net zero emissions by 2050.
- Lifecycle emissions of a typical battery electric vehicle, taking into account manufacture, operation (under the existing electricity generation mix), and disposal are around 20% lower than a typical petrol vehicle. This differential will increasingly favour battery electric vehicles as Victoria's grid continues to decarbonise.
- Australia lags the world in ZEV uptake.
- The barriers to consumer uptake of ZEVs are upfront financial cost, concerns around access to vehicle charging, and vehicle driving range.
- There has been an absence of strong action from the Australian Government to encourage ZEV uptake.
- Vehicle manufacturers are not prioritising Australia as a ZEV market. This results in a cycle of repressed demand and constrained supply.
- Jurisdictions around the world that have successfully increased ZEV uptake have used a mix of policy approaches, with a focus on addressing barriers and providing regulatory certainty.
- Policies that reduce the upfront cost of ZEVs, improve access to charging infrastructure, and send a clear market signal are likely to have the biggest impact on uptake.

## Priority actions for the Victorian Government

- The Victorian Government should immediately start to **develop a statewide charging network strategy** which considers the needs of all road users. The charging strategy should include standards for design and placement of public charging infrastructure, and principles for smart charging and integrated payment systems, so electric vehicle owners can use any provider for charging. In addition, the charging strategy should consider the sufficiency of electricity distribution infrastructure to meet highly localised energy demands in areas with high levels of ZEV uptake. The statewide charging network strategy should be published within two years.
- The Victorian Government should **monitor and review the effectiveness of financial incentives in encouraging early ZEV purchases**. The Victorian Government's ZEV subsidy program provides financial incentives to help overcome the cost barrier. Subsidies are particularly important until ZEVs reach purchase price parity with internal combustion engine vehicles, potentially as early as 2023. To ensure the subsidies are operating effectively to increase ZEV uptake, over the next five years the Victorian Government should regularly monitor and review the subsidy.
- To help reduce road transport emissions in the public sector, the Victorian Government should **transition the government vehicle fleet to ZEVs where available**. To help reduce road transport emissions in the industry sector, the Victorian Government should also **incentivise uptake of zero emissions freight vehicles** by reviewing restrictions on zero emissions freight movements on freight routes.
- The Victorian Government should immediately **commit to no longer registering new petrol and diesel vehicles in Victoria by 2035 at the latest**. In the lead up to this date, there should be a combination of increasingly strict air quality standards and vehicle registration requirements. This would strengthen the market signal of the ZEV roadmap which sets a target for 50% of new light vehicle sales to be ZEVs by 2030.

# Context of this work

## Victoria will not reach its emissions reduction targets with continued reliance on petrol and diesel vehicles.

In the transport sector, road transport is the biggest contributor to emissions at 88%, see Figure 1. This is driven mostly by cars, followed by heavy-duty trucks and light commercial vehicles.

Victoria is making progress in emissions reduction, but more needs to be done to reach the legislated net zero target.

Despite being Australia's second most populous state, Victoria is the third-largest contributor to Australia's total net emissions, contributing 19% to the national total. Due to a combination of policy interventions, changes in consumer behaviour and technological evolution, Victoria's emissions have decreased over the last two decades and fell to 25% below 2005 levels in 2019.<sup>1</sup> Victoria's total net emissions in 2018 were 102.2 million tonnes.<sup>2</sup>

Vehicle emissions in Victoria are increasing. Emissions from vehicles are a significant contributor to Victoria's overall greenhouse gas emissions. The transport sector (23%) is the second-largest contributor to greenhouse gas emissions in Victoria behind electricity generation (45%), see Figure 2.<sup>3</sup> Vehicle emissions have increased in Victoria in recent years, even as Victoria's overall emissions levels have declined.

In Victoria, climate change is expected to result in more frequent and intense bushfires, heatwaves, droughts, extreme rainfall events and coastal inundation in coming decades. Like other jurisdictions across Australia and around the world, Victoria is seeking to reduce greenhouse gas emissions to respond to and minimise the risks posed by climate change.

The Victorian Government has set a target of reaching net zero greenhouse gas emissions by 2050, meaning it intends to eliminate, or reduce and offset carbon dioxide (CO<sub>2</sub>) and other emissions to a point where they are effectively zero. This target is outlined in the *Climate Change Act 2017*.

Advancing climate change mitigation and adaption is one of the ten objectives that underpin *Victoria's infrastructure strategy 2021–2051*, which makes 94 recommendations to guide the state's infrastructure planning over the next 30 years. The strategy includes 41 recommendations which respond to this objective and the challenges and opportunities which arise from a changing climate.

To help inform *Victoria's infrastructure strategy*, we consulted widely on the themes and recommendations through 34 community and stakeholder events held during a three-month engagement program. Nearly 18,800 visits to our website were recorded, plus a further 7,000 to the engagement portal, and we received more than 2,600 contributions across all engagement activities, including more than 360 survey responses and 200 written submissions providing feedback on the recommendations.

As part of this robust consultation program, we commissioned a deliberative engagement process to better understand the community's views on supporting the uptake of ZEVs.<sup>4</sup> This paper builds on the feedback we received through that process, and examines a range of evidence, research and community insight and experience to identify and prioritise potential policy levers that could be used in Victoria to encourage ZEV uptake.

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<sup>1</sup>Department of Environment, Land, Water and Planning (2021) *Victoria's greenhouse gas emission* available at <https://www.climatechange.vic.gov.au/victorias-greenhouse-gas-emissions>

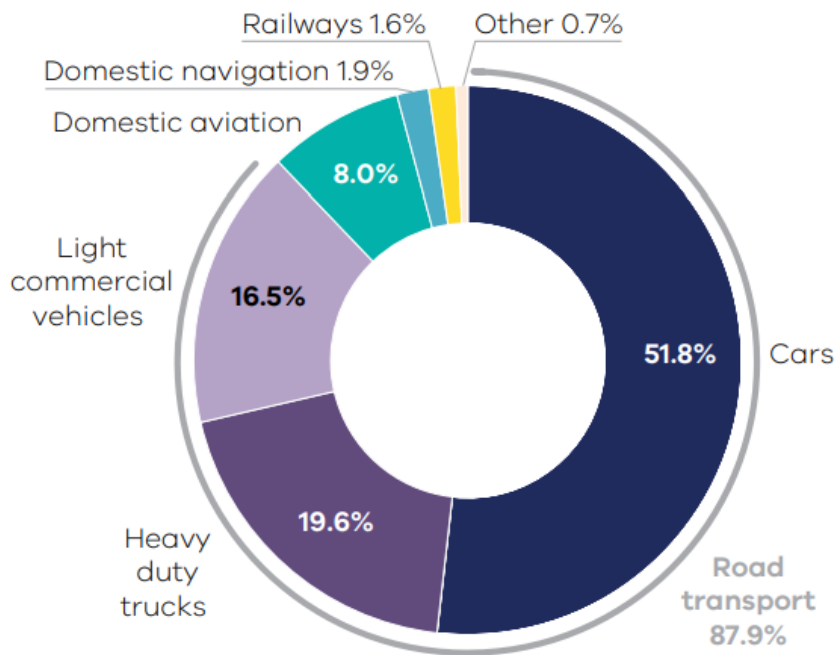
<sup>2</sup> Department of Environment, Land, Water and Planning (2020) *Victorian Greenhouse Gas Emissions Report 2018* available at [https://www.climatechange.vic.gov.au/\\_\\_data/assets/pdf\\_file/0026/504188/Victorian-Greenhouse-Gas-Emissions-Report-2018a1.pdf](https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0026/504188/Victorian-Greenhouse-Gas-Emissions-Report-2018a1.pdf)

<sup>3</sup> Department of Environment, Land, Water and Planning (2020) *Victorian Greenhouse Gas Emissions Report 2018* available at [https://www.climatechange.vic.gov.au/\\_\\_data/assets/pdf\\_file/0026/504188/Victorian-Greenhouse-Gas-Emissions-Report-2018a1.pdf](https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0026/504188/Victorian-Greenhouse-Gas-Emissions-Report-2018a1.pdf)

<sup>4</sup> Deliberative engagement refers to a process by which a diverse group of people is selected to meet regularly over a specified period to learn about and deliberate on a particular topic before coming to a group decision at the program's conclusion. The full engagement report is available at <https://www.infrastructurevictoria.com.au/wp-content/uploads/2021/04/Tackling-Transport-Emissions-Community-Panel-Report-April-2021.pdf>

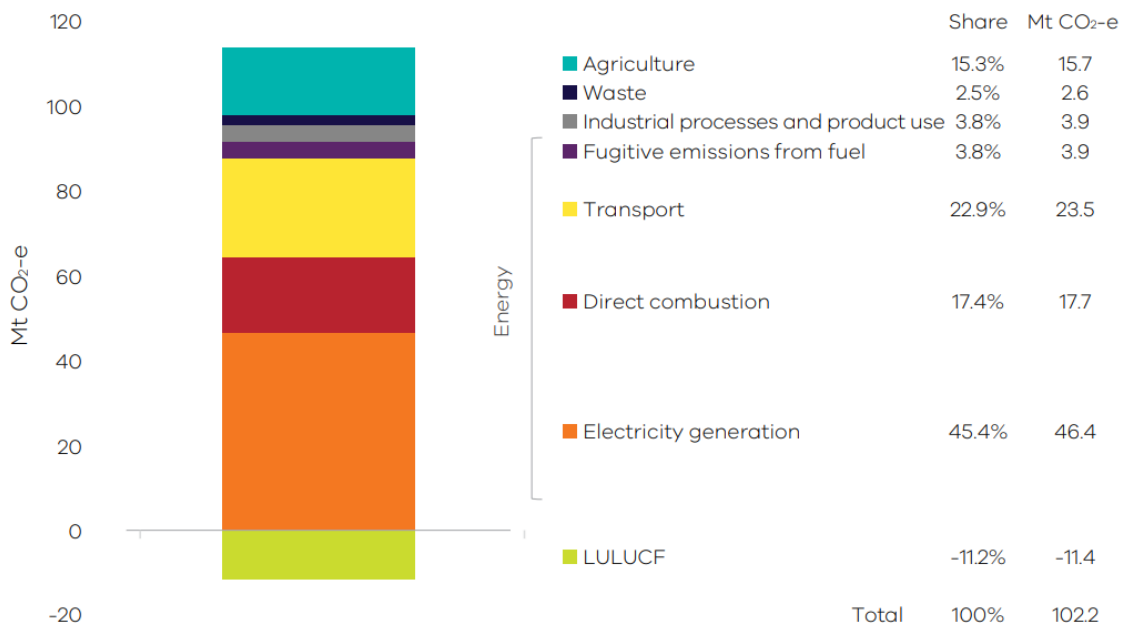


Figure 1: Victorian transport emissions by mode and category (2018)



Source: Department of Environment, Land, Water and Planning (2020) Victorian Greenhouse Gas Emissions Report 2018

Figure 2: Victorian emissions by sector (2018)



Source: Department of Environment, Land, Water and Planning (2020) Victorian Greenhouse Gas Emissions Report 2018

Note: 'LULUCF' denotes land use, land-use change and forestry. This includes new forests planted on previously unforested land which contributes to net negative emissions in this sector.

## Climate change and the cost of doing nothing

The Victorian Government has identified climate change as one of the biggest threats to our future. Warmer and drier conditions will impact the health of the community, as well as the infrastructure, agriculture, water and biodiversity across the state, particularly in alpine and coastal areas. As well as the environmental impacts, there is also a significant economic burden including the financial cost of extreme weather events, lost primary production and a decline in alpine tourism. The cost involved with reducing Victoria's emissions through measures such as encouraging ZEV uptake, are far outweighed by the potential environmental and economic burden of not planning for climate change.<sup>5</sup>

## Commuter behaviour and transport choices

Despite an increase in investment in major public transport infrastructure projects in recent years, the dominant mode of transport in Victoria is still cars. While the share of trips by public transport is expected to increase in the future with substantial investments in public transport, cars are still expected to persist as the dominant mode of transport. Our transport modelling for *Victoria's infrastructure strategy* found that by 2036 over 20 million car trips are expected each day in Victoria. This accounts for approximately 90% of all motorised trips, with public transport making up the remainder.<sup>6</sup>

While increasing active and public transport use is necessary and should continue to be pursued, as long as there are traditional internal combustion engine (ICE) vehicles on the road, there will be greenhouse gas emissions from transport. Additionally, while the electrification of motorbikes, emergence of e-bikes and other forms of micro-mobility will help reduce transport sector emissions, it is the transition of cars to zero emissions that is likely to have the most significant impact. Therefore, a key opportunity to reduce Victoria's transport emissions to net zero is by accelerating the transition of cars, trucks and light commercial vehicles to zero emissions.

Victoria's strong population growth has been a key reason behind the 25% rise in emissions from cars since 1990.<sup>7</sup> The challenge of reducing emissions in line with Victoria's targets is therefore intensified by Victoria's projected population growth, which is expected to grow 41% from current levels over the next 30 years.<sup>8</sup>

## Policy context

The following sections outline some of the recent developments in policy for addressing emissions in the transport sector globally, nationally, and here in Victoria.

### International Energy Agency's *Net zero by 2050: a roadmap for the global energy sector*

At the international level, the International Energy Agency, the main international forum for energy cooperation, released its report *Net zero by 2050: a roadmap for the global energy sector* in May 2021. Australia is a member of the International Energy Agency.

The report details the global energy pathway required to reach net zero emissions by 2050.<sup>9</sup> The necessary, high-level actions required to be enacted across all regions include:

- massive clean energy infrastructure investment
- market reforms such as carbon pricing
- the elimination of fossil fuel subsidies
- development and deployment of new technologies
- energy standards for products including buildings, appliances, and vehicles
- awareness measures to change behaviour, for example to encourage more active transport
- direct emissions reduction regulations, for example ceasing the sale of new internal combustion engine cars
- setting near term milestones to achieve long term goals

The report notes the biggest reduction in global energy demand will need to be in the transport sector from an accelerated shift to electric vehicles. Electric vehicles are around three-times as energy efficient as conventional internal combustion engine vehicles.

