

PARLIAMENT OF THE COMMONWEALTH OF AUSTRALIA

Innovating Transport across Australia

Inquiry into automated mass transit

House of Representatives Standing Committee on Infrastructure, Transport
and Cities

March 2019
CANBERRA

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Foreword

The automation and electrification of mass transit is a potentially revolutionary development in transport. Done well, it has the potential to make our cities and regions cleaner, greener, more accessible and more liveable. It also has the potential to make our cities and regions more productive and sustainable.

Achieving this outcome will demand vision and leadership from government. The Committee's previous report, *Building Up & Moving Out*, set out a blueprint for the planning of our cities and regions at a national, regional and local scale. It identified opportunities for transforming connectivity and accessibility through integrated, multi-modal, transport networks. This current report is an extension of that previous work.

Mass transit is the key to creating better connectivity and mobility. Automation and electrification will make mass transit safer, more efficient, cleaner and quieter. But they will also demand changes in the regulatory environment and the physical and communications infrastructure of our transport networks. This will require careful planning and substantial investment, with policy responses framed around the different requirements of cities and regions, greenfield and brownfield sites.

Ideally, our transport networks will consist of integrated multi-modal networks—seamless transport systems operating across a variety of transport modes, connected by information exchanges (such as mobile apps) between users and network owners and managers, with seamless ticketing—creating Mobility as a Service (MaaS). These networks will serve cities and regions that are characterised by densification and decentralisation. Mass transit has an important role to play, providing high-volume trunk routes as the arteries of the transport network, with shared mobility and active transport providing the capillaries of the system. It is important to recognise that while automation can contribute to the connectivity of less densely populated areas, it should not be allowed to contribute to urban sprawl. The goal should be the creation of a new transport ecosystem.

Consideration should be given to policies which promote the development of this ecosystem.

Rail in its various forms, including trackless trams, has an essential role to play in this vision. Road mass transit—buses—also has a vital role to play. Buses combine volume and flexibility. They can travel as platoons on dedicated busways, and concentrate or disperse as single vehicles operating on separate routes. Shared rides on automated shuttle buses or in driverless cars, combined with active transport, will cover the first and last mile.

The electrification of transport has the potential to lower costs, reduce the environmental impacts of land transport and enhance fuel security. Australia could eliminate greenhouse gas emissions related to land transport, reduce noise pollution, make vehicles simpler and safer to operate and maintain, and largely eliminate reliance on fuel imports. Hydrogen fuel cell technology in particular has the capacity to power mass transit options. It is well suited to buses, trucks, long-haul vehicles and even trains. Hydrogen also has development potential as an export industry—as long as fuel security is given priority. The key to electrification is ensuring that the relevant infrastructure, especially refuelling stations, is put in place.

The synergies between automation and electrification mean that their convergent development should be encouraged, that electrification and automation should be implemented and managed together.

The most important thing the Australian Government can provide to the future development of automated transport and new energy sources is vision, encompassing planning of the urban and regional environment, including automated mass transit and new energy sources; clear articulation of the optimum design of the urban environment, including mass transit and active transport; a vision for shared mobility incorporating MaaS; and the goal of fuel security.

Within