



Submission to Infrastructure Victoria

Automated and zero emission
vehicle infrastructure

March 2018

Introduction

With more than 2.1 million members, RACV is a household name in Victoria and we have long represented our members on motoring and transport issues, advocating on their behalf, and expressing their views to both government and stakeholders.

How Victorians move around their state in the future is of vital importance, and RACV is pleased to have the opportunity to provide input to Infrastructure Victoria on both automated and zero emission vehicles. Through our previous submissions to both Federal and State governments, RACV has recognised important future benefits of automated vehicles (AV's) and zero emission vehicles. We encourage Infrastructure Victoria (IV) to continue taking a holistic approach to better understanding these topics. The potential benefits in improved safety, accessibility and the reduction of emissions are of great importance to all road users.

We understand that the characteristics of zero emission vehicles, specifically electric vehicles (EV's) can facilitate highly automated features. However, the technologies do not necessarily coincide. We suggest that IV examine zero emission vehicles as a separate topic to automated vehicles, to enable full consideration of their individual benefits and challenges.

This submission is structured as follows;

1. A general discussion providing the context through which RACV considers AV's and zero emission vehicles. This highlights RACV's extensive involvement in market research and vehicle trials in these areas;
2. Specific discussion regarding the 'areas of focus' (provided by IV); and
3. Specific discussion regarding the 'target outcomes' (provided by IV).

Summary of key points:

- **Safety the highest priority target outcome.** Whilst there are many potential benefits of AV's, we consider public safety to be central to any future assessments of how these technologies may impact the lives of Victorians.
- **A holistic, integrated approach is essential.** The scope of IV's advice to Government on these topics is broad, and enables wide-ranging, holistic recommendations to be provided. We encourage the advice to not only consider the private transport markets (passenger and commercial), but also on the application of these technologies to public transport.
- **The governance of these trends is as important as the technology being developed.** There will be a need for a revised regulatory, legal and enforcement framework regarding AV's and zero emission vehicles. This should where possible, anticipate the roll out timeframe of these technologies to realise the greatest benefit of vehicle automation. We encourage proactive governance that seeks to enhance public value that may be delivered through these emerging technologies.

1. Discussion

1.1. General

Whilst RACV considers the challenges and benefits to AV and EV introduction from a Victorian perspective, we also acknowledge that there are general principles that apply in any jurisdiction.

Due largely to the fact that Australia no longer has a large-scale local vehicle manufacturing industry, a more outward looking approach to regulation and infrastructure is necessary to maximise the benefit and reduce the costs of these emerging technologies.

RACV believes that an approach that takes into account overseas experience and best practice should inform the guidelines adopted in Australia. However careful consideration should also be given to Australian circumstances as appropriate.

A consistent approach is essential across Australia to ensure that jurisdictions considering policy and infrastructure around both zero emission vehicles and AVs do so in concert with other jurisdictions, using where possible the same regulations, standards and operating principles.

1.2. Automated Vehicles

There is little doubt that automated technologies are becoming more prominent and sophisticated, especially within the passenger and commercial transport sectors. This represents a wholesale change to the current model, bringing with it a suite of potential benefits.

With human error contributing to more than 90 per cent of crashes, RACV believes that removing the human element from much or all of the driving task will have enormous potential to reduce the road toll. Moreover, there are numerous other societal benefits from automation including helping those with limited mobility travel more easily.

When it comes to transport automation, there's still a lot more to discover. With global auto maker executives from companies such as Ford, Toyota, Honda Hyundai and Daimler on record (Walker 2017) as predicting we are just five to 10 years away from delivering Level 4 and 5 automated vehicles onto the market, Victoria's road infrastructure must be ready.

In anticipation of the new technology, RACV is a partner in several automated vehicle technology trials which will help us better understand how road infrastructure and regulations must adapt, and will help prepare the community for

driverless cars. Our program of activities will gauge public attitudes to automated driving and examine how the changes will affect the everyday life of Victorians.

1.3. RACV Trials

RACV is participating in a diverse range of automated technology trials to help us get a clear understanding of the potential safety improvements offered by automated vehicles; how the technology works and what the implications are for the community.

AIMES Test bed

Australian Integrated Multimodal EcoSystem (AIMES) is a project that creates a living laboratory on the streets of Melbourne. The project has already trialed an autonomous vehicle in Carlton and will implement other highly integrated transport technologies which will help deliver safer, cleaner and more sustainable transport outcomes within complex urban environments.

Four and a half square kilometres in inner Melbourne, encompassing Carlton, Fitzroy and Collingwood are being used to test a new generation of connected transport systems. The test bed includes a broad mix of roads ranging from busy arterials to small local streets and laneways.