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<sup>5</sup> Independent Expert Panel (2019) *Interim Emissions Reduction Targets for Victoria (2021-2030)* available at [https://www.climatechange.vic.gov.au/\\_\\_data/assets/pdf\\_file/0016/420370/Final-Report\\_Interim-Emissions-Reduction-Targets.pdf](https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0016/420370/Final-Report_Interim-Emissions-Reduction-Targets.pdf)

<sup>6</sup> Infrastructure Victoria analysis of Arup *Strategic Modelling Outcomes* (2021)

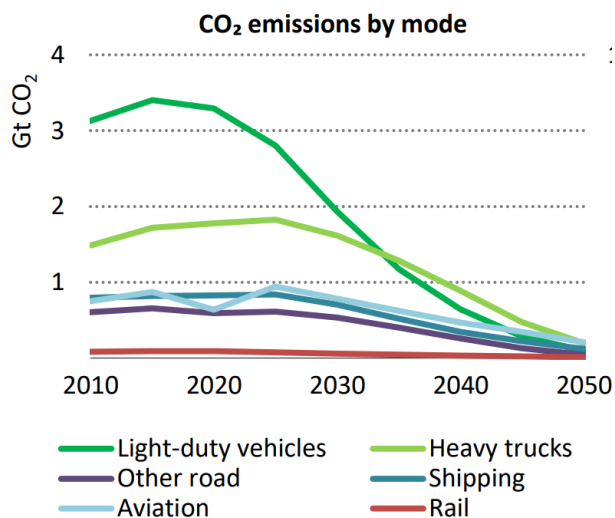
<sup>7</sup> Department of Environment, Land, Water and Planning (2020) *Victorian Greenhouse Gas Emissions Report 2018* available at [https://www.climatechange.vic.gov.au/\\_\\_data/assets/pdf\\_file/0026/504188/Victorian-Greenhouse-Gas-Emissions-Report-2018a1.pdf](https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0026/504188/Victorian-Greenhouse-Gas-Emissions-Report-2018a1.pdf)

<sup>8</sup> Department of Environment, Land, Water and Planning (2019) *Victoria in Future 2019: Population projections 2019 to 2056*

<sup>9</sup> International Energy Agency (2021) *Net zero by 2050: a roadmap for the global energy sector* available at <https://www.iea.org/reports/net-zero-by-2050>

To reach net zero emissions by 2050, the Agency emphasises the need to globally end the sale of new internal combustion engine cars by 2035 and for policies to encourage take up of electric vehicles. If the Agency’s recommended actions are taken, the modelled trajectory of global transport emissions will fall over the next three decades, as shown in Figure 3.

Figure 3: Global CO<sub>2</sub> transport emissions (gigatonnes) to reach net zero by 2050



Source: International Energy Agency (2021) *Net zero by 2050: a roadmap for the global energy sector*

The Agency states that if the recommended actions are taken globally and immediately “we have a fighting chance of reaching net zero by 2050 and limiting the rise in global temperatures to 1.5 degrees Celsius”.

### Australian Government’s *Future fuels strategy*

At the national level, the Australian Government has an important role to play in encouraging the uptake of ZEVs. While Victoria’s transport sector emissions are influenced by Victorian Government policy, the Australian Government is responsible for setting national policies and standards, such as vehicle emissions standards. A nationally consistent approach to promoting ZEVs is particularly important given the relatively small size of the Australian vehicle market in the global context.

In February 2021, the Australian Government released the *Future fuels strategy discussion paper*. The discussion paper sets out the Australian Government’s direction and planned actions to enable the private sector to deploy low-emissions road transport technologies. The discussion paper is underpinned by three principles:

- Addressing barriers to the roll out of new vehicle technologies will increase consumer choice.
- Government investment in early stage technologies can stimulate the market and private sector investment.
- Access to information can help people make informed choices.

The strategy identifies ways to deliver on these principles while seeking to avoid providing financial subsidies for purchase of low or ZEVs. The five priority areas are:

- Electric vehicle charging and hydrogen refuelling infrastructure where it is needed.
- Early focus on commercial fleets.
- Improving information for motorists and fleets.
- Integrating battery electric vehicles into the electricity grid.
- Supporting Australian innovation and manufacturing.<sup>10</sup>

The actions proposed in the discussion paper are likely to address some, but not all, of the barriers to ZEV uptake in Australia. Infrastructure Victoria considers there is scope for the Australian Government to send stronger signals through actions such as the application of stricter CO<sub>2</sub> emissions standards, and identifying a target date for the phase out of ICE vehicles. The Australian Government is currently seeking feedback on the discussion paper, with the final strategy planned to be released in 2021.

<sup>10</sup> Department of Industry, Science, Energy and Resources (2021) *Future Fuels Strategy: discussion paper* available at [https://consult.industry.gov.au/climate-change/future-fuels-strategy/supporting\\_documents/Future%20Fuels%20Strategy%20Discussion%20Paper.pdf](https://consult.industry.gov.au/climate-change/future-fuels-strategy/supporting_documents/Future%20Fuels%20Strategy%20Discussion%20Paper.pdf)

## Victorian Government's Climate Change Act and emissions reductions targets

At the state level, climate targets help guide government decision-making and are legislated in the Climate Change Act which is Victoria's response to the climate change challenge. Having a legislative framework to achieve net zero emissions and a climate-resilient Victorian community by 2050 reflects Victoria's commitment to obligations within the Paris Agreement. As part of the Act, five-yearly interim emission reduction targets were set to keep Victoria on track to meet this long-term goal. The first and most recent interim climate targets were to reduce Victoria's emissions by 15-20% below 2005 levels by 2020, and to reduce emissions from government operations by 30% below 2015 levels by 2020.<sup>11</sup>

The transition to a low-emissions economy is gathering pace in Victoria and across the world. Victoria's abundance of wind and sun means the state is in a good position to capitalise on this transition and harness opportunities to explore renewable energy generation.

## Infrastructure Victoria's *Advice on automated and zero emissions vehicles infrastructure*

In October 2018, Infrastructure Victoria provided advice to the Victorian Government on automated vehicles and ZEVs. This advice outlines the practical opportunities and challenges associated with enabling automated vehicles and ZEVs. The advice also measured, in some cases for the first time, the significant benefits that ZEVs could deliver to Victorians. This included improved environmental outcomes and benefits to human health resulting from lower emissions. For example, we found that a transition to ZEVs could reduce Victoria's overall emissions by 25%, reduce vehicle operating costs by 50%, and deliver over \$700 million of health benefits per year by the year 2046 while requiring energy network upgrades of at least \$2.2 billion.<sup>12</sup> The result of that 2018 research led to 17 recommendations being made to the Victorian Government on actions it could take to prepare for the emergence of automated and ZEVs, ranging from upgrading the energy network and enabling the energy sector to better plan and prepare for ZEVs through to planning for the new waste streams arising from battery electric vehicles.

While it was not the main focus of the advice, this research also revealed insights into how to promote ZEV uptake. These findings have now informed the development of our latest recommendations on ZEVs in *Victoria's infrastructure strategy*. Specifically, our research suggested that, in jurisdictions where one or more of the following actions have been taken, ZEV take up has been high:

- Subsidising ZEVs.
- Establishing vehicle emissions standards, ideally at the national level.
- Implementing low or zero emissions zones for all or a segment of vehicles (for example, freight).
- Providing public charging infrastructure.
- Continuing (or strengthening) renewable energy targets.
- Phasing out internal combustion engine vehicles over time, ultimately leading to a ban on petrol/diesel vehicles beyond a certain date.

More detail on Infrastructure Victoria's *Advice on automated and zero emissions vehicle Infrastructure* is available at <https://www.infrastructurevictoria.com.au/project/automated-and-zero-emission-vehicle-infrastructure/>.

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<sup>11</sup> Department of Environment, Land, Water and Planning (2020) *Emissions reduction targets* available at <https://www.climatechange.vic.gov.au/reducing-emissions/emissions-targets>

<sup>12</sup> 2046 was the reference year for the advice and its associated modelling

## Victoria's zero emissions vehicle roadmap

In May 2021, the Victorian Government published *Victoria's zero emissions vehicle roadmap* (ZEV roadmap), which addresses the transport sector's responsibility in helping to achieve Victoria's net zero emissions target by 2050. The ZEV roadmap outlines actions that will be taken in this decade to address key barriers to the uptake of ZEV technology and explores opportunities associated with this major technological transition.<sup>13</sup>

The actions set in the ZEV roadmap are outlined in Table 1.

**Table 1: Key ZEV roadmap actions**

<b>Public education</b>	Addressing concerns about ZEVs and their performance
	Supporting an improved understanding about ZEV options and transition
<b>Advocacy</b>	Working with other States and Territories to look at options for developing a harmonised approach to vehicle emissions standards, given the lack of action at the national level, and allowing parallel imports from other right-hand drive markets
<b>Promoting 'ZEV-readiness'</b>	Investing \$19 million to accelerate the rollout of battery electric vehicle charging infrastructure across regional Victoria, and support electric vehicle fleets
	Supporting changes to the National Construction Code from 2022 to reduce barriers to future installation of EV charging in new buildings
	Undertaking a \$298,000 study on ZEV-readiness in new developments
	Developing an online guide for apartment owners and body corporate committees to assist them in identifying and assessing options to enable EV charging in existing buildings
	Investigating the need for, and feasibility of, hydrogen re-fuelling stations and other supporting infrastructure
<b>Transitioning our fleets</b>	Investing \$46 million for Australia's first public ZEV subsidy program – supporting the purchase of more than 20,000 ZEVs
	Setting a target of 50% of new light vehicle sales to be ZEV by 2030
	Establishing an expert panel to recommend policies, enabling investments and timelines to support the achievement of this 2030 target
	\$10 million to green the Victorian Government Fleet, including replacement of 400 vehicles with ZEVs by 2023
	\$5 million to establish a Commercial Sector Zero Emissions Vehicle Innovation Fund
	\$20 million to undertake a ZEV bus trial
	Setting a target for all public transport bus purchases to be ZEVs from 2025
<b>Transitioning our energy sector</b>	Managing the integration of ZEVs into our energy system through participation in inter-jurisdictional forums and research activities
<b>Transitioning Victorian industry and workforce</b>	Commencing work on an industry development and transition plan to explore opportunities for Victorian industry associated with ZEV manufacturing, maintenance, repair and recycling
	Identifying industry development pathways for emerging technologies, including investigating the potential for hydrogen in transport
	Planning to support our workforce through the transition to zero emissions road transport as part of Victoria's clean economy workforce development strategy

Source: Department of Environment, Land, Water and Planning (2021) *Victoria's zero emissions vehicle roadmap*

Note: The initiatives for zero emission buses are also contained in *Victoria's bus plan*

The ZEV roadmap also responds to Infrastructure Victoria's 2018 *Advice on automated and zero emissions vehicles Infrastructure*, and explicitly responds to the six key recommendations in the advice relating to ZEVs. Infrastructure Victoria's community panel report on low and zero emissions vehicles is also noted in the ZEV roadmap.

Infrastructure Victoria supports the actions laid out in the ZEV roadmap. Our recommended actions on ZEVs will complement and further strengthen the actions the Victorian Government is already taking.

<sup>13</sup> Department of Environment, Land, Water and Planning (2021) *Victoria's zero emissions vehicle roadmap* available at [https://www.energy.vic.gov.au/\\_\\_data/assets/pdf\\_file/0014/521312/Zero-Emission-Vehicle-ZEV-Roadmap-FINAL.pdf](https://www.energy.vic.gov.au/__data/assets/pdf_file/0014/521312/Zero-Emission-Vehicle-ZEV-Roadmap-FINAL.pdf)

## ZEVs represent an opportunity to significantly reduce overall emissions in Victoria and deliver health benefits

Australia is lagging in the adoption of ZEVs compared to other countries. This is due to a combination of high cost, lack of choice, and consumer opinion. Some countries, such as Norway, have uptake as high as 74% of new vehicle sales, compared with 0.7% in Australia.<sup>14</sup> Globally, 19% of two-and three-wheeled vehicles (such as motorised scooters) on the road, and 31% of the global municipal bus fleet, are already electric. The current worldwide EV fleet is already displacing one million barrels per day of oil demand.<sup>15</sup>

Global progress in the transition to ZEVs represents an opportunity to promote ZEV use and significantly reduce Victoria's overall greenhouse gas emissions. Our research has shown that if all vehicles on Victorian roads were ZEVs, around 27 million tonnes of greenhouse gas emissions would be eliminated in Victoria in the year 2046, equivalent to around 25% of today's total emissions.<sup>16</sup>

The transition to ZEVs could also deliver significant health benefits to Victorians through improved air quality. Air pollutants emitted by ICE vehicles have negative human health impacts including increases in morbidity and mortality related to respiratory disease, cardiovascular disease, cardiac disease, pneumonia, and bronchitis.<sup>17</sup> Infrastructure Victoria has previously estimated that the transition to ZEVs could create health benefits, from avoided morbidity and mortality and morbidity, of over \$700 million annually by 2046.<sup>18</sup> The health of residents in urban areas with high population densities would particularly benefit from more ZEVs on the road.

In the following sections, we explore ZEV technology, barriers to uptake, steps that other jurisdictions are taking to boost uptake of ZEVs, and how the Victorian Government could accelerate uptake here in Victoria.

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<sup>14</sup> Department of Environment, Land, Water and Planning (2021) *Victoria's zero emissions vehicle roadmap* available at [https://www.energy.vic.gov.au/\\_\\_data/assets/pdf\\_file/0014/521312/Zero-Emission-Vehicle-ZEV-Roadmap-FINAL.pdf](https://www.energy.vic.gov.au/__data/assets/pdf_file/0014/521312/Zero-Emission-Vehicle-ZEV-Roadmap-FINAL.pdf)

<sup>15</sup> BloombergNEF (2020) *New Energy Outlook 2020*

<sup>16</sup> Infrastructure Victoria (2018) *Automated and Zero Emissions Vehicles Infrastructure Advice* available at <https://www.infrastructurevictoria.com.au/wp-content/uploads/2019/04/Advice-on-automated-and-zero-emissions-vehicles-October-2018.pdf>

<sup>17</sup> Aurecon, for Infrastructure Victoria (2018) *AV/ZEV Environmental & Health Impact Assessment* available at [https://www.infrastructurevictoria.com.au/wp-content/uploads/2019/04/AVZEV\\_Environmental\\_\\_Health\\_Impact\\_Assessment.pdf](https://www.infrastructurevictoria.com.au/wp-content/uploads/2019/04/AVZEV_Environmental__Health_Impact_Assessment.pdf)

<sup>18</sup> Infrastructure Victoria (2018) *Automated and Zero Emissions Vehicles Infrastructure Advice* available at <https://www.infrastructurevictoria.com.au/wp-content/uploads/2019/04/Advice-on-automated-and-zero-emissions-vehicles-October-2018.pdf>



# Zero emission vehicle technology types

There are two main types of ZEV technologies – battery electric and hydrogen fuel cell. Each technology type has different energy requirements and present their own opportunities and challenges. Low-emissions vehicles, such as plug-in hybrid electric vehicles, will likely have a role in meeting the interim emissions reduction targets but ultimately are not likely to deliver the results required to achieve net zero emissions by 2050.

## Battery electric vehicles

Battery electric vehicles run entirely on electricity which is stored in the vehicle's battery pack. They are typically recharged from either the power grid or through home energy capture (e.g. solar). In general, the larger the battery, the further the vehicle can travel on a single charge. Most battery electric vehicles on the market today have an estimated range of around 300km per charge.<sup>19</sup> This means that they are likely to provide ample range for regular day-to-day use for most Victorians. For instance, 90% of car trips to work in Victoria are less than 27km a day.<sup>20</sup> We also note that some currently available vehicles with larger batteries have a range of around 650km.<sup>21</sup>

In recent years, battery electric vehicles sales have accounted for around 0.27% of new car sales in Victoria, or 27 battery electric vehicles for every 10,000 vehicles sold.<sup>22</sup> Across Australia it is estimated that there are currently around 20,000 battery electric vehicles on the road, with 5,800 of these in Victoria.<sup>23</sup> Battery electric vehicles make up around 0.1% of the total vehicle fleet in Australia.<sup>24</sup> Based on current trends, and in the absence of any further policy incentives, uptake of battery electric vehicles is projected to reach only 3% of the total Australian vehicle fleet, or half a million vehicles, by 2029-30.<sup>25</sup>

Battery electric vehicles are the most widely available of the two ZEV technologies. In Australia in 2021, we have access to around a dozen fully electric vehicle models. This is more selection than ever, but still significantly fewer than other comparable markets, including other right-hand drive markets. For example, consumers in the United Kingdom have 130 electric vehicle models to choose from.

## Hydrogen fuel cell vehicles

Unlike battery electric vehicles, which get their power from a built-in battery charged from an external power source, hydrogen vehicles produce energy internally using a fuel cell. Hydrogen stored in the vehicle's fuel tank reacts with oxygen in the fuel-cell stack through a process called reverse electrolysis, which produces electrical energy, heat and water. While heat and water are emitted through the exhaust as water vapour, the electricity either flows to the electric motor to power the vehicle directly or charges a battery that stores the energy until it is needed. A battery in a hydrogen-

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<sup>19</sup> Infrastructure Victoria (2018) *Automated and Zero Emissions Vehicles Infrastructure Advice* available at <https://www.infrastructurevictoria.com.au/wp-content/uploads/2019/04/Advice-on-automated-and-zero-emissions-vehicles-October-2018.pdf>

<sup>20</sup> Department of Environment, Land, Water and Planning (2021) *Victoria's zero emissions vehicle roadmap* available at [https://www.energy.vic.gov.au/\\_\\_data/assets/pdf\\_file/0014/521312/Zero-Emission-Vehicle-ZEV-Roadmap-FINAL.pdf](https://www.energy.vic.gov.au/__data/assets/pdf_file/0014/521312/Zero-Emission-Vehicle-ZEV-Roadmap-FINAL.pdf)

<sup>21</sup> Tesla (2021) *Model 3 Overview* available at [https://www.tesla.com/en\\_au/model3/design#overview](https://www.tesla.com/en_au/model3/design#overview)

<sup>22</sup> Tesla does not make local sales data available, so sales of Teslas are not included in these figures. Electric Vehicle Council (2020) *State of Electric Vehicles August 2020* available at <https://electricvehiclecouncil.com.au/wp-content/uploads/2020/08/EVC-State-of-EVs-2020-report.pdf>

<sup>23</sup> The Driven (December 2020) *How many electric cars are there in Australia, and where are they?* available at <https://thedriven.io/2020/12/23/how-many-electric-cars-are-there-in-australia-and-where-are-they/>

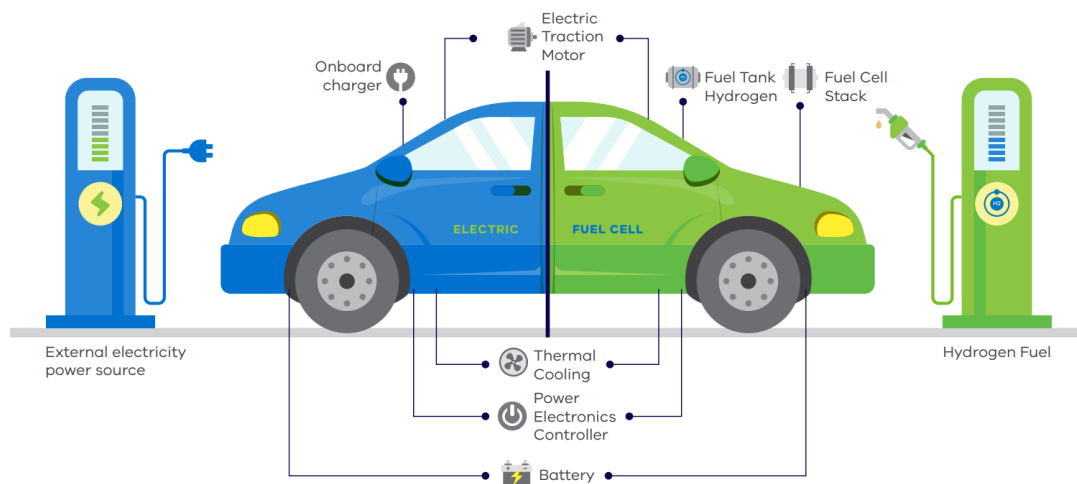
<sup>24</sup> Based on around 20,000 battery electric vehicles, and around 20 million motor vehicles in total (ABS Motor Vehicle Census available at <https://www.abs.gov.au/statistics/industry/tourism-and-transport/motor-vehicle-census-australia/latest-release>)

<sup>25</sup> Australian Energy Market Operator (2020) *2020 Electricity Statement of Opportunities* available at [https://aemo.com.au/-/media/files/electricity/nem/planning\\_and\\_forecasting/nem\\_esoo/2020/2020-electricity-statement-of-opportunities.pdf?la=en](https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/nem_esoo/2020/2020-electricity-statement-of-opportunities.pdf?la=en)

powered vehicle is much smaller and lighter than one in a fully electric car. It is constantly recharged by the fuel cell. Hydrogen fuel cell vehicles typically have a driving range of around 500-600km before needing to be refuelled.<sup>26</sup>

Hydrogen fuel cell vehicles are still an emerging market. In early 2021 there were only two models in use in Australia – the Toyota Mirai and Hyundai Nexo – both of which are only operating in a trial capacity.

Figure 4: Battery electric & hydrogen fuel cell vehicles



Source: Department of Environment, Land, Water and Planning (2021) Victoria's zero emissions vehicle roadmap

### ZEV emissions and energy sources

A commonly cited concern is that battery electric ZEVs emit as much, if not more, CO<sub>2</sub> emissions than petrol and diesel vehicles due to the emissions intensity of electricity generation. Fossil fuel use in energy production is a significant contributor to overall greenhouse gas emissions and there is a risk that the electricity generation required to power increased use of ZEVs in Victoria will contribute to emissions. This risk is greater in the present than in the future, given the current sources of Victoria's energy grid are a mix of renewables and carbon intensive generation.

However, as far back as 2014, the Climate Change Authority estimated that when powered by the average Australian energy grid (with 13.5% renewables at the time), the fully electric vehicles available in Australia are less emissions-intensive than the average light car (Climate Change Authority (2014) *Light vehicle emissions standards for Australia - research report*).

A 2019 investigation by academics found that an electric vehicle would emit 170 grams of CO<sub>2</sub> per km compared to 251 grams for an equivalent petrol-fuelled vehicle (about a 30% reduction), based on an energy grid of 21% renewables. Infrastructure Victoria has cross checked this result against a Victorian specific energy mix, including brown coal, and found similar results. The 2019 investigation also noted that on a lifecycle basis, taking into account manufacture, operation, and recycling phases, electric vehicles have an approximately 20% lower carbon footprint than conventional petrol fuelled cars (Hasan, M and Chapman, R (2019) *Climate explained: the environmental footprint of electric versus fossil cars*).

As the emissions intensity of Victoria's energy grid continues to fall, the emissions performance of electric vehicles will further improve. As of 2020, around 27.7% of Victoria's energy is sourced from renewable sources This compares with 14.2% five years prior, in 2015. (Clean Energy Council (2021) *Clean energy Australia report 2021*). It is assumed that the 2050 net zero emissions target will be met in the energy sector as the use of renewable generation and storage continues to increase. This will allow electric vehicles to operate emissions free.

<sup>26</sup> RACV (2020) *Everything you need to know about hydrogen cars* available at <https://www.racv.com.au/royalauto/moving/news-information/hydrogen-cars-explained.html>

## The different vehicle technologies have their own challenges

The two different technologies have significantly different charging and refuelling infrastructure needs. Battery electric vehicles can be charged directly from the grid almost anywhere there is a power outlet or at dedicated fast-charging locations. While the emissions intensity of Victoria's grid means that battery electric vehicles are still contributing to overall emissions, the real-world lifecycle emissions of a typical battery electric vehicle would still be 20% lower than a typical petrol vehicle.<sup>27</sup> This differential will improve in favour of battery electric vehicles as Victoria moves toward its net zero emissions target.

Conversely, large-scale use of hydrogen fuel cell vehicles would likely require developing a new hydrogen supply chain encompassing generation, distribution and refuelling infrastructure. Local and international evidence suggests that hydrogen supply chains can be very costly to develop. Japanese gas and energy company Iwatani put the cost of building its first hydrogen refuelling station at around AUD\$6 million, which is around four times the cost of a comparable-sized petrol station.<sup>28</sup> Also, zero emissions hydrogen production is still yet to reach scale in Australia. There are some examples of where developing hydrogen supply and refuelling infrastructure can be viable. Hydrogen has potential range-to-weight benefits when used as a fuel for heavy vehicles, such as freight and public transport. Current battery technologies are generally considered too heavy to be commercially viable for trucks and buses that need to travel longer distances, limiting their ability to carry goods and passengers. This could make hydrogen fuel cell vehicles a more feasible option than battery electric vehicles for these uses.

The Victorian Government is actively working with other states to implement *Australia's national hydrogen strategy* and help the nation capitalise on hydrogen opportunities, particularly green hydrogen (i.e. hydrogen produced using renewable electricity) in Victoria. Uptake of green hydrogen could help Victoria achieve significant greenhouse gas emissions reductions.

For Victoria, green hydrogen as a fuel substitute option is made attractive given its substantive natural gas distribution and transmission pipeline infrastructure. Hydrogen technology has the potential to provide greater energy security and build resilience in Victoria's electricity network by adding storage capacity, essentially acting like a battery. Continued investment in hydrogen for these purposes may increase the likelihood of hydrogen fuel cell passenger vehicles being seen on Victorian roads in the future.

Of the two technologies, battery electric is the most established and its supporting infrastructure more easily integrated within existing energy networks. The focus of subsequent sections of this report is on battery electric ZEVs as it offers the most promising path in the near future. However, we also acknowledge there will be a role for hydrogen fuel cell vehicles in the medium to long term.

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<sup>27</sup> Hasan, M and Chapman, R (2019) *Climate explained: the environmental footprint of electric versus fossil cars* available at <https://theconversation.com/climate-explained-the-environmental-footprint-of-electric-versus-fossil-cars-124762>

<sup>28</sup> Infrastructure Victoria (2018) *Automated and Zero Emissions Vehicles Infrastructure Advice* available at <https://www.infrastructurevictoria.com.au/wp-content/uploads/2019/04/Advice-on-automated-and-zero-emissions-vehicles-October-2018.pdf>

# Barriers to uptake

ZEV uptake is highest and most successful in countries where governments have an active role in encouraging it. It is useful to first understand the barriers and concerns surrounding electric cars in Victoria, before considering how the Victorian Government can promote widespread ZEV uptake. Surveys of Australian consumers in 2018 found that 43% of Australians would not consider buying an electric vehicle. The main reasons identified were the price of electric vehicles, the distance they could travel between charges (and therefore, access to charging infrastructure), and concerns around reliability.<sup>29</sup> These barriers are not surprising and are closely aligned with the findings of multiple surveys and studies into ZEV uptake – particularly battery electric vehicles – which identify cost, range anxiety and availability of charging infrastructure as the main barriers to uptake.<sup>30 31</sup> For example, a 2020 survey conducted by Ford found the main reasons consumers don't intend to switch to ZEVs were, lack of affordability (53%) concerns over where to charge (51%), and range anxiety (37%).<sup>32</sup> Similarly, Deloitte's 2021 *Global automotive consumer study* shows these concerns as top of mind for consumers in almost all of their focus countries (Figure 5).

Figure 5: Concerns regarding battery electric vehicles

Concern	United States	Germany	Japan	Rep. of Korea	China	India
Driving range	28%	28%	22%	11%	25%	13%
Lack of charging infrastructure	25%	22%	29%	32%	20%	26%
Cost/price premium	20%	16%	23%	17%	9%	16%
Time required to charge	13%	13%	15%	18%	13%	14%
Safety concerns	8%	12%	10%	19%	29%	25%
Lack of choice	4%	5%	1%	3%	4%	6%
Other	2%	4%	0%	0%	0%	0%

Source: Deloitte (2021) *Global automotive consumer study*

## Financial costs

The upfront purchase price is a significant barrier for potential buyers of ZEVs.<sup>33</sup> The cost of electric vehicles is largely a reflection of the newness of the technology, particularly battery technology, and the lack of choice of ZEVs in the Australian market. Price parity between new ZEVs and ICE vehicles will be a significant driver to increase ZEV uptake. For battery electric vehicles – the most widely available ZEV technology – the point at which price parity with ICE vehicles is reached is projected to be when the cost of battery manufacture falls below \$100 per kilowatt hour. At this point battery electric vehicles will have a cost advantage and similar performance to ICE vehicles.<sup>34</sup>

<sup>29</sup> Climateworks (2018) *The state of electric vehicles in Australia second report driving momentum in electric mobility* available at [https://www.climateworksaustralia.org/wp-content/uploads/2018/06/climateworks\\_australia\\_state\\_of\\_electric\\_vehicles2\\_june\\_2018.pdf](https://www.climateworksaustralia.org/wp-content/uploads/2018/06/climateworks_australia_state_of_electric_vehicles2_june_2018.pdf)

<sup>30</sup> New Zealand Ministry for the Environment (2018) *Reducing barriers to electric vehicle uptake Behavioural insights: Analysis and review* available at [https://www.iccc.mfe.govt.nz/assets/PDF\\_Library/ad42c96b5f/MfE-Reducing-Barriers-to-Electric-Vehicle-Uptake.pdf](https://www.iccc.mfe.govt.nz/assets/PDF_Library/ad42c96b5f/MfE-Reducing-Barriers-to-Electric-Vehicle-Uptake.pdf)

<sup>31</sup> Citi GPS (2021) *Electric Vehicle Transition: EVs Shifting from Regulatory- to Supply Chain-Driven Disruption* available at <https://www.citivelocity.com/citigps/electric-vehicle-transition/>

<sup>32</sup> Alice Grundy (2020) *Affordability and charging concerns remain top barriers for EV uptake* available at <https://www.current-news.co.uk/news/affordability-and-charging-concerns-remain-top-barriers-for-ev-uptake>

<sup>33</sup> Christidis, P and Focas C (2019) *Factors Affecting the Uptake of Hybrid and Electric Vehicles in the European Union*

<sup>34</sup> Citi GPS (2021) *Electric Vehicle Transition: EVs Shifting from Regulatory- to Supply Chain-Driven Disruption* available at <https://www.citivelocity.com/citigps/electric-vehicle-transition/>

However, some battery electric vehicles are already cost competitive on a total-cost-of-ownership basis, due to the lower ongoing costs. Recent studies are challenging the notion that ZEVs are more expensive. For instance, an analysis of costs in four European countries (France, Germany, Norway, and the United Kingdom) suggests that ownership costs for electric vehicles are lower than for ICE vehicles over a four-year period.<sup>35</sup>

The situation could be similar in Australia; an average car traveling 12,400km in a year has petrol costs of around \$1,900 compared to an electric vehicle which has energy costs of around \$700.<sup>36</sup> Even with the Victorian Government's road user charge for electric vehicles adding around \$300 a year in this example, electric vehicles are still almost half as expensive to run in fuel costs than a petrol vehicle. In addition, maintenance costs of electric vehicles are typically lower than ICE vehicles. Electric vehicles have fewer moving parts and easier to replace parts compared to ICE vehicles. Previous analysis for Infrastructure Victoria found that maintenance costs for electric vehicles could be up to 35% lower than ICE vehicles.<sup>37</sup>

Globally, the cost of electric vehicles is expected to fall to the same level as ICE vehicles in the next two to seven years, although how this translates to specific car markets around the world may vary.<sup>38</sup>

## Range anxiety

The concept of 'range anxiety' is a major fear among potential purchasers of ZEVs. Range anxiety is best described as the worry of ending up with an empty battery and having nowhere to recharge it. A European Union survey found range anxiety to be the second highest barrier to ZEV adoption after the purchase costs.<sup>39</sup> Range anxiety is a concern for consumers mostly because battery electric vehicles have typically lower driving range compared to ICE vehicles.