The area is systematically being equipped with advanced communication systems on both infrastructure and vehicles including the RACV roadside assistance fleet. Sensors for measuring emissions and noise levels are also included in the trial. These systems allow for better management of our road and great transport systems as well as the ability to increase capacity using existing infrastructure.

The test bed covers all modes of transport, collecting data on vehicles, cyclists, public transport, pedestrians and traffic infrastructure.

RACV is a participant at all levels of the project including the technical committee.

Transurban Automated Vehicle Trial

The Transurban Automated Vehicle Trial on the Monash-Citylink-Tullamarine corridor uses vehicles with automated features that are already on the market, including the Volvo S90, Tesla Model S and X, BMW 540i and Mercedes E300.

The trial sought to discover how autonomous features, such as lane-keep assist, adaptive cruise control and traffic-sign recognition respond and interact with road features including tunnels, road works, congestion, electronic speed signs and varying line markings.

The trial findings will help shape road infrastructure, rules and regulations, increase safety and prepare and inform the community about driverless cars and automated vehicle features.

The trial also examined community attitudes to automated driving and how negative perceptions can be ameliorated, including whether motorways should have designated lanes for automated vehicles.

The whole trial program will take over two years to complete with interim results expected to be made public shortly.

ConnectEast Automated Vehicle Trial

This trial tested cars equipped with automated driving features on Melbourne's EastLink toll road. The aim was to test a wider range of vehicles on a more consistent and less congested driving environment than CityLink.

The EastLink trial ran in partnership with VicRoads, the Australian Road Research Board (ARRB), La Trobe University and RACV to identify opportunities to improve the compatibility between the latest self-driving car technologies and freeway infrastructure.

Vehicles included BMW, Honda, Lexus, Mazda, Mercedes, Mitsubishi, Tesla, Toyota, Volvo. Toyota and Volkswagon.

La Trobe Autonobus trial

RACV is a partner in the Autonobus trial at La Trobe University's Bundoora campus in northern Melbourne.

The project focus is on showcasing and demonstrating the long-term operational and commercial benefits of AV technologies.

This is the first time an automated shuttle has been trialed in Victoria to examine first and last mile connectivity requirements.

The shuttle is an Arma-4 model developed by NAVYA, designed to meet SAE level-4 standards and can operate in full autonomous mode on mapped routes. Initially the vehicle will be trialed along Science Drive at speeds of up to 30km/h, but this will be expanded to higher speed on longer routes.

1.4. Zero Emission Vehicles

RACV has had a long and diverse involvement with electric vehicles in our advocacy for an integrated approach to mobility to meet Victoria's transport needs.

A snapshot of the suite of electric vehicle programs and activities undertaken by RACV includes:

- Premier partner in the Victorian Electric Vehicle Trial run by the Victorian Government (2010-2014).
- Community partnership with the Royal District Nursing Service in 2013 centered on an Australian-first trial of electric vehicles to test their suitability as part of a metropolitan fleet.
- Introduction of electric vehicles into our resorts for guests and members to use as part of their leisure experience and to become more accustomed and informed about this emerging vehicle technology.
- Progressive expansion of a public and free to use EV charging network across all RACV sites in Victoria, Queensland and Tasmania and many additional Victorian and interstate tourist sites.
- Member of The Electric Vehicle Council, a national body representing companies and organisations involved in the provision, powering and support of electric vehicles and aiming to accelerate the electrification of road transport in Australia in a sustainable manner.
- Member of the Charging Infrastructure Working Group (as part of the EV Council) focusing on a coordinated and standardised approach in the rollout of EV charging infrastructure in Australia.
- Undertaken an electric vehicle consumer attitudes survey in June 2017.
- Collaborated and contributed to [The State of Electric Vehicles in Australia Report](#) produced by Electric Vehicle Council and ClimateWorks (June 2017).
- Major sponsor of the annual [Melbourne Electric Vehicle Expo](#) run by the Alternative Technology Association.
- Since 1991, RACV has led the [RACV Energy Breakthrough](#) in partnership with the Country Education Board and Central Goldfields Shire - the country's leading school-based technical, science and environmental program where students design, build and race a vehicle that represents an 'energy breakthrough' including the categories of hybrid and electric technology.

Electric vehicles can also offer benefits to public health through reduced air pollution in urban areas, save motorists money (reduced fuel, maintenance and servicing costs), and could help to generate Australian jobs in retail, infrastructure deployment, and potentially in the manufacture of batteries and electric vehicle components.