Most battery electric vehicles on the market today have an estimated range of around 300km per charge. Driving range will continue to increase as the technology evolves, with the average range per charge expected to increase to around 600km over the next decade.<sup>40</sup> Comparatively 90% of car trips to work in Victoria are less than 27km a day.<sup>41</sup>

This suggests that while battery electric vehicles can easily meet the day to day driving needs of most people, the perception around range anxiety persists, especially for infrequent but longer journeys. Therefore, governments need to strike the right balance between addressing these concerns through infrastructure provision and public awareness while not overinvesting in charging assets that will be underutilised.

The Victorian Government's ZEV roadmap includes actions for an education campaign to reduce public misconceptions and promote confidence in ZEVs.<sup>42</sup> This includes social media messaging, online tools, and grassroots 'drive days' which will all help assuage range anxiety.

## Charging infrastructure

The availability of charging infrastructure faces a 'chicken and egg' dilemma. The evidence suggests that while concerns around a lack of charging infrastructure does suppress ZEV uptake, without a critical mass of ZEVs on the road there is insufficient demand for charging infrastructure to encourage private sector investment.<sup>43</sup> If the private sector is failing to provide enough charging infrastructure to drive ZEV uptake, there may be a role for Victorian Government investment to make up this shortfall. However, research and analysis of international jurisdictions found that public charging infrastructure was a necessary but not sufficient factor in ZEV adoption. In other words, the lack of public charging infrastructure will hold back ZEV adoption, but it will not, by itself, driver greater levels of ZEV adoption.<sup>44</sup>

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<sup>35</sup> Christidis, P and Focas C (2019) *Factors Affecting the Uptake of Hybrid and Electric Vehicles in the European Union*

<sup>36</sup> Based on a fuel efficiency of 10.8 litres of fuel for every 100 kilometres travelled and a fuel price of \$1.40. An average EV uses around 18 kilowatt hours to travel 100 kilometres with costs of around 30 cents per kWh, based on AGL *Are Electric cars really better than petrol cars?* available at <https://discover.agl.com.au/energy/electric-cars-better-petrol-cars>.

<sup>37</sup> KPMG for Infrastructure Victoria (2018), *Vehicles Advice – financial analysis* available at [https://www.infrastructurevictoria.com.au/wp-content/uploads/2019/04/Vehicles\\_Advice\\_-\\_Financial\\_Analysis.pdf](https://www.infrastructurevictoria.com.au/wp-content/uploads/2019/04/Vehicles_Advice_-_Financial_Analysis.pdf)

<sup>38</sup> BloombergNEF (2020) *Electric Vehicle Outlook 2020* available at <https://about.bnef.com/electric-vehicle-outlook/>

<sup>39</sup> Christidis, P.; Focas, C. (2019) *Factors Affecting the Uptake of Hybrid and Electric Vehicles in the European Union*. *Energies* 2019, 12, 3414

<sup>40</sup> Citi GPS (2021) *Electric Vehicle Transition: EVs Shifting from Regulatory- to Supply Chain-Driven Disruption* available at <https://www.citivelocity.com/citigps/electric-vehicle-transition/>

<sup>41</sup> Department of Environment, Land, Water and Planning (2021) *Victoria's zero emissions vehicle roadmap* available at [https://www.energy.vic.gov.au/\\_\\_data/assets/pdf\\_file/0014/521312/Zero-Emission-Vehicle-ZEV-Roadmap-FINAL.pdf](https://www.energy.vic.gov.au/__data/assets/pdf_file/0014/521312/Zero-Emission-Vehicle-ZEV-Roadmap-FINAL.pdf)

<sup>42</sup> Department of Environment, Land, Water and Planning (2021) *Victoria's zero emissions vehicle roadmap* available at [https://www.energy.vic.gov.au/\\_\\_data/assets/pdf\\_file/0014/521312/Zero-Emission-Vehicle-ZEV-Roadmap-FINAL.pdf](https://www.energy.vic.gov.au/__data/assets/pdf_file/0014/521312/Zero-Emission-Vehicle-ZEV-Roadmap-FINAL.pdf)

<sup>43</sup> Foley, B., Degrimenci, K. & Yigitcanlar, T. (2020) *Factors Affecting Electric Vehicle Uptake: Insights from a Descriptive Analysis in Australia* Urban Science

<sup>44</sup> Energeia (2018) *Australian Electric Vehicle market study* available at <https://arena.gov.au/assets/2018/06/australian-ev-market-study-report.pdf>

International research indicates that some prospective buyers have a negative perception of how long electric vehicles take to recharge compared to refuelling.<sup>45</sup> However, like range anxiety, for many people this barrier is likely to be more theoretical than practical, given the majority of car trips are much shorter than the full vehicle range and our research suggests that 90% of charging will occur at home.<sup>46</sup> This suggests that improving awareness around vehicle use may be as effective in eliminating these barriers as infrastructure provision. However, investment in charging infrastructure is likely to still be important to address concerns around range anxiety and availability of chargers, particularly along key transport corridors and regional destinations. Charger-unit costs can be as low as \$500 for home charge points, \$3,000 for public AC level 2 charge points (supplying up to 19 kW), and more than \$40,000 for lower-end DC fast charger points (supplying 50 to 150 kW).<sup>47</sup>

Access to at-home charging infrastructure is another direct challenge to the prediction that 90% of charging will occur at home.<sup>48</sup> For example, people living in multi-unit developments may not have access to charging infrastructure in their allocated parking space – if they have one at all, and those without dedicated off-street parking may also find it difficult. This further underpins the case for public investment in charging infrastructure to overcome this direct challenge.

### Charging infrastructure explained

Slow chargers are typically connected to household mains power and take six to 12 hours to fully recharge a battery electric vehicle. Fast chargers (9.5kW) could charge most current battery electric vehicles in one to five hours, depending on the power draw. Due to their cost, these are more likely to be seen at activity centres (such as shopping centres), although some vehicle owners might choose to install them at home. Rapid charging infrastructure is a broad category and includes some proprietary infrastructure (e.g. Tesla Superchargers) and competing charging standards.

Rapid chargers can use either alternating current (AC), which can deliver 80% charge to a typical battery electric vehicle in an hour or less, or direct current (DC), which can deliver 80% in 30 minutes. Rapid chargers are the most likely solution for roadside charging stations or shared vehicle fleets.

Adding a 9.5kW fast charger to a local grid is the equivalent of more than three new homes being connected to the local network. The actual impact of each additional charging unit on the local network is heavily dependent on the proximity of the charger to the local transformer. One local study found that one charger located at a relatively weak point in the network could have the same impact as 45 charging loads located close to a local transformer (Infrastructure Victoria (2018) *Advice on automated and zero emission vehicles infrastructure*). This could have significant implications on the ability of local networks to support the uptake of battery electric vehicles.

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<sup>45</sup> New Zealand Ministry for the Environment (2018) *Reducing barriers to electric vehicle uptake Behavioural insights: Analysis and review* available at [https://www.iccc.mfe.govt.nz/assets/PDF\\_Library/ad42c96b5f/MfE-Reducing-Barriers-to-Electric-Vehicle-Uptake.pdf](https://www.iccc.mfe.govt.nz/assets/PDF_Library/ad42c96b5f/MfE-Reducing-Barriers-to-Electric-Vehicle-Uptake.pdf)

<sup>46</sup> Climateworks (2016) *The path forward for electric vehicles in Australia Stakeholder recommendations* available at [https://www.infrastructure.gov.au/vehicles/environment/forum/files/Climate\\_Works\\_and\\_Electric\\_Vehicle\\_Ecosystem.pdf](https://www.infrastructure.gov.au/vehicles/environment/forum/files/Climate_Works_and_Electric_Vehicle_Ecosystem.pdf)

<sup>47</sup> McKinsey & Company (2021) *How charging in buildings can power up the electric vehicle industry* available at <https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/how-charging-in-buildings-can-power-up-the-electric-vehicle-industry>

<sup>48</sup> Infrastructure Victoria (2018) *Advice on automated and zero emission vehicles infrastructure* available at <https://www.infrastructurevictoria.com.au/wp-content/uploads/2019/04/Advice-on-automated-and-zero-emissions-vehicles-October-2018.pdf>



## Regulatory certainty: supply and demand

A coordinated, national approach is needed to foster a successful ZEV market in Australia and Victoria. The deterrents identified above limit demand for ZEVs, however there are also barriers affecting the supply. National policy certainty would give manufacturers confidence of ZEV uptake and give consumers a greater choice and more options by encouraging supply of ZEVs into the Australian market. However, due to the lack of an effective national policy or regulatory settings to promote the uptake of ZEVs, vehicle manufacturers and Australian consumers are being caught in a cycle of repressed demand and constrained supply. This could have long-term implications if the cycle is not broken. As noted in our 2018 *Advice on automated and zero emissions vehicles infrastructure*, manufacturers may be reluctant to bring ZEV models to Australia without further encouragement of their uptake, while without a range of options, wide take-up by consumers is highly unlikely.<sup>49</sup> There are opportunities for the states to work together, and steps the Victorian Government can take either in collaboration with other states and territories, or unilaterally, to promote ZEV uptake in the absence of a national approach.

While any policy aimed at addressing the demand-related barriers identified above will likely provide policy certainty and increase supply, strong market signals aimed at vehicle manufacturers, such as strong ZEV uptake targets, vehicle emissions standards or bans on ICE vehicles can be used as part of a package of complementary policies that can work together to drive ZEV uptake.

Countries around the world are increasingly setting timeframes for sunsetting ICEs in their vehicle fleets, placing bans firstly on the sale of new ICEs as of a given date, before banning ICEs from the road entirely. In most instances, new ICE sales are typically banned 10 years prior to completely banning ICEs on the roads. This implies a curtailing of vehicle lifetimes, which are 20 years in Australia, as the sales ban approaches.<sup>50</sup> The importance of the growing number of countries banning sales of ICEs for Australia will most likely be in the impact of the bans on vehicle manufacturers' strategy. If the trend continues, and other major jurisdictions including China, the US and Japan follow suit, then manufacturers are increasingly likely to stop producing ICEs, or stop investing in them, leading to increasingly inferior products.<sup>51</sup> If this happens, and Australia has not sent a signal to the market that it too is intending to transition, it could lead to Australia becoming a global 'dumping ground' for ICE vehicles.<sup>52</sup> This outcome can already be observed in relation to a lack of regulatory certainty with regard to vehicle fuel efficiency standards leading to a relatively less fuel-efficient fleet in Australia.<sup>53</sup>

Australia is among a small minority of countries without mandatory greenhouse gas emissions or fuel efficiency standards in place for cars. Mandatory greenhouse gas emissions standards for cars now cover 80% of the global car market (including the United States, Europe, Japan, Korea, China, India, Canada and Mexico). The lack of mandatory emissions standards here has meant that in 2015, new cars sold in Australia emitted 43% more CO<sub>2</sub>/km on average compared with new cars sold in Europe.<sup>54</sup> Emissions standards, ZEV uptake and the phase out of ICEs are closely linked. Research by Energeia identified vehicle emissions regulations as a key policy lever driving ZEV uptake in leading overseas jurisdictions and that vehicle emissions standards would increase ZEV uptake in Australia, as it can be the lowest cost way for vehicle manufacturers to meet their overall emissions targets.<sup>55</sup>

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<sup>49</sup> Infrastructure Victoria (2018) *Advice on automated and zero emission vehicles infrastructure* available at <https://www.infrastructurevictoria.com.au/wp-content/uploads/2019/04/Advice-on-automated-and-zero-emissions-vehicles-October-2018.pdf>

<sup>50</sup> Energeia (2018) *Australian Electric Vehicle market study* available at <https://arena.gov.au/assets/2018/06/australian-ev-market-study-report.pdf>

<sup>51</sup> Energeia (2018) *Australian Electric Vehicle market study* available at <https://arena.gov.au/assets/2018/06/australian-ev-market-study-report.pdf>

<sup>52</sup> Kurlmelovs, R. (2021) 'NSW to go it alone on vehicle emissions standards to avoid becoming "dumping ground"'. The Guardian available at <https://www.theguardian.com/environment/2021/mar/11/nsw-to-go-it-alone-on-vehicle-emissions-standard-to-avoid-becoming-dumping-ground>

<sup>53</sup> Department of Infrastructure and Regional Development (2016) *Improving the efficiency of new light vehicles draft regulation impact statement* available at [https://www.infrastructure.gov.au/vehicles/environment/forum/files/Vehicle\\_Fuel\\_Efficiency\\_RIS.pdf](https://www.infrastructure.gov.au/vehicles/environment/forum/files/Vehicle_Fuel_Efficiency_RIS.pdf)

<sup>54</sup> Climate council (2017) *Factsheet Transport Emissions: Driving down car pollution in cities* available at <https://www.climatecouncil.org.au/wp-content/uploads/2017/09/FactSheet-Transport.pdf>

<sup>55</sup> Energeia (2018) *Australian Electric Vehicle market study* available at <https://arena.gov.au/assets/2018/06/australian-ev-market-study-report.pdf>

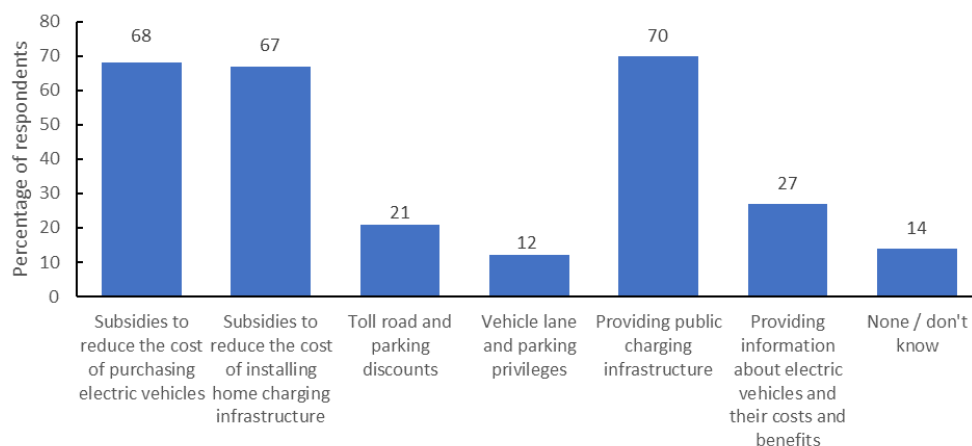
# Opportunities to promote uptake

Government intervention has played a critical role in encouraging the transition to ZEVs globally. Results from our own research and nationwide surveys has shown there is strong public support for the role of the Victorian Government in implementing and guiding the transition to ZEVs.

Some of the specific actions we identified that the Victorian Government could take to encourage ZEV uptake were based on examples from other jurisdictions. These examples were tested through our own research and community consultation, to determine which ones, and to what extent, were likely to be supported by Victorian communities.

A survey conducted by the Climate Council in 2019 and reported in the Electric Vehicle Council's *State of EVs 2019* identifies Australians' perceptions of different government policies on electric vehicle uptake. In this survey, respondents rated subsidies to reduce the purchase cost of electric vehicles, subsidies for installing home charging infrastructure and provision of public charging infrastructure to be the most important (Figure 6).<sup>56</sup> The results of this study closely reflect our own findings, through research and engagement, that cost and charging infrastructure were the main barriers that people would respond most to when considering transitioning to a ZEV

Figure 6: Consumer views on policies to encourage EV uptake



Source: *Electric Vehicle Council (2019) State of electric vehicles 2019*

Note: Chart shows the percentage of respondents nominating each policy as a response to the question "What policies do you think the government could implement that would encourage you to purchase an electric vehicle? (please nominate your top three)"

## Low emissions freight future

Through our consultation on *Victoria's draft 30-year infrastructure strategy*, we received feedback from individuals and organisations on how ZEV technology could be applied to the freight sector and what the Victorian Government could do to support this. While the technology for zero emissions heavy freight vehicles is not as well-established as it is for light vehicles, it is continuing to develop and could bring a range of benefits to the sector. The freight sector has a lot to gain from embracing ZEV technology, particularly if it leads to lower operating costs. Potential noise and exhaust emissions

<sup>56</sup> Energeia (2018) *Australian Electric Vehicle market study* available at <https://arena.gov.au/assets/2018/06/australian-ev-market-study-report.pdf>

reductions could allow transitioned businesses to operate more freely and frequently, as there are currently time-of-use restrictions in some localities due to the noise and exhaust emissions of heavy vehicles. We have recommended regulatory changes for zero emissions freight vehicles for these and other restrictions as one approach the government can take to encourage the freight sector to embrace low and zero emissions technologies.

## Consulting the community through a deliberative engagement

Earlier this year, a total of 211 participants took part in a month-long virtual workshop series to answer the question of: “How should the Victorian Government support more people to adopt low or zero-emissions vehicles sooner?”

For Victoria to be successful in a widespread uptake of ZEVs, it is critical that the needs and perspectives of the Victorian community are understood, considered and factored into the planning and policy development from the outset. That is why we commissioned a separate, deliberative engagement program on electric vehicles as part of the wider consultation process on *Victoria’s infrastructure strategy*.

In order to better understand what the community was most likely to respond to when considering choosing an electric vehicle over a petrol or diesel car, we put the call out to all Victorians to be part of a community panel to discuss the barriers to ZEV uptake and ways to overcome them.

Deliberative panels generally have around 45 participants, as such this undertaking is believed to be the largest of its kind in Victoria. To reach as many Victorians as possible, the panel was recruited through an Expressions of Interest process through targeted emails, social media promotion, and newspaper and radio advertisements across metropolitan and regional Victoria. Participants were selected to represent Victoria’s diverse population by representing a range of ages, genders, jobs, cultural backgrounds, and postcodes. The full report on the engagement approach and panel demographics is at <http://www.infrastructurevictoria.com.au/wp-content/uploads/2021/04/Tackling-Transport-Emissions-Community-Panel-Report-April-2021.pdf>.

The program ran over four weeks during January and February 2021. Each week started with an introductory webinar, followed by an online workshop and discussion activity or survey. The panel process was iterative, with each session building on the previous session’s content and outcomes.

By the end of each week, participants received a weekly summary report. They were asked to provide suggestions, comments or to vote on options which formed the basis of draft recommendations, which were presented back to the group for review and discussion. Infrastructure Victoria supported the engagement process by providing subject matter expertise, contextual information and responding to participant questions over the course of the engagement process.

At the final workshop, the panel voted on each of these recommendations, of which 21 received a majority vote of 70% endorsement.

The panel then presented these recommendations back to Infrastructure Victoria to consider in advising the government on ZEV uptake, covering key themes such as infrastructure provision, financial support, industry support and community awareness programs. The deliberative engagement process took place prior to the release of the Victorian Government’s ZEV roadmap. The ZEV roadmap specifically references the work of the community panel and many of the roadmap actions take a similar approach to the recommendations put forward by the community panel. The full list of the community panel’s recommendations is at Table 2.

### What we heard

We received valuable insight from the Victorian community on what they considered to be main barriers to ZEV uptake and options for practical solutions to overcome them.

The panel’s recommendations address availability of charging infrastructure through initiatives such as a statewide charging network strategy, improving affordability through subsidies, low-interest loans and other financial incentives, and increasing awareness of the benefits of ZEVs through a community education campaign or independent cost comparison websites. The recommendations, and their level of support from panel members, are outlined in Table 2.

Many panellists noted the Victorian Government’s distance-based charge announcement had exacerbated the community’s existing concerns around cost of ZEVs. They also noted alternative modes of transport could be effective in reducing transport sector emissions. While *Victoria’s infrastructure strategy* makes 11 recommendations to change Victorians’ travel behaviour, including reducing car use and increasing public transport usage, the purpose of this report is focusing specifically on promoting ZEV uptake as this is an important step to achieving net zero emissions.

Table 2: Community panel recommendations

Recommendation	Support
<p><b>1. Advocate to local governments to change their fleets to electric vehicles.</b></p> <p><i>This demonstrates the commitment of the government to meet the emission target.</i></p>	99%
<p><b>2. Create a statewide charging network strategy.</b></p> <p><i>This strategy would set out a network of charging infrastructure across Victoria and the staging of its roll-out.</i></p>	95%
<p><b>3. Deliver a broad community awareness and education campaign.</b></p> <p><i>This campaign could use a myth busting approach to address concerns around range, charging technology, battery life and reuse to support uptake of EVs. The campaign could highlight the ongoing benefits of ZEVs in reducing transport emissions as a response to climate change.</i></p>	95%
<p><b>4. Establish Vehicle Emissions Standards.</b></p> <p><i>This is where the government sets specifications relating to the level of carbon dioxide emissions produced by ICE and low emission vehicles.</i></p>	93%
<p><b>5. Introduce planning controls that require new developments to install charging infrastructure.</b></p> <p><i>This will ensure charging infrastructure is a requirement of new developments and is considered as part the design.</i></p>	92%
<p><b>6. Provide financial incentives to individuals to support the initial transition to low or zero emissions vehicles.</b></p> <p><i>This enables a just and timely transition by providing rebates, subsidies or low-interest loans.</i></p>	90%
<p><b>7. Support the installation of electric vehicle charging point as part of the 'Solar Homes Program'.</b></p> <p><i>This supports households to integrate their EV charging with home-based energy capture through solar panels.</i></p>	90%
<p><b>8. Provide electric vehicle charging stations at activity and town centres.</b></p> <p><i>This supports private vehicle drivers and the commercial sector to use charging infrastructure and contribute to the local economy. This includes the opportunity to create a new industry through hydrogen and leverage existing petrol station infrastructure.</i></p>	89%
<p><b>9. Advocate to the private sector to lease low or zero emissions vehicles to employees.</b></p> <p><i>This will create further visibility of EVs and significantly reduce emissions from private fleets.</i></p>	88%
<p><b>10. Introduce planning controls that require electric vehicle charging infrastructure in new carparks.</b></p> <p><i>This will ensure charging infrastructure is provided as a minimum standard in all new developments.</i></p>	87%
<p><b>11. Support the integration of energy capture through solar panels and storage in batteries.</b></p> <p><i>This relates to all types of buildings to reduce reliance on the electricity transmission network powered by fossil fuels to create a closed loop system for charging EVs.</i></p>	87%
<p><b>12. Provide incentives for taxis, rideshare vehicles and courier vehicles to use low or zero emissions vehicles.</b></p> <p><i>This will support reduction of transport emissions and provide more opportunities for people to experience EVs.</i></p>	85%
<p><b>13. Provide subsidies to reduce the cost of installing home charging infrastructure.</b></p> <p><i>This relates to any infrastructure required at home to charge the EV.</i></p>	84%
<p><b>14. Build professional and business knowledge to instil zero-emission workforce and commerce.</b></p> <p><i>This relates to a smooth transition of ICE workforce and commerce to an EV workforce and commerce. Current EV commerce relies heavily on overseas ideas, technologies and services. This advice</i></p>	84%

<i>includes initiatives that will create commercial pathways that will build zero emission communities and economies. This will have a ripple effect on associated industries and workforces.</i>	
<b>15. Introduce a Vehicle Emissions Scheme.</b> <i>This is where individuals enjoy a rebate or pay a surcharge depending on their vehicle's emissions in relation to a vehicle emissions standard.</i>	80%
<b>16. End the sale of new internal combustion engine vehicles by 2030.</b> <i>This is intended to send a clear signal to broader community and market that transition to EVs is required to meet emission reduction targets.</i>	78%
<b>17. Introduce a means tested loan scheme for purchasing low or zero emissions vehicles.</b> <i>This is intended to ensure those who have lower levels of resources to transition to an EV are supported.</i>	78%
<b>18. Create an independent vehicle cost comparison website.</b> <i>This will help buyers make better decisions using independent information.</i>	78%
<b>19. Create a trade-in scheme for internal combustion engine vehicles.</b> <i>This would incentivise community members to transition sooner.</i>	77%
<b>20. Mandate a standardised charging connector for use across Victoria.</b> <i>This would ensure equity of access to charging infrastructure that is not dependent on car model.</i>	76%
<b>21. Undertake community engagement to inform the strategic planning of electric and hydrogen vehicle infrastructure.</b> <i>This would build community knowledge and awareness about what is happening now and to bring people on a journey as future technology develops.</i>	71%

## Equity and fairness

Equity, fairness, and inclusivity were key considerations for the panel in developing their recommendations. Participants were encouraged to use an equity and fairness lens in their deliberations, and discussed at length how to ensure these recommendations are implemented inclusively to ensure no Victorian is disadvantaged. Through these discussions, the community panel developed three principles to guide implementation of the recommendations:

- A Just Transition – to ensure all Victorians have time to plan for low and ZEVs. A staged and strategic approach should ensure an equitable and just transition
- Equitable Access – to information and infrastructure and means test financial assistance.
- Shared Knowledge – to support individuals and organisations in the public, private and not-for-profit sector.

The panel noted that the transition to ZEVs, and particularly the use of financial incentives to encourage their uptake, have the potential to lead to inequitable outcomes. As such, equity principles are embedded in the recommendations put to Infrastructure Victoria. This aligns with objectives underpinning *Victoria's infrastructure strategy*, one of which is to reduce disadvantage, and is also reflected in our assessment of the recommendations.

Policy proposals can also be grouped into three broad categories – financial, infrastructure and policy/regulatory. These categories provide a useful framework for considering actions the Victorian Government could take. These categories are explored below, with examples of the types of approaches.

## Financial

Financial incentives can be used to reduce the cost of purchasing and/or using a ZEV. Governments often use financial incentives to encourage uptake where there is either a market failure or a considerable public benefit. Both issues exist in the case of ZEVs, where a lack of public understanding of the capabilities (which could be a form of market failure) is at odds with the potential for significant benefits through widespread adoption.

There are already financial incentives in place in Victoria. A \$100 registration fee discount for hybrid and electric vehicles has been on offer in Victoria for over a decade. More recently, as part of the ZEV roadmap, a ZEV subsidy program has been implemented by the Victorian Government. The first round of this program offers a \$3,000 subsidy on the purchase

of a ZEV under \$68,740.<sup>57</sup> The subsidy program provides early, time-limited, targeted, one-off financial incentives to help overcome the cost barrier. This is consistent with measures recommended by Infrastructure Victoria's deliberative engagement panel. Subsidies are particularly important until ZEVs reach purchase price parity with ICE vehicles.

## Infrastructure

Direct investment in the infrastructure required to support ZEVs can be used to overcome some practical barriers to adoption, and address commonly cited concerns from consumers around a lack of charging infrastructure. However herein lies another market failure that needs to be addressed to support the transition to ZEVs. Given the current low levels of ZEV uptake, there is little incentive for the private sector to provide the necessary charging infrastructure, exacerbating the challenge.

As part of the ZEV roadmap, the Victorian Government has committed to accelerate the delivery of charging infrastructure across the state. This includes fast-charging stations at popular destinations around Victoria, including regional town centres, tourist hotspots and high-use locations.

## Legislative/regulatory

There is a spectrum of legislative and regulatory measures the Victorian Government could use to support ZEV uptake by influencing behaviour through to more direct actions such as bans. One approach is using vehicle emissions standards to encourage the market to provide lower emitting vehicles. Over time, this can work to improve the cost-competitiveness of ZEVs, helping accelerate the transition. Another more direct approach is prohibiting the sale of new ICE vehicles, which is in line with our recommendation. In jurisdictions where this approach has been taken, governments tend to nominate a future date beyond which new ICE vehicles are no longer able to be sold. This sends a very clear signal to the market and to consumers about the government's intentions and can pave the way for more action from the private sector, such as providing more vehicles to the market, or investing more heavily in charging infrastructure.

The ZEV roadmap takes steps to signal the Victorian Government's intent to transition Victoria from ICE vehicles with its target of 50% of new light vehicle sales to be zero emissions by 2030.

The types of interventions described above could be used either individually or in combination. In many cases, a range of approaches are likely to complement each other, and further reinforce their effectiveness.

## Governments around the world are trying a range of different approaches

As part of our extensive research on ZEV uptake, we have explored a range of case studies from around the world to compare and learn from the different initiatives and their outcomes. The examples from other jurisdictions with high uptake provide useful insight and ideas as to what could be applied in Victoria. However, there may be practical, cultural, and governance differences which could mean some approaches would not translate effectively to Victoria.

Jurisdictions worldwide are using a range of regulatory, financial and infrastructure incentives to promote ZEV uptake and meet their emissions reduction goals. For example, Norway is the country with the highest ZEV market share using a combination of financial and infrastructure incentives to drive uptake. Meanwhile, China has the highest level of ZEV uptake while disincentivising ICE vehicles, and has also focussed on developing a domestic supply chain for ZEVs and their components.

The market for ZEVs is strongly driven by CO<sub>2</sub>-emission limits since they encourage manufacturers to build more fuel-efficient vehicles. Likewise, government incentives such as purchase-price subsidies and tax exemptions have a major effect on consumer demand. The COVID-19 pandemic has already prompted some changes in both emission regulations and incentives. For instance, many local and federal governments have increased consumer incentives for ZEV purchases, often as part of stimulus programs designed to soften the economic impact of the pandemic. In Germany, for example, purchase-price subsidies for new ZEVs can amount to more than \$10,000 per vehicle.<sup>58</sup>

Some governments are also investing in charging infrastructure as part of their economic stimulus programs. These range from direct investments for public charging stations to installation subsidies for private charging stations at homes and workplaces. For example, China committed more than \$1.4 billion in April 2020 to subsidize the construction of charging stations, on top of existing programs that promote the sale of ZEVs.<sup>59</sup>

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<sup>57</sup> Solar Victoria (2021) *Zero Emissions Vehicle (ZEV) Subsidy* available at <https://www.solar.vic.gov.au/zero-emissions-vehicle-subsidy>

<sup>58</sup> Fred Lambert (2020) *Germany boosts EV incentives to ~\$10,000, helping Tesla Model 3 and VW ID.3* available at <https://electrek.co/2020/06/04/germany-boost-ev-incentives-9000-euros-helping-tesla-model-3-vw-id-3/>

<sup>59</sup> McKinsey & Company (2020) *Electric mobility after the crisis: Why an auto slowdown won't hurt EV demand* available at <https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/electric-mobility-after-the-crisis-why-an-auto-slowdown-wont-hurt-ev-demand>



When it comes to regulatory interventions, simply removing the ability to choose a traditional ICE vehicle is a powerful mechanism. To date, around a dozen countries and around 30 cities/regions have announced plans to phase out sales of internal combustion vehicles to encourage the transition to ZEVs.<sup>60</sup> At the same time, major vehicle manufacturers including Volvo, Volkswagen, General Motors and Jaguar Land Rover have announced intentions to cease or greatly scale back the manufacture of ICE vehicles.