Moreover, RACV's Electric Vehicle Attitudes Survey (2017 and updated in February 2018) has revealed the following findings which RACV submitted to inform the recent Government Inquiry on Electric Vehicles:

- More than 50% of respondents would consider buying an electric vehicle if in the market for a car.
- 33.5% would be willing to buy an electric vehicle if it was the same price as other petrol or diesel options.
- More than 25% of respondents would be willing to pay more for an electric vehicle than a petrol or diesel vehicle only if there were more support, incentives and infrastructure in place.
- Respondents would be encouraged to buy an electric vehicle based on the following features: environmentally friendly (72%); cost to run and maintain (67%); confidence in electric vehicles as a reliable and proven technology (63%); on board technological features (63%); convenience of recharging (62%); purchase cost compared to petrol and diesel vehicles (59%); range of models to choose from (59%); distance able to be travelled per charge (58%); and vehicle size, performance or aesthetics (58%).
- On the flipside, respondents would be discouraged by: distance able to be travelled per charge (23%); convenience of recharging (20%); and purchase cost compared to petrol or diesel vehicles (18%)
- More than 55% respondents think subsidies to reduce the cost to purchase electric vehicles should be implemented by government and a similar percentage (53%) believe government should implement subsidies to reduce the cost of installing home charging, and provide public charging infrastructure.
- 80% respondents consider the availability of public fast charging (i.e. 15 minutes to full charge) to be an important factor in influencing their decision to buy/own an electric vehicle.

Based on what our members have told us, and what we have found through the varied electric vehicle activities we have undertaken, RACV supports measures and incentives by government to encourage the uptake of electric and ultra-low emissions vehicles (such as plug-in hybrid), on the proviso that consumer choice and affordability is not detrimentally affected. In doing so, it is critically important that adequate recharging infrastructure and appropriate standards are in place to support the uptake of electric vehicles (e.g. plug consistency and charger interoperability).

2. IV Areas of Focus

Technology development

Automated and zero emission vehicle technologies are advancing rapidly, but exactly how rapidly – and in what direction – will have a significant impact on the infrastructure required to support its roll-out. We will also need to look at what might be needed to allow automated and human drivers to exist together on the road, any opportunities or drawbacks to particular technologies, and the specific opportunities for freight.

There are varying estimates on the expected timeline for functional, automated vehicles. Some manufacturers expect the arrival of automated cars as early as 2019.

Others have different timelines extending to 2030. Some of the technologies are here today and some will depend on specific technical innovations or policy choices. There is a strong momentum and commitment from the industry to speed up technology development.

Whilst the technology is in place conceptually, it needs considerable refinement. A product that is fully automated can only be realistically offered to the public when reliability and public confidence can be assured. The two toll road trials detailed above revealed several areas where the technology needs to be improved, in particular regarding lane tracking and sign recognition.

Irrespective of the date at which a viable, fully automated vehicle is ready to use on Australia's public road network, there will be an extended period where regular and automated vehicles will need to coexist. That period of time is likely to extend from years to decades. This will require policy and regulation, as well as the development of vehicle technology, to enable a mix of regular, semi-automated and fully automated vehicles to share public roads and parking facilities.

We note that automated train operations are fully functional in many cities around the world. We encourage IV to consider the applicability of automation for Victoria's rail network as well as the viability of automation on Victoria's bus and tram networks.

Automated technologies present specific opportunities for the freight and logistics sector. RACV considers the freight sector to be a likely leader in AV uptake, owing primarily to the potential safety and commercial benefits to be gained through automation.

Levels of sharing and ownership

Whether the introduction of automated vehicles leads to no one owning their own vehicle – or to everyone having their own, fully automated car – will have significant implications for what and when infrastructure is needed. We will also be looking to understand the potential market and commercial models for fleets, and how these might impact on how we are likely to use our transport infrastructure in the future.

The extent to which AV's are likely to impact the current model of vehicle ownership in Australia is subject to ongoing industry discussion. Factors such as vehicle cost, regulation of on-demand or 'shared' fleet operators, as well as people's attitudes to sharing, will influence ownership models in the future.

The proposition of sharing an AV may be very different to sharing a regular vehicle, as various concerns regarding the ability or risk profile of another driver may not be relevant. In addition to this, as vehicle, mobile and payment technology improves and people become more familiar with emerging sharing platforms, current attitudes are likely to change.

The interest in AV's from on-demand transport operators has been made clear (Uber, 2017). AV's are well suited to the on-demand transport market due to the trip types that this market caters for, and the potential for operators to scale up the deployment and management of automated fleets. This also applies to the freight and logistics sector. Introduction of AV's to the market through the on-demand model, as opposed to individual ownership, accords well with the mobility as a service (MaaS) concept.

RACV believes the MaaS trend has the potential to alter the way Victorians gain access to transport. At its core is a fundamental shift, where access to the service becomes more desirable, viable and convenient than the alternative of owning and operating a private vehicle. The impact of this shift is potentially significant, given the prominence of private car ownership in Australian society today. We expect that AV's will add diversity to the broader 'mobility ecosystem'. Automated cars may compliment core public transport services by improving the first and last-kilometer experience, expanding the reach of our train, tram and bus systems. The viability of MaaS platforms, such as multi-modal booking and payment apps, are likely to increase as the depth and appeal of mobility options expand. It is critical that the State Government facilitate access to its public transport ticketing systems to ensure the benefits of the mobility service economy can be realised in Victoria.

Interface with physical infrastructure

What might the roads of the future look like without drivers or emissions? That is a question we will be asking through this advice. We will consider issues such as road markings, signage, road quality, drop-off and pick-up areas, dedicated lanes, charging and fuelling infrastructure, and parking. We will also look at how the infrastructure needs for automated vehicles could change over time, from introduction to full roll-out, and what the implications could be for future infrastructure projects.

As highlighted in the ‘technology development’ section, a scenario where all vehicles on the road network are fully-automated is not likely in the near term. Physical infrastructure will therefore need to cater for a mix of regular, semi and fully automated vehicles for decades to come.

In general terms, this suggests that signage, lane markings and other design characteristics of the current road network will be relevant into the future.

While necessary improvements to markings and infrastructure are manageable in the context of metropolitan roads, a question will be raised over the standard of sealed and unsealed regional roads. RACV recommends the Victorian Government consider what testing might be necessary for regional AV trials.

Current AV prototypes do not require special infrastructure for navigating. However, during the period where conventional and highly automated vehicles transition, instrumentation of road infrastructure may be necessary.

Autonomous vehicles are prompting some authorities to reassess long term infrastructure priorities, given uncertainty around how AV’s will impact people’s transport behaviour. The volume of car travel may at times increase as vehicles need to re-position after they drop off passengers, adding trips to the network.

However, this increase may be partially offset by improved efficiencies on the road network. Reports reviewed by RACV (Greenblatt & Saxena 2015) highlight that human drivers are responsible for between 20% and 30% of inefficiencies in vehicles. This suggests that shared self-driving fleets may be able to deliver the same access as today with significantly fewer cars.

Automated on-demand vehicle sharing may be preferable to a second car or even first car. Some studies have shown that self-driving cars could slash car sales by nearly 50% (Read 2015). Any advances in technology that provide for automated vehicles could also result in automated freight delivery, saving on the cost of operations by reducing the need for driver labour. This must be debated to ensure that the future will see broad-based prosperity as automation becomes widespread.

Research conducted by RACV suggests that the largest benefits for automated mobility-on-demand systems are achieved in the presence of a high-capacity public transport system. This reflects the potential role that AV’s may play in

facilitating access to and from core public transport services (known as the last-kilometre transport concept).

Revenue sources such as federal fuel and vehicle taxes, state registration and licensing fees, traffic infringement revenue and TAC revenue and expenses may be severely affected.

We encourage IV to explore how AV's may impact the supply and demand equation for car parking. We expect this to be significant, however factors such as the ownership model of AV's will have a major bearing on this. We expect the demand for drop-off or 'kiss-and-ride' zones to increase, especially in major activity centres. Involving the local government sector in this transition will be important given their management of on-street car parking and, in many cases, reliance on the revenue raised from it.

More EV's in the public vehicle fleet will likely impact physical infrastructure associated with refuelling. Demand for a range of charging options is likely to increase, such as charging facilities at workplaces as well as publicly available charging points on-street and within off-street parking facilities. These facilities can help alleviate real and perceived 'range anxiety' associated with EV's. Thinking longer term, if we see a decline in petrol cars, this may impact the business model for petrol stations. Closure of petrol stations due to a lack of business may introduce the 'range anxiety' issue to drivers of petrol cars.

Digital infrastructure

To fully reap the benefits of automation, driverless cars will need to be connected. But how connected do they need to be and to what? Their exact communication and data needs, including mapping accuracy, will determine what digital infrastructure might be needed to support their operation. Cybersecurity also needs to be addressed to build confidence and protect consumer privacy.

It is likely that future transport systems will focus more on transportation integration than ever before. Instead of numerous independent systems controlling movement of buses or trams or cars or trains, this will increasingly be undertaken by a single system.

In the future, as our population and transport grow, emphasis will shift to getting more goods and people efficiently to their destinations by whatever means works best. To achieve this, accurate real-time data from all road users including cars, trams, buses, cyclists, and pedestrians will be essential to make intelligent decisions about traffic flow.

To achieve this, networks need to communicate and digital and roadside infrastructure will be a key part of these communications. RACV believes that the Victorian Government should continue to support projects like Australian Integrated Multimodal EcoSystem (AIMES) to trial and refine this technology, and should investigate a central control centre for the road and public transport networks.