A common feature shared by the most successful jurisdictions in encouraging ZEV uptake (such as Norway, China and Singapore) is a combination of financial, infrastructure and regulatory interventions, rather than just one domain.

An overview of approaches undertaken in selected jurisdictions is covered below.

### The United Kingdom

The UK has several strategies to reduce road transport emissions. Two of these are the development of the ultra-low emission zone (ULEZ) and bringing the ban on ICEs forward to 2030 (originally set to 2040).

The ULEZ was launched in London in 2019. Most vehicles driving in the ULEZ must meet tighter new emission standards or pay a daily charge to travel within the area. The ULEZ operates in the same area as the congestion charge zone and is in effect 24 hours a day, 7 days a week. During a public consultation with more than 18,000 Londoners, nearly 60% strongly supported the ULEZ and 63% supported or strongly supported early implementation.<sup>61</sup>

In 2020, the British Prime Minister unveiled a plan to bring forward a ban on selling new ICE vehicles by 10 years, from 2040 to 2030.<sup>62</sup> This decision is intended to help cut car emissions by approximately 32% by 2030.<sup>63</sup>

### Norway

Norway has a reputation as a global leader in supporting the uptake of battery electric vehicles. The capital city, Oslo, has the highest number per-capita of battery electric vehicles in the world, with 10% of Norway's total fleet of vehicles and more than half of new car sales.<sup>64</sup>

Norway has implemented both incentives for electric car buyers and financial penalties for motorists who continue to use gas or diesel cars. It also has tax regimes in place to reduce the premium cost of electric vehicles. These were advantageous when electric vehicles were more expensive, and choice of models were limited. From as early as 1990, electric vehicles were exempt from purchase and import taxes, and from the VAT (the equivalent of the GST) from 2001 onwards. From 1997 to 2017, electric vehicles were not charged road or ferry tolls, and could be driven in bus lanes. The Norwegian Electric Vehicle Association lists 15 incentive schemes related to electric vehicles, which have contributed to the rising share of electric vehicles within Norway's fleet.

Norway also has more than 1500 public charging points per million population, with over 8500 charging points in total. In 2008, a charging infrastructure program was launched in Oslo. By 2011, Norway had 1900 charging points. The current government has launched a program to establish two fast-charging stations every 50km, with one on every main road in Norway.<sup>65</sup>

### Singapore

Singapore has set a target to phase out vehicles with internal combustion engines by 2040, making commitments to pave the way for a greater adoption of battery electric vehicles. As of 2020, Singapore had an electric vehicle fleet of 1125 cars, fewer than 0.2% of the total private car population. By 2030, EVs are estimated to form one-third of the private car fleet.<sup>66</sup>

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<sup>60</sup> BloombergNEF (2020) *Electric Vehicle Outlook 2020* available at <https://about.bnef.com/electric-vehicle-outlook>

<sup>61</sup> Mayor of London (2021) *The Mayor's Ultra Low Emission Zone for London* available at <https://www.london.gov.uk/what-we-do/environment/pollution-and-air-quality/mayors-ultra-low-emission-zone-london>

<sup>62</sup> Pickard, J. Campbell, B. (2020) 'UK to ban new petrol and diesel cars by 2030' Australian Financial Review available at <https://www.afr.com/world/europe/uk-to-ban-new-petrol-and-diesel-cars-by-2030-20201115-p56er0>

<sup>63</sup> Ambrose, J (2020) 'UK ban on fossil fuel vehicles by 2030 "not enough" to hit climate targets' The Guardian available at <https://www.theguardian.com/environment/2020/nov/18/uk-ban-on-new-fossil-fuel-vehicles-by-2030-not-enough-to-hit-climate-targets>

<sup>64</sup> Joshi, K. (2020) *The electric recipe of Norway's zero emissions transport boom* available at <https://reneweconomy.com.au/the-electric-recipe-of-norways-zero-emissions-transport-boom-49932/>

<sup>65</sup> Joshi, K. (2020) *The electric recipe of Norway's zero emissions transport boom* available at <https://reneweconomy.com.au/the-electric-recipe-of-norways-zero-emissions-transport-boom-49932/>

<sup>66</sup> Young, C (2020) *Parliament: Spore needs more than the planned 28,000 electric vehicle charging points by 2030, says Ong Ye Kung* available at <https://www.straitstimes.com/singapore/parliament-singapore-needs-more-than-the-planned-28000-electric-vehicle-charging-points-by>

Singapore has recently announced a goal of creating 28,000 charging points, a significant infrastructure surge from the current 1600.<sup>67</sup> The government has noted that it must work closely with private sector infrastructure entities and in partnership with carpark owners and operators to meet these targets.

Incentives to encourage more drivers to use electric cars have also been announced, including extending the Vehicular Emissions Scheme, whereby individuals enjoy a rebate or pay a surcharge depending on their vehicle's emissions. The scheme has been extended to include light commercial vehicles and provide rebates for early adoption, and the revision of road taxes for qualifying vehicles. Singapore has also put policies in place to manage and reduce numbers of ICE vehicles, including maintaining a high Certificate of Entitlement price (which allows a vehicle to be legally registered, owned and used for 10 years) and a target of zero ICE vehicle growth.<sup>68</sup>

## USA

Several states in the USA have enacted vehicle greenhouse gas emissions standards, adopted goals for ZEV deployment, including both battery electric vehicles and fuel cell electric vehicles, provided rebates for ZEVs, and incentives for ZEV infrastructure, such as electric vehicle supply equipment and hydrogen-fuelling infrastructure.

California is a leader in the USA when it comes to supporting ZEV uptake, as well as being one of the largest ZEV markets in the world.<sup>69</sup> The state has created targeted programs such as the *Advanced clear cars program*, which requires major manufacturers of passenger cars and light trucks to attain a certain number of ZEV credits.<sup>70</sup> California has also set a target of all new passenger vehicles sales being ZEVs by 2035.<sup>71</sup> However, this is not reflected across all USA states, with only 13 across the USA implementing standards and programs for ZEVs.<sup>72</sup>

## China

In recent years, China has established the *New energy vehicle mandate*, which has a goal of promoting new energy vehicles (i.e. ZEVs), providing additional flexibility to policy surrounding existing fuel consumption regulation and ensuring average fuel consumption of new passenger cars at 4 litres/100km by 2025, down from 5.5l/100km in 2019.<sup>73</sup>

Under this mandate, domestic car manufacturers are awarded higher scores based on the more electric and hybrid vehicles they sell. The scheme functions as a points system, with points awarded using a formula based on production levels and taking into account factors such as energy efficiency and driving range. Each ZEV sold generates some number of credits, depending on characteristics such as electric range, energy efficiency, and rated power of fuel cell systems. This targets 10% of the conventional passenger vehicle market in 2019 and 12% in 2020.<sup>74</sup> Failure to meet targets can result in penalties, including denial of approval for new models until targets are met.<sup>75</sup>

## Japan

Japan has recognised the importance of ZEVs as part of the *Zero emissions Tokyo strategy*, a climate change plan that aims to achieve net zero emissions by 2050. Published in December 2019, one of the 14 policies formulated was the promotion of ZEVs, including targets of introducing at least 300 zero-emission buses, increasing market share of ZEVs to 50% of new passenger car sales by 2030, limiting new small route buses for sale to ZEVs and developing new infrastructure to support ZEVs, including 1000 fast chargers and 150 hydrogen stations.<sup>76</sup>

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<sup>67</sup> Young, C (2020) *Parliament: S'pore needs more than the planned 28,000 electric vehicle charging points by 2030, says Ong Ye Kung* available at <https://www.straitstimes.com/singapore/parliament-singapore-needs-more-than-the-planned-28000-electric-vehicle-charging-points-by>

<sup>68</sup> Kuttan, S.C. 'Electric Vehicles will take over Singapore. But here's what must happen first' available at <https://www.channelnewsasia.com/news/commentary/singapore-budget-2020-electric-vehicles-ice-ves-hybrid-car-2040-12457240>

<sup>69</sup> Electrify America (2020) *Our Investment Plan* available at <https://www.electrifyamerica.com/our-plan/>

<sup>70</sup> Centre for Climate and Energy Solutions (2020) *U.S. State Clean Vehicle Policies and Incentives* available at <https://www.c2es.org/document/us-state-clean-vehicle-policies-and-incentives/>

<sup>71</sup> Office of Governor Gavin Newsom (2020) *Governor Newsom Announces California Will Phase Out Gasoline-Powered Cars* available at <https://www.gov.ca.gov/2020/09/23/governor-newsom-announces-california-will-phase-out-gasoline-powered-cars-drastically-reduce-demand-for-fossil-fuel-in-californias-fight-against-climate-change/>

<sup>72</sup> Centre for Climate and Energy Solutions (2020) *U.S. State Clean Vehicle Policies and Incentives* available at <https://www.c2es.org/document/us-state-clean-vehicle-policies-and-incentives/>

<sup>73</sup> Argus Media (2020) *China issues NEB credit scheme for 2021-23* available at <https://www.argusmedia.com/en/news/2116465-china-issues-nev-credit-scheme-for-202123>

<sup>74</sup> The International Council on Clean Transportation *China's new Energy Vehicle Mandate policy* available at <https://theicct.org/publications/china-nev-mandate-final-policy-update-20180111>

<sup>75</sup> The International Council on Clean Transportation *China's new Energy Vehicle Mandate policy* available at <https://theicct.org/publications/china-nev-mandate-final-policy-update-20180111>

<sup>76</sup> C40 Cities (2020) *Zero Emission Tokyo Strategy* available at [https://www.c40.org/case\\_studies/zero-emission-tokyo-strategy](https://www.c40.org/case_studies/zero-emission-tokyo-strategy)

## New South Wales

The New South Wales (NSW) Government released its *Electric vehicle strategy* in June 2021 accompanied with \$490 million in funding to incentivise ZEV uptake.<sup>77</sup> The strategy includes consumer incentives such as a \$3,000 rebate for the purchase of ZEVs under \$68,750 and waiving stamp duty for vehicles under \$78,000. For a limited period of time, single occupancy ZEVs will also be permitted in T2 and T3 lanes.

\$171 million of the funding is set aside for charging infrastructure. This will cover fast chargers at 100km intervals across all major highways in NSW, and every 5 kilometres across Sydney's major road commuting corridors. The NSW Government will also co-fund charging infrastructure for households with limited off-street parking, commuter carparks, and regional tourism businesses.

The NSW Government has set a target for 50% of new vehicle sales to be ZEVs by 2030 and the 'vast majority' of new cars to be ZEVs by 2035. Additionally, the NSW Government vehicle fleet will transition to fully electric by 2030.

## South Australia

The South Australian Government has recently announced a \$18.3 million investment into delivering an *Electric vehicle action plan*, which aims to accelerate the uptake and integration of electric vehicles in South Australia. This includes both smart charging trials and a statewide charging network.<sup>78</sup>

South Australia has also proposed a distance-based charge for electric vehicles. Initially proposed for 2021 introduction, the South Australian Government announced a 12-month delay to monitor developments in other jurisdictions and consult further.<sup>79</sup>

## Queensland

In 2017, the Queensland Government released *The future is electric: Queensland's electric vehicle strategy*. This strategy aims to pave the way for electric vehicle uptake across the state. The Queensland Government has noted the importance of providing the right charging infrastructure in increasing confidence in electric vehicle usage, such as alleviating 'range anxiety'. A key element of the Queensland strategy was creating the Queensland Electric Superhighway, which features 31 fast-charging sites and allows Queenslanders and tourists to easily travel from Coolangatta to Cairns, and from Brisbane to Toowoomba in a low or ZEV.<sup>80</sup>

The fast-charging sites were made free-to use for the first 12 months to encourage electric vehicle uptake, which has coincided with more affordable electric vehicle models entering the market. The fast chargers are installed in convenient, safe locations close to major highways where there are existing amenities, such as cafes, restaurants and shops.<sup>81</sup>

Table 3 summarises the approaches outlined above.

**Table 3: Summary of interventions by jurisdiction**

Countries	Type/s	Initiatives
UK	Financial, Regulatory	<ul style="list-style-type: none"> <li>The ULEZ in central London, where vehicles must meet new, tighter emission standards or pay a daily charge to travel within the area.</li> <li>2030 ban on the sale of internal combustion engine vehicles</li> </ul>
Norway	Financial, Infrastructure	<ul style="list-style-type: none"> <li>Incentives to ZEV buyers</li> <li>Financial penalties for those continuing to use gas or diesel cars through the use of purchase taxes calculated by a combination of weight, CO<sub>2</sub> and NOx emissions.</li> <li>More than 1500 public charging points per million population, with over 8500 charging points in total</li> </ul>

<sup>77</sup> New South Wales Government (2021), *Electric vehicle strategy*, available at <https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Climate-change/nsw-electric-vehicle-strategy-210225.pdf>

<sup>78</sup> Renewables SA (2020) *Electric Vehicles* available at <http://www.renewablesa.sa.gov.au/topic/zero-emission-vehicles>

<sup>79</sup> Opie, R. *Electric vehicle user charge put on hold as SA Government monitors similar taxes interstate* available at <https://www.abc.net.au/news/2021-03-04/sa-electric-car-tax/13216892>

<sup>80</sup> Queensland Government (2018) *Charging an Electric Vehicle* available at <https://www.qld.gov.au/transport/projects/electricvehicles/about/charging>

<sup>81</sup> EVolution (2020) *The Queensland Electric Super Highway (And how to get the best out of it!)* available at <https://www.evolutionaustralia.com.au/queensland-electric-super-highway>

Singapore	Regulatory, Financial, Infrastructure	<ul style="list-style-type: none"> <li>• Target to phase out vehicles with ICE vehicles by 2040. The mechanism for delivering on this target has not been identified.</li> <li>• Goal of creating 28,000 charging points</li> <li>• Extension of the Vehicular Emissions Scheme, whereby individuals enjoy a rebate or pay a surcharge depending on their vehicle's emissions</li> </ul>
Australia (NSW)	Regulatory, Financial, Infrastructure	<ul style="list-style-type: none"> <li>• A target for 50% of new vehicle sales to be ZEVs by 2030</li> <li>• Rebates and stamp duty exemptions for ZEVs</li> <li>• \$171m for charging infrastructure across NSW</li> </ul>
Australia (SA)	Infrastructure	<ul style="list-style-type: none"> <li>• An <i>Electric vehicle action plan</i>, which aims to accelerate the uptake and integration of EVs, including both ZEV smart charging trials and a statewide EV charging network</li> </ul>
Australia (QLD)	Infrastructure	<ul style="list-style-type: none"> <li>• Release of <i>The future is electric: Queensland's electric vehicle strategy</i>, aiming to accelerate ZEV uptake across the state, including the creation of the Queensland Electric Superhighway</li> </ul>
USA	Financial, Regulatory	<ul style="list-style-type: none"> <li>• Application of greenhouse gas emissions and fuel efficiency standards (Federal and State)</li> <li>• Goals for ZEV deployment, which include both plug-in electric vehicles and fuel cell electric vehicles</li> <li>• Rebates for ZEVs and incentives for ZEV infrastructure</li> </ul>
China	Financial, infrastructure	<ul style="list-style-type: none"> <li>• Establishment of the <i>New energy vehicle mandate</i>, where domestic car manufacturers required to meet ZEV credit targets.</li> <li>• Heavy investment in charging infrastructure - the International Energy Agency's Global EV outlook 2020 shows China is home to 60% of the world's 862,118 public slow and fast charging spots.</li> </ul>
Japan	Regulatory, Infrastructure	<ul style="list-style-type: none"> <li>• Release of the <i>Zero emissions Tokyo strategy</i>, a climate change plan that aims to achieve net zero emissions by 2050</li> <li>• Targets of introducing zero-emission buses, increasing market share of ZEVs</li> <li>• Developing new infrastructure to support ZEVs</li> </ul>

# Analysis of options

Infrastructure Victoria has reviewed and assessed the advice from the community panel, our own extensive research and the lessons learned from other jurisdictions to make recommendations for priority actions in encouraging ZEV uptake to the Victorian Government. Our recommendations complement and strengthen the actions the Victorian Government is already taking as part of its ZEV roadmap.