AVs will be required in the most part to operate within the parameters of the existing road network; therefore it is imperative that the best use is made of this infrastructure with an overlay of a modern and future-proofed digital communications system. Establishing what this will look like will be the most important outcome of the AIMES project which has in its test bed area one of the heaviest traffic vehicle corridors in Melbourne.

Security, at both a personal and a systemic level is important and one of the most frequently expressed concerns from our members. This is another area that the AIMES project is exploring.

Changes to travel and land use patterns

The introduction of automated vehicles could dramatically change the way we interact with all forms of transport, particularly if the potential of ‘Mobility as a Service’ is fully realised – or not. The potential impacts that these changes could have on how and where we want to travel will have implications for the infrastructure that we need as a state, in both urban and regional areas. Active transport and how this will be integrated with new types of vehicles is also an important area for us to investigate. Urban planning and infrastructure requirements may change if people live and work in different places or ways due to use of automated vehicles.

RACV encourages IV to align this project with the aspirations of Plan Melbourne. AV’s should be considered as an enabler of the future state that is being planned for. In this context, we would expect AV’s to contribute to a more productive and liveable Melbourne, notably, increasing residential density around employment centres and reducing low-density urban sprawl. Plan Melbourne also contains within it the ‘20-minute neighborhood’ aspiration. Assessing how AV’s may enable progress towards such a target would be useful.

Specific consideration of how AV’s may impact travel is required. ‘Marchetti’s constant’ (Marchetti, C. 1994) suggests that irrespective of transport innovations over time, people have generally held a travel time budget of approximately one hour per day. This has played a large role in shaping our urban and regional settlement and land use patterns. Questions regarding the potential of AV’s disrupting this constant are valid, given other tasks (work, entertainment, etc) may be carried out while in transit. If people are willing to travel for a longer period, this may promote living further from their place of work, impacting land use and travel patterns not only in metropolitan areas but more broadly around the state.

The points raised regarding car parking (under the ‘interface with physical infrastructure’ section) should extend to the land use opportunities that may arise from repurposing existing car parking.

We have included discussion about “mobility as a service” under the ‘levels of sharing and ownership’ section.

Energy supply and charging capacity

The type of zero emission technologies that fuel our future vehicles will have specific infrastructure requirements and impacts across the state's energy network. If all vehicles are electric, the implications for the grid, the need for charging stations and how batteries engage with the network all have flow-on effects for infrastructure. Hydrogen fuel cell vehicles, on the other hand, could have a different set of implications. We also need to consider when and how our behaviour might change as a result of the introduction of these vehicles. Will we still charge or fuel up at stations, or will this be done at home or work? And can our cars act as batteries to provide energy for our homes? The implications of these decisions will help to determine what infrastructure we need to build or change to accommodate a future with zero emissions vehicles.

It is likely that most electric vehicle charging will occur at home or in the workplace. However, in part due to perceptions around range anxiety and in part due to reality of the long distances inherent in non-metro travel on Australian roads, there is a clear and pressing need for a rollout of a charging network.

There are currently around 500 dedicated public electric vehicle charging stations in Australia. Although Victoria is well represented in this total, these tend to be concentrated in capital cities. RACV believes there should be a concerted effort to expand the regional electric charging infrastructure to improve the viability of EVs. To date the roll-out has been undertaken mainly by Government, membership organisations such as RACV and vehicle manufacturers. This has been a separate and individual initiative on behalf of these organisations, rather than a coordinated strategy. There may be a role for the Victorian Government to consider a charging roll-out strategy that best serves the needs of all Victorians.

The energy requirements and relative cost to harness hydrogen for fuel cell type vehicles will be challenges that must be overcome for the technology to be adopted. Pre-distribution and in-vehicle cryogenic storage solutions will be needed and the safety implications of transporting such a flammable material will need to be addressed.

As a corollary to hydrogen fuel cell vehicles, IV also needs to consider hydrogen internal combustion engine vehicles (HICEV) as a zero-emission vehicle which, in practical applications, emits only water vapour. RACV believes that the same infrastructure and transportation challenges will apply to HICEV vehicles as already described in hydrogen fuel cell applications.

Public acceptance and Government policy

Drivers today are wary of travelling in a fully automated vehicle, car or ride sharing in Victoria is not very common, and we are lagging behind some other countries in adopting zero emissions vehicles. Public attitudes could affect uptake levels, so it is important that we consider how behaviour might change – and when. Whether the government has a role in encouraging the use of automated or zero emission vehicles could have implications for infrastructure, particularly if it affects adoption rates. The rate of uptake also has implications for how the government funds future infrastructure maintenance and investments, and how the economy reacts to these technologies more broadly.

Regulations will play a key role in the emergence of automated vehicles and will likely be the biggest hurdle.

Regulators must adapt and their approach to avoid stifling innovative uses of these technologies. Developing a framework for determining who, or what, is at fault for crashes is a major hurdle for self-driving vehicles.

Regulation has in equal parts a federal and state element to it. For instance, vehicle standards and the Australian Design Rules will require significant modification to capture what constitutes the operating features of all the incremental levels of automation up to, and including a fully autonomous vehicle. Likewise, state laws particularly Vehicle Road Rules, currently place emphasis on the behaviour of the driver. This will need to change to acknowledge that the entity in charge of the vehicle may not be a person travelling in the vehicle but may instead be the manufacturer. The National Transport Commission has commenced work on this issue.

The number of trials of AV technologies has been growing markedly over the past few years as the technology is maturing and public interest grows. RACV is actively participating in four trials at present which were outlined earlier in the discussion section of this submission.

Levels of public acceptance of AVs and Automated technologies in general is likely to be fluid, with people becoming more comfortable as the benefits become apparent to them and concerns are allayed. Botsman (2017) suggests public acceptance of AV's may increase relatively quickly, given the act of being a passenger is a familiar experience to most people, and therefore the 'trust leap' involved in accepting the new technology will occur once people see and experience the technology.

This indicates that when technology improves, or when public policy or regulations are adapted to accommodate AVs, clear and simple public communications will be essential. Public trials, such as those that the RACV is involved with, will be

essential stepping stones to enable the community to better understand the capabilities of automated technology and the experience of traveling in these vehicles.

An important aspect of this focus area is governance. We consider the public sector to have a central role in helping navigate the mobility transition. As highlighted throughout this submission, the potential benefits that automated and zero-emission vehicles may help yield are significant. These can be understood to potentially enhance 'public value'. That is to say, that the upside of these technologies can, on balance, benefit our society and its economic and environmental performance.

However, to achieve this, the potential negative effects need to be recognised, understood, and – as far as possible – mitigated. This is where we see all tiers of Government, with the suite of regulatory and public policy tools available to them, playing a significant role in governing this transition.

A clear governance aim for this transition should therefore be creating and enhancing public value. *'A failure to address both the short and longer-term governance issues risks locking the mobility system into transition paths which exacerbate rather than ameliorate the wider social and environmental problems that have challenged planners throughout the automobility transition'* (Docherty 2017).

Environmental and human health impacts

Zero emission vehicles can make a contribution to achieving carbon emission reduction targets. But what will be the extent of this contribution, what will be the source of the generated electricity and will it be stored in batteries or hydrogen fuel cells? The environmental impacts of automated and zero emission vehicles over their entire lifecycle, with different possible uses and technologies, requires consideration. Automated vehicles have the potential to reduce road injuries and deaths. But to what level and what transitional safety issues might we face with a mixed fleet of vehicles? As air and noise pollution from vehicles have effects on human health, the contribution that zero emission vehicles can make to improving health may be important.

A large proportion of crashes today could be avoided with high levels of vehicle automation. If they deliver on their promise to eliminate the clear majority of causes of fatal and serious injury crashes, they will rank among the most transformative safety initiatives in human history.

Some estimates put the potential reduction in crashes due to the introduction of automated vehicles at higher than 90%. This may make the funding model employed by providers of compulsory third party insurance such as TAC less viable or open a debate about the justification for the rate at which it is charged.

However, the fact will remain that there will be ongoing legacy liabilities for such organisations.

Collectively, passenger cars currently generate around eight per cent of Australia's total greenhouse gas emissions, and slightly more than half of the nation's transport sector emissions (which includes commercial vehicles, rail, sea and air travel). Light commercial vehicles account for 2 per cent of total emissions. In unison with a move towards decarbonising the grid, and increasingly sourcing transport energy from renewable sources, RACV believes that electric vehicles will form a major component of a future integrated, sustainable transport mix for Victoria. Amongst their many benefits, electric vehicles can play an important role in reducing emissions in the transport sector and enabling Australia to meet its Paris Agreement emission reduction goals as well as future vehicle emission standards likely to be introduced as per the current Federal Ministerial Forum on Vehicle Emission Standards.

Furthermore, RACV believes that an increased uptake of electric vehicles in Victoria, will only make sense from a sustainability context, if coupled with supportive measures to decarbonise Victoria's electricity grid. It is a challenge for Government to ensure Victoria has a sustainable supply of electricity, with reduced emissions, priced fairly, and enables people to make a choice about their mode of travel.

Economic impacts

Automated and zero emission vehicles, and the infrastructure provided to support their deployment, are likely to have different economic impacts depending on how and when they are rolled out and used. We will seek to understand these economic impacts to inform investment choices and other policy decisions.