We used a qualitative assessment approach to analyse the panel's recommendations based on what actions were likely to be supported by the Victorian community. We then compared the panel's list of comprehensive recommendations with approaches used in other jurisdictions and found a significant overlap. As such, we have used precedent in jurisdictions with higher EV uptake as one of the assessment criteria for our recommendations. The criteria used in assessing the long list of proposals from the community engagement is below.

**Table 4: Assessment criteria**

Criterion	Description
Targeted	Does the recommendation address one of the three key barriers to ZEV uptake – cost, range anxiety or availability of charging infrastructure – and is there a clear role for government intervention?
Actionable	Does the recommendation identify a specific action the Victorian Government can take, as this is the level of government that <i>Victoria's infrastructure strategy</i> primarily addresses?
Direct	Is there evidence to suggest the recommended action will directly address the problem or opportunity it targets, or will the impact be secondary?
Cost/benefit	Based on a qualitative informed assessment, will the benefits of the recommended intervention likely outweigh the costs? Where possible, who bears the cost that has been identified (the Victorian Government, or the public)?
Precedent	Is the approach being used effectively in other jurisdictions?

These criteria have been identified on the basis that they:

- Ensure any proposed actions will directly address the evidence-based barriers to ZEV uptake that have been identified across many jurisdictions, including in Victoria.
- Identify whether the Victorian Government has the power to act to implement the proposed action, and whether there is a role for government intervention.
- Are likely to provide a greater benefit to Victorians than the cost they impose.
- Align with, or have the potential to take lessons from, approaches being used in other jurisdictions.

We have assessed the list of recommendations using the criteria outlined above and grouped each of the panel's proposed recommendations under the three categories – financial, infrastructure and legislative/regulatory. A summary of our assessment of the proposed interventions is at Table 5.

Table 5: Assessment summary

Financial	Targeted	Actionable	Direct	Cost/benefit	Precedent
Provide financial incentives to individuals to support the initial transition to low or zero emissions vehicles	Yes Addresses cost barrier	Yes	Yes Reducing the purchase price of ZEVs is likely to encourage uptake	Cost borne by government will scale in line with size of incentive and level of uptake	Norway provides financial incentives for ZEV purchases.
Support the installation of electric vehicle charging points as part of the <i>Solar homes</i> program	Yes Addresses concerns around charging infrastructure	Yes	Yes Improving access to charging infrastructure is likely to encourage uptake	Cost dependent on scale of uptake. Benefit is questionable, given dedicated charging infrastructure is non-essential to charge a vehicle and may have equity implications for renters or those unable to afford solar panels	The UK Electric vehicle homecharge scheme provides grant funding of up to 75% toward the cost of installing EV charging infrastructure in homes.
Provide subsidies to reduce the cost of installing home charging infrastructure	Yes Addresses concerns around charging infrastructure	Yes	Yes Improving access to charging infrastructure is likely to encourage uptake	Cost dependent on scale of uptake. Benefit is questionable, given dedicated charging infrastructure is non-essential to charge a vehicle and may have equity implications for renters or those unable to afford charging infrastructure.	The UK Electric vehicle homecharge scheme provides grant funding of up to 75% toward the cost of installing ZEV charging infrastructure in homes.
Introduce a means tested loan scheme for purchasing low or zero emissions vehicles	Yes Addresses cost barrier	Yes	Yes Reducing the purchase price of ZEVs is likely to encourage uptake	Likely to be lower cost than direct financial incentive, but also lower benefit as the impact on uptake may not be as large.	ACT is offering interest-free loans of up to \$15,000 to purchase ZEVs



Create a trade-in scheme for ICE vehicles	Yes Addresses cost barrier	Yes	Unclear Would need to be specifically tied to ZEV purchase in order to be effective.	Cost would depend on the cash provided at trade-in. Benefit dependent on tying trade-in to future ZEV purchase. If purchasing another ICE, benefit is less clear	France offers a scrappage scheme for drivers replacing an old ICE vehicle with a ZEV.
<b>Infrastructure</b>					
Develop and publish a statewide charging network strategy	Yes Addresses concerns around charging infrastructure and range anxiety	Yes	Yes Could boost uptake if it fills gaps of concern to Victorians	Low cost, potential benefit of providing certainty to market to invest in infrastructure	Queensland <i>Electric vehicle strategy</i> includes charging infrastructure
Provide electric vehicle charging stations at activity and town centres	Yes Addresses concerns around charging infrastructure and range anxiety	Yes	Likely to boost uptake if it addresses infrastructure and range concerns	Charging infrastructure and supporting civil infrastructure could be costly. Potentially benefits to regional centres and businesses	Scotland has a public network of chargers that drivers can access using a standard mechanism (such as RFID)
<b>Legislative/regulatory</b>					
Establish vehicle emissions standards	No May reduce vehicle cost as more choice becomes available	Unclear if Victorian Government can unilaterally implement. NSW is also currently considering its approach to vehicle emissions standards. <sup>82</sup>	If prices fall, uptake may increase	Emissions standards are thought to deliver cost savings to consumers by leading to more fuel-efficient vehicles and sends a clear signal to industry on the intent to transition to ZEVs. Provides greater certainty that emissions reduction will be achieved.	Australia has road vehicle emissions standards based on the Euro 5 standards. However, mandatory fuel efficiency (CO <sub>2</sub> emission) standards cover 80% of the global car market but are not in place in Australia. <sup>83</sup>

<sup>82</sup> NSW Government (2021) *NSW Clean Air Strategy 2021–30: Draft for Consultation*

<sup>83</sup> Climate council (2017) *Factsheet Transport Emissions: Driving down car pollution in cities*

Provide incentives for taxis, rideshare vehicles and courier vehicles to use low or zero emissions vehicles	Yes Could directly increase uptake of ZEVs in the broader vehicle fleet	Yes	Yes Would directly increase ZEV uptake	Cost dependent on the level of incentive. Benefit is questionable given the most intensive road users, such as rideshare and taxis have the most to gain from not using petrol and are more likely to buy electric vehicles.	Amsterdam facilitates ZEV taxis by: <ul style="list-style-type: none"> <li>• purchase subsidies</li> <li>• placement of (fast) chargers,</li> <li>• Priority incentive at particular taxi stands and</li> <li>• an environmental zone</li> </ul>
Introduce planning controls that require new developments to install charging infrastructure	Yes Addresses concerns around charging infrastructure	Yes	Likely to boost uptake if it addresses infrastructure concerns	Likely to impose additional costs on developers. Benefit is questionable, given dedicated charging infrastructure is non-essential to charge a vehicle.	The International Code Council added a provision in the model building code that sets minimum thresholds for ZEV-capable and ZEV-ready parking spaces
Introduce planning controls that require electric vehicle charging infrastructure in new carparks	Yes Addresses concerns around charging infrastructure	Yes	Likely to boost uptake if it addresses infrastructure concerns	Likely to impose additional costs on developers. Benefit is questionable, given dedicated charging infrastructure is non-essential to charge a vehicle.	The EU-27 plus the United Kingdom now requires member states to enact regulations on the installation of a minimum number of charging points for all non-residential buildings with more than 20 parking spaces by January 1, 2025.
End the sale of new ICE vehicles by the mid-2030s	No However, may reduce cost as more choice becomes available over time	Yes	Eliminating ICE vehicles will boost ZEV uptake by default	Low cost to government. Cost to consumer may be in higher purchase costs and low resale value of existing ICE vehicles. Purchase costs are likely to fall as more regulatory certainty leads to greater choice and will be further offset by lower running costs. Provides greater certainty that emissions reduction will be achieved.	17 governments have set ICE vehicle phase-out targets - these include UK, Ireland, France, Spain, Sweden, Norway, Denmark, Canada and California.

Mandate a standardised charging connector for use across Victoria	No May address concerns around charging infrastructure	Yes	Would boost uptake if effectively addresses concerns around charging infrastructure	Low cost to government. Industry appears to already be moving toward a standard. Benefit is unclear.	Jurisdictions have not moved to standardise connectors, although industry is already moving toward a standard approach.
Other					
Advocate to local governments to change their fleets to electric vehicles	No Boosts visibility of ZEVs, could grow second-hand market (Cost)	No Advocating not a concrete action	Would boost ZEVs on the road if effective	Additional up-front costs borne by local governments.	ACT and New Zealand have similar policies in place.
Deliver a broad community awareness and education campaign	Yes Directly addresses the lack of understanding around ZEVs – can mitigate range anxiety and concerns around cost	Yes	Not directly linked to ZEV uptake. Impact could be measured over time.	Low cost to government.	US-based scheme 'Electrify America' seeking to normalise ZEVs.
Advocate to the private sector to lease low or zero emissions vehicles to employees	No Boosts visibility of ZEVs, could grow second-hand market (Cost)	No Advocating not a concrete action	Would boost ZEVs on the road if effective	Additional up-front costs likely to be borne by business	Australian Government Future Fuels Strategy proposes focusing on commercial fleets as a way to boost uptake.
Build professional and business knowledge to instil zero-emission workforce and commerce	No Not linked to barrier to uptake	Yes	Not likely to have a direct impact on uptake.	Could deliver broader benefits around supporting workforce transition away from ICE maintenance and servicing, but not within scope of this work	The UK Government is investing in R&D for manufacture of ZEV components and in upskilling mechanics to maintain ZEVs
Create an independent vehicle cost comparison website	Yes Directly addresses the lack of understanding	Yes	Not directly linked to ZEV uptake. Impact could be measured over time. Helps consumers	Low cost to government.	Similar to the Australian Government <i>Green vehicle guide</i> , which provides info about efficiency of vehicles.

	around ZEVs – can mitigate range anxiety and concerns around cost and can be linked to broader community awareness approach		understand overall financial benefits to them.		
Undertake community engagement to inform the strategic planning of electric and hydrogen vehicle infrastructure	No Not directly linked to a barrier. Could address infrastructure concerns.	Yes	Not likely to have a direct impact on uptake.	Low cost to government	Consultation is a common feature across jurisdictions

# Recommended actions

Following our research, consideration of the community panel's recommendations, and the efficacy of different policy approaches in other jurisdictions, we have identified priority actions for the Victorian Government to promote ZEV uptake. Our recommendations complement and strengthen the actions the Victorian Government is already taking as part of its ZEV roadmap.

These priority actions have been identified as they directly address barriers to uptake, align with the outcomes of our desktop research and reflect some of the recommendations made by the community panel.

Our advice on priority actions form the basis of *Victoria's infrastructure strategy* recommendation 1 which focuses on consumer uptake of ZEVs. Recommendation 2 includes actions to encourage uptake of ZEVs in the public and industry sectors.

The recommended actions are outlined below.

## Action: Publish a statewide electric vehicle charging network strategy (strategy recommendation 1)

The charging strategy should include design and placement standards for public charging infrastructure and establish principles for smart charging and integrated payment systems, so electric vehicle owners can use any provider for charging. The strategy should be developed in collaboration with community and industry. Development of the strategy should commence immediately and be published within two years.

### Barrier

Charging infrastructure, range anxiety

### Considerations

Evidence suggests that investment in public charging infrastructure, particularly direct current fast chargers is a precondition for high levels of ZEV uptake globally, as evidenced by the impact of deployment in Norway.

As part of the ZEV roadmap, the Victorian Government has committed to accelerate the delivery of charging infrastructure across the state. This includes fast charging stations at popular destinations around Victoria, including regional town centres, tourist hotspots and high use locations.<sup>84</sup> Furthermore, the Victorian Government is working with other jurisdictions on potential changes to the National Construction Code to encourage electric vehicle readiness in new developments. The Victorian Government is also considering how to promote ZEV-readiness in existing residential buildings, including developing an online guide for apartment owners to assist them in identifying and assessing options to enable electric vehicle charging in resident carparks.

To further support the Victorian Government's actions on charging infrastructure, Infrastructure Victoria recommends that the Victorian Government develop and publish a statewide charging network strategy which considers the needs of all road users, including private vehicles, freight and commercial vehicles, and those in urban and regional areas.

The charging strategy should include design and placement standards for public charging infrastructure and establish principles for smart charging and integrated payment systems, so electric vehicle owners can use any provider for charging. This will help provide consumers and industry with certainty. A charging network strategy would also encourage more investment in charging infrastructure from the private sector, reducing the need for additional government investment.

Increased certainty around access to charging infrastructure is likely to be particularly important for Victorians living in regional areas, who often need to travel further. Access to charging infrastructure in regional areas will ensure equitable outcomes for regional Victorians and that they are not discouraged from adopting ZEVs. In addition, it can also address concerns for city living Victorians intending to travel to regional Victoria that they will have access to charging

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<sup>84</sup> Department of Environment, Land, Water and Planning (2021) *Victoria's zero emissions vehicle roadmap* available at [https://www.energy.vic.gov.au/\\_\\_data/assets/pdf\\_file/0014/521312/Zero-Emission-Vehicle-ZEV-Roadmap-FINAL.pdf](https://www.energy.vic.gov.au/__data/assets/pdf_file/0014/521312/Zero-Emission-Vehicle-ZEV-Roadmap-FINAL.pdf)

infrastructure, both at their destination and at key points of their journey. This will minimise the risk of increased ZEV uptake having a negative impact on regional tourism and the economies of regional areas.

The charging strategy should also consider the sufficiency of electricity distribution infrastructure to meet highly localised energy demands in areas with high levels of ZEV uptake.<sup>85</sup> This would involve reviewing the regulatory frameworks governing energy network investment to ensure these allow investment in the distribution network to support the uptake of ZEVs. The Victorian Government could also advocate that the Australian Government work through the Energy National Cabinet Reform Committee to review regulatory settings and remove barriers to distributors addressing highly-localised impacts of ZEV uptake.