AV's will have deep and far reaching economic impacts. We encourage IV to consider the following;

- Labour economics; the extent to which AV's will impact employment in the commercial and public transport sectors, and the flow on implications of this.
- Land economics; the extent to which land use and settlement patterns are impacted by AV's.
- Productivity; the extent to which AV's will influence commercial freight and logistics business models, as well as the productivity of the general labour force.

As suggested in the 'public acceptance and government policy' section, a focus on how AV's can enhance public value should be central to this. Better understanding of the full range of costs and benefits associated with AV's will enable decisions around future investments, policy and regulatory changes to be aimed at achieving the widest societal benefits possible.

Presently, all State and Federal Governments draw income directly or indirectly from fuel excise on petroleum-based fuels. If the mix of vehicles changes significantly in the direction of EV's then this revenue stream would be affected. Governments should ensure they anticipate this and can present a fair and effective alternative when that time comes.

Similarly, the Victorian Government must consider what a large-scale roll-out of fully or even partially automated vehicles will have on how policing resources need to be allocated. This may be a net benefit if there is less need to concentrate on traffic offences and police resources can be re-allocated to other enforcement and public safety issues.

Social consequences and opportunities

Victoria's ageing population and those living with a disability are potentially beneficiaries of automated vehicles, which promise increased access to mobility, services and employment. Our work will consider how infrastructure investments and policies can help harness these opportunities while mitigating potential negative consequences.

In addition to reducing driver stress and freeing up time, driverless vehicles may provide a personal mobility option to people currently unable or unwilling to drive. The potential benefits for these groups may include greater independence, reduced social isolation, and improved access to essential services and opportunities.

Previous inquiries undertaken by the National Transport Commission (NTC) have emphasised the pressing need to reconsider existing road rules and vehicle legislation. This includes the definition of what or who will be considered in control of a vehicle at various levels of automation. This is particularly significant since the degree to which we shift toward the vehicle system and thus, by extension, the manufacturer/distributor being responsible for operational safety as opposed to the 'driver' will largely define the utility of an AV as a mobility enabler for people who are mobility impaired.

There are several privacy and security concerns about connected and automated vehicles that pose challenges to automakers. During RACV research into the impact of vehicle automation, we consulted with a range of external stakeholders who generally acknowledged this as a concern but were confident that these issues will ultimately be resolved through the deployment of new technologies.

The potential effects of automation on Australia's workforce have been well documented (CEDA, 2015). AV's have the potential to bring wholesale change to the transport labour market, and these effects require close consideration.

3. IV Target Outcomes

RACV broadly supports the target outcomes identified, however, we encourage Infrastructure Victoria to be mindful of the established outcomes set out in Plan Melbourne. It is important for the conversation and inevitable policy development regarding automated and zero-emission vehicles to be aligned with the aspirations and context of Plan Melbourne. The following table highlights our high-level support and specific points that require clarification.

Target Outcomes	Regarding AV's	Regarding zero-emission vehicles
<p>Improve safety and public health</p>	<p>Support as a headline target outcome. Safety should be the primary consideration regarding the application of AV's on Victorian roads. Injuries and fatalities arising from road crashes are too high; despite decades of positive reform, vehicle safety advancement and improvements to infrastructure quality. AV's have the potential to greatly improve road safety. We support this as the most important Target Outcome.</p> <p>Broader public health implications of AV's also warrant consideration. eg how may AV's impact people travel behaviour, and how does this impact physical activity?</p>	<p>Support. This target outcome should consider the population wide public health benefits that may be achieved through reduced vehicle emissions. This should highlight the specific benefits of reduced tail-pipe emissions in highly populated areas, especially with regard to noxious gases, but also noise and other flow on effects resulting from a reduction of greenhouse gas emissions.</p> <p>As with AV's, there is scope to consider the public health implications of ebike usage stemming from their impact on people's travel behaviour.</p>
<p>Improve transport system performance and accessibility</p>	<p>Support in principle. The term 'transport system performance' requires definition. We encourage this outcome to focus on people movement, not simply the movement of vehicles. This will enable a holistic consideration of the application of AV technology across all transport segments, including passenger cars, mass transit, freight and logistics. A key question here is the extent to which AV's may influence vehicle occupancy / patronage rates and</p>	<p>Support. Zero-emission vehicles have a significant role to play in improving the environmental performance of the transport system.</p>

	how this might impact the carrying capacity of infrastructure.	
Improve mobility options	Support. Transport choice is central to people's perceptions of freedom and has a significant bearing on people's lives. The target outcome of improving mobility options will require a nuanced understanding of how AV's are likely to impact different segments of the community, and synthesise these different effects in a way that arrives at a holistic view of 'improvement'.	Support. As per AV comments. Specific to EVs, fit for purpose (i.e limited capacity to tow), and battery range act as barriers towards improving mobility options
Improve access to jobs and services	Support. As with the above point, determining 'improvement' will require an understanding of the different labour markets that might benefit from AV's.	Support. Every destination with a power-point serves as a potential charging station, however travel distance (and fit for purpose vehicles) are limiting factors.
Enable optimal land use	Support in principle. The term 'optimal' is subjective. Differing interpretations could potentially skew the intent of this outcome. We have read 'optimal land use' in the context of Plan Melbourne which emphasises the importance of limiting urban sprawl and enabling high quality urban activity centres to meet the needs of their local communities. As highlighted in the preamble to this table, clear alignment with the aspirations of Plan Melbourne is encouraged. 'Optimal' land use in reference to regional Victoria also requires consideration and an understanding of the different factors affecting different regions of Victoria.	Support in principle. As with the comment relevant to AV's, 'optimal' land use will need definition, as will consideration of regional Victoria.

Decrease carbon emissions	Support. This is a valid target outcome, given the pressing need to address current high levels of carbon emissions associated with the transport sector.	Support.
Decrease air and noise pollution	Support. AV's have the potential to improve traffic flow, which may in turn decrease air and noise pollution and lead to general efficiency gains in the function of the road network.	Support. Electric cars almost eliminate engine noise and have no tailpipe emissions so therefore direct air pollution is almost entirely eliminated. This does not extend to tiny pollution particles from brake and tyre dust which remain a cause of concern in terms of human health. Further, air pollutants related to vehicle lifecycle, such as battery production and recharging using electricity generated from brown coal, must be taken into account in combination with a strategy to decarbonise Victoria's energy grid. Both EVs and hydrogen vehicles will play a significant role in decreasing carbon emissions.
Improve reliability and sustainability of energy systems	Support. AV's have the potential to improve traffic management and reduce inefficiencies in energy use within the transport sector.	Support in general. Electric vehicles by their nature have significantly less moving parts and engine components thus reducing the amount of specific points and parts that can go wrong. Essentially, the battery and its connections are two points of potential failure in an EV. This also extends to the charging stations which can fail due to outages, tripping and other malfunctions (eg. software errors). In terms of sustainability, energy security, cost, reliability, and 'cleanliness' in terms of emissions in Victoria at the point of generation remain big factors that require improvement and greater long term certainty.
Support the productivity and growth of the Victorian economy	Support. This target outcome is consistent with various elements of Plan Melbourne. There is specific relevance here to the application of AV technology	Support as per AV comments.

	within the freight and logistics sector.	
Improve the function and appeal of metropolitan and regional activity centres as places for people.	<p>This outcome highlights the importance of walkability and urban design that promotes streets as places rather than purely movement corridors. High level recognition of this, through the addition of this target outcome, will help to ensure AV's contribute to, not deteriorate, people-oriented places.</p> <p>For example, a scenario whereby car parking demand reduces may present opportunities for parking to be repurposed.</p>	Zero emission vehicles have the potential to improve the amenity and appeal of highly populated centres, through air and noise pollution reduction.

References

Walker, J August 2017

The Self-Driving Car Timeline – Predictions from the Top 11 Global Automakers
<https://www.techemergence.com/self-driving-car-timeline-themselves-top-11-automakers/>

Botsman, R. 2017. *Who can you trust? How technology bought us together and why it might drive us apart*, accessed via <https://rachelbotsman.com/books/>

Marchetti, C., 1994: Anthropological Invariants in Travel Behavior, Technological Forecasting and Social Change , 47 :75–88, Internal Publication, International Institute for Applied Systems Analysis, Laxenburg, Austria
http://www.cesaremarchetti.org/archive/electronic/basic_instincts.pdf

CEDA, 2015. *Australia's future workforce?* Accessed via
http://www.ceda.com.au/CEDA/media/ResearchCatalogueDocuments/Research%20and%20Policy/PDF/26792-Futureworkforce_June2015.pdf

Docherty, I. 2017 *The governance of smart mobility*. Transport Research Part A, accessed via <http://dx.doi.org/10.1016/j.tra.2017.09.012>

Uber, 2017. *Submission to the inquiry into the Australian Government's role in the development of cities*. House of Representatives Standing Committee on Infrastructure, Transport and Cities. Submission 56. Accessed via
https://www.aph.gov.au/Parliamentary_Business/Committees/House/ITC/DevelopmentofCities/Submissions

RACV, 2017. Future of Mobility Market Research (unpublished).

Read, R. (2015, February). Self-Driving Cars Could Slash Auto Sales By Nearly 50% [Online]. Available http://www.thecarconnection.com/news/1096761_self-driving-cars-could-slash-auto-sales-by-nearly-50

Jeffery B. Greenblatt & Samveg Saxena - Nature Climate Change volume 5, pages 860–863 (2015)