### Action: Monitor and review the effectiveness of financial incentives in encouraging early zero emission vehicle purchases (strategy recommendation 1)

To ensure the existing Victorian Government ZEV subsidies are operating effectively to increase ZEV uptake, the Victorian Government should regularly monitor and review the subsidies over the next five years.

#### Barrier

Cost

#### Considerations

The Victorian Government's ZEV subsidy program provides financial incentives for the purchase of new ZEVs. The first round of this program offers a \$3,000 subsidy on the purchase of a ZEV under \$68,740.

Financial incentives, such as subsidies can be costly to governments. However, interventions that reduce the purchase price of ZEVs will directly address cost – the most significant barrier to ZEV uptake. Increased uptake of ZEVs in early years will also mean quicker accumulation of the environmental and public health benefits associated with reduced emissions.<sup>86</sup> Direct financial subsidies were also recommended by Infrastructure Victoria's community panel.

Subsidies are particularly important in early years where ZEVs are generally more expensive than ICE vehicles. Prices of ZEVs are likely to decrease over time as technology improves and more vehicles become available. Price parity could be achieved as early as 2023.

To ensure the subsidies are operating effectively to increase ZEV uptake in early years, and are not maintained longer than necessary, the Victorian Government should regularly monitor and review the subsidy program over the next five years.

### Action: Transition government and freight vehicles to zero emissions technologies (strategy recommendation 2)

Within the next five years, require all new government fleet vehicles to be ZEVs where available. Incentivise uptake of zero emissions freight vehicles through reviewing restrictions on zero emissions freight movements on freight routes.

#### Considerations

Reaching net zero emissions by 2050 will require widespread adoption of ZEVs by public and industry sectors, as well as households. Buses, trucks and light commercial vehicles generate more than a third of transport sector greenhouse gas emissions

The Victorian Government funds public buses and coaches, which make up around 70% of scheduled kilometres travelled by public transport vehicles.<sup>87</sup> The Victorian Government's target for all public transport bus purchases to be ZEVs from 2025 will assist in reducing transport sector emissions and improve people's health.<sup>88</sup>

The Victorian Government's ZEV roadmap sets a target to purchase 400 new ZEV vehicles for the Victorian Government fleet by 2023.<sup>89</sup> Infrastructure Victoria recommends that the Victorian Government should further commit to making all new vehicles in its fleet zero emissions within the next five years, where appropriate models are available. This not only directly increases ZEVs on Victorian roads but, over time, supports a growing second-hand market.

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<sup>85</sup> Infrastructure Victoria (2018) *Automated and Zero Emissions Vehicles Infrastructure Advice* available at <https://www.infrastructurevictoria.com.au/wp-content/uploads/2019/04/Advice-on-automated-and-zero-emissions-vehicles-October-2018.pdf>

<sup>86</sup> Infrastructure Victoria (2018) *Automated and Zero Emissions Vehicles Infrastructure Advice* available at <https://www.infrastructurevictoria.com.au/wp-content/uploads/2019/04/Advice-on-automated-and-zero-emissions-vehicles-October-2018.pdf>

<sup>87</sup> Department of Transport (2020) *Annual Report 2019-20* available at <https://transport.vic.gov.au/about/governance/reporting#annualreports>

<sup>88</sup> Department of Environment, Land, Water and Planning (2021) *Victoria's zero emissions vehicle roadmap* available at [https://www.energy.vic.gov.au/\\_\\_data/assets/pdf\\_file/0014/521312/Zero-Emission-Vehicle-ZEV-Roadmap-FINAL.pdf](https://www.energy.vic.gov.au/__data/assets/pdf_file/0014/521312/Zero-Emission-Vehicle-ZEV-Roadmap-FINAL.pdf)

<sup>89</sup> Department of Environment, Land, Water and Planning (2021) *Victoria's zero emissions vehicle roadmap* available at [https://www.energy.vic.gov.au/\\_\\_data/assets/pdf\\_file/0014/521312/Zero-Emission-Vehicle-ZEV-Roadmap-FINAL.pdf](https://www.energy.vic.gov.au/__data/assets/pdf_file/0014/521312/Zero-Emission-Vehicle-ZEV-Roadmap-FINAL.pdf)



Many freight truck movements occur through residential areas, creating noise and pollution. Consequently, hundreds of roads have restrictions, bans and curfews to limit truck movements.<sup>90</sup> Zero emissions freight vehicles are quieter and less polluting. Creating exemptions from some of these restrictions for zero emissions freight vehicles would incentivise faster adoption, especially where the exemptions are primarily due to noise and pollution, such as night curfews. Restricting some freight routes to only ZEVs could also incentivise uptake. This should be done where appropriate and safe, noting that ZEVs can still create noise and disruption.

Infrastructure Victoria recommends that in the next five years, the Victorian Government should incentivise zero emissions freight vehicles by reviewing restrictions on zero emissions freight movements on freight routes. This particularly applies to roads leading to the Port of Melbourne, where Infrastructure Victoria has found the community impact of freight traffic could be a barrier to increasing the port's capacity. The initiatives in the ZEV roadmap which boost industry education on ZEV benefits and charging infrastructure will complement these incentives.

### Action: Commit to no longer registering new petrol and diesel vehicles in Victoria from 2035 at the latest (strategy recommendation 1)

In the lead up to this date, apply increasingly stringent air quality standards associated with new vehicle registration culminating with zero exhaust emissions being the precondition for registering a new passenger vehicle in Victoria from 2035, at the latest.

#### Barrier

Regulatory certainty

#### Considerations

The Victorian Government's ZEV roadmap sets a target for 50% of new light vehicle sales to be ZEVs by 2030. Infrastructure Victoria recommends this target be reinforced by immediately committing to no longer registering new petrol and diesel vehicles from 2035 at the latest. This strengthens the market signal and helps achieve the 50% sales target. To reach these targets, Infrastructure Victoria also recommends sequentially imposing more stringent air quality standards for registering new vehicles over time.

Regulatory intervention through a ban on registering new ICE vehicles complements uptake incentives, such as the Victorian Government's ZEV subsidies. By setting a date now, the Victorian Government can provide confidence to consumers, industry, and vehicle manufacturers to start transitioning.

This type of approach of a clear date and increasing vehicle emissions standards is supported by Infrastructure Victoria's community panel, the International Energy Agency, and many other jurisdictions around the world. The Victorian community panel recommended 2030 for ending the sale of ICE vehicles. From a broader international perspective, the International Energy Agency has set 2035 as the date from which new ICE vehicles should no longer be sold in developed countries. Infrastructure Victoria's recommendation sets the date at 2035, at the latest. This would allow adequate time for technology and infrastructure developments, and while a date of 2035 is the latest, it could be brought forward to the early 2030s, if feasible.

The Victorian Government should use vehicle registration rules and air quality standards to reach these targets. It is somewhat challenging for the Victorian Government to unilaterally implement vehicle emissions standards or a ban on the sale of ICE vehicles due to the Australian Government's legislation on vehicle importation and standards. Ideally, these standards would be amended at a national level, however, there has not been strong policy direction from the Australian Government in this area. Nevertheless, the Victorian Government should not delay action, it has powers relating to environmental air quality through *the Environment Protection Act 1970* and *Environment Protection (Vehicle Emissions) Regulations 2013* and can also set standards associated with vehicle registration pursuant to the *Road Safety (Vehicles) Interim Regulations 2020*.

The full transition to ZEVs will also be staged. From the present to 2035, the sale of new ZEVs will rapidly increase as people become more familiar with the technology. From 2035, ZEVs will become increasingly common on the road, and a substantial second-hand ZEV market will develop. In the 2040s, ZEVs will be ubiquitous, allowing the target of net zero transport emissions to be met by 2050. Over the whole transition period, there will be different technologies on the road, but from 2035 ICE vehicles will become increasingly rare as vehicles reach their lifespan.

The exact timing for the eventual complete phase out of all ICE vehicle registration (new and old) should reflect the Victorian Government's emission targets and vehicle lifecycles while balancing equity concerns for Victorians who own ICE cars and may not have the means to purchase a ZEV within the prescribed period. The recommendation for restricting registration of new ICE vehicles rather than the resale of existing ones mitigates the risk of unfairly disadvantaging owners in the medium term, while allowing low income Victorians to still purchase ICEs at lower cost in the transition period. Some jurisdictions that have implemented bans on the sale or registration of ICE vehicles (France,

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<sup>90</sup> Vicroads (2020) *Victoria's Truck Curfew Map*, Department of Transport available at <https://nhvr.maps.arcgis.com/apps/webappviewer/index.html?id=c451ccf96c3546b391b9216f947ee58a>

UK) have also set targets for eliminating them from the road entirely within 10 years after the proposed ban on sales. This implies a curtailing of vehicle lifetimes, which are an average of 15-20 years in Australia, as the sales ban approaches.<sup>91</sup>

### Actions for further consideration

An additional three actions have been assessed as warranting further consideration by the Victorian Government. These actions have the potential to increase ZEV uptake in Victoria but lack either a clear role for the Victorian Government or evidence of a market failure, or do not directly address one of the barriers to uptake.

These are:

#### **Support the development of a second-hand ZEV market by:**

- Advocating to local governments to change their fleets to ZEVs.
- Advocating to the private sector to lease low or ZEVs to employees.
- Providing incentives for taxis, rideshare vehicles and courier vehicles to use low or ZEVs.

Increased uptake of ZEV in local government and private sector fleets would help develop the market for new and second-hand ZEVs in Victoria. Government and private sector fleet targets, and the associated bulk buying of ZEVs, has been identified as a driver of broader ZEV uptake in other jurisdictions.<sup>92</sup> This underpins Infrastructure Victoria's recommendation that the Victorian Government transition its own car fleet to ZEVs in the next five years.

The ZEV roadmap notes that the Victorian Government will seek opportunities to collaborate with industry and local government to improve understanding of ZEVs for those responsible for car fleets.

Incentivising taxis and rideshare vehicles to transition could also directly boost ZEV uptake but may not represent the most effective use of public funding. As taxis, demand responsive and ride share operators are among the most intensive road users, they have the most to gain from transitioning to ZEVs in the form of reduced operating costs and are more likely to transition to ZEVs sooner. Illustrating this, Uber Australia has already announced incentives for drivers who use battery electric vehicles.<sup>93</sup>

In London, an ultra-low emissions zone has been used to encourage taxis and other rideshare vehicles to transition to ZEVs sooner. Given taxis and other rideshare services are more likely to predominantly operate in inner urban areas, an ultra-low emissions zone increases costs for ICE use, making ZEVs more attractive.

These considerations could also be applied to freight vehicles. Given the fuel intensity of heavy freight vehicles, they are more likely to adopt zero emissions technologies sooner, so long as they are fit for purpose, given the vehicle operating costs tend to be lower.

#### **Support the integration of energy capture through solar panels and storage in batteries**

This would directly address concerns around charging infrastructure and encourage greater alignment of ZEVs energy requirements with solar energy. However, if charging is not coordinated with solar energy generation, then it can still have a large impact on electricity distribution networks. It also risks excluding some households such as those which are unable to install, or cannot afford, solar panels. This would leave larger energy system infrastructure costs to those who cannot take advantage of solar panel installation. If applied in workplaces, this can also lead to equity issues, as not everyone can drive to work or has access to parking at their place of work. This could also create a perverse incentive for more people to drive to work to make use of charging infrastructure. In addition, the Victorian Government's 2050 net zero emissions target will lead to greater decarbonisation of Victoria's energy grid, meaning vehicles are increasingly utilising renewable energy by default.

The ZEV roadmap notes that the Victorian Government is exploring the role that rooftop solar, in combination with storage batteries, can play in managing peak demand and thereby reducing the net cost of supporting electric vehicles.

#### **Build professional knowledge to instil zero emission workforce and commerce**

Supporting the vehicle maintenance sector is likely to be an important part of the transition to ZEVs, but its direct impact on ZEV uptake is limited. However, the transition is likely to have an impact on employment in the vehicle maintenance and refuelling sectors. Our 2018 advice identified that if the entire fleet converted to ZEVs, there could be up to a 25% reduction in ongoing maintenance requirements for battery electric vehicles. In a workforce forecast to employ 16,300 people in 2046, lower maintenance requirements could lead to some job losses. In addition, nearly 11,000 jobs in the fuelling sector may also be affected. Overall, new employment opportunities are likely to emerge alongside ZEVs that will

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<sup>91</sup> Energeia (2018) *Australian Electric Vehicle market study* available at <https://arena.gov.au/assets/2018/06/australian-ev-market-study-report.pdf>

<sup>92</sup> *Vicroads (2020) Victoria's Truck Curfew Map*, Department of Transport available at [vicroadsmaps.maps.arcgis.com/apps/webappviewer/index.html?id=be41782b97254d258d41b8e012895448](http://vicroadsmaps.maps.arcgis.com/apps/webappviewer/index.html?id=be41782b97254d258d41b8e012895448)

<sup>93</sup> Uber Newsroom (2021) *Helping lift the handbrake on EVs* available at <https://www.uber.com/en-AU/newsroom/evsoz/>

offset these potential employment impacts. However, it is worth noting that some of these workers may not have easily transferrable skills and might need some help transitioning into new roles.

The Victorian Government's recently released ZEV roadmap highlights that the government is working on an industry development and transition plan for ZEVs, as part of its broader plan to explore new opportunities relating to emerging transport technologies, including those related to Connected and Automated Vehicles. The key objectives of this plan include the boosting of Victorian manufacturers' capabilities to export and secure global supply chain opportunities related to electric vehicles and batteries, as well as prioritising attraction of advanced manufacturing investment in Victoria that builds on the State's existing strengths in automotive engineering.<sup>94</sup>

## Conclusion

Infrastructure Victoria's recommended actions, along with the Victorian Government's ZEV roadmap, have the potential to create confidence and certainty both for Victorian consumers and international vehicle manufacturers regarding Victoria's transition to ZEVs. This could leave Victoria well-placed to respond to the emergence of ZEV technologies and progress meeting its target of net zero emissions by 2050. These actions have the potential to break the 'vicious cycle' that is suppressing ZEV uptake in Victoria and create a 'virtuous cycle' that results in ZEV uptake accelerating over time.

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<sup>94</sup> Department of Environment, Land, Water and Planning (2021) *Victoria's zero emissions vehicle roadmap* available at [https://www.energy.vic.gov.au/\\_\\_data/assets/pdf\\_file/0014/521312/Zero-Emission-Vehicle-ZEV-Roadmap-FINAL.pdf](https://www.energy.vic.gov.au/__data/assets/pdf_file/0014/521312/Zero-Emission-Vehicle-ZEV-Roadmap-FINAL.pdf)

# About us

Infrastructure Victoria is an independent advisory body, which began operating on 1 October 2015 under the *Infrastructure Victoria Act 2015*.

Infrastructure Victoria has three main functions:

- preparing a 30-year infrastructure strategy for Victoria, which is refreshed every three to five years
- providing written advice to government on specific infrastructure matters
- publishing original research on infrastructure-related issues

Infrastructure Victoria also supports the development of sectoral infrastructure plans by government departments and agencies.

The aim of Infrastructure Victoria is to take a long-term, evidence-based view of infrastructure planning and raise the level of community debate about infrastructure provision.

Infrastructure Victoria does not directly oversee or fund infrastructure projects.



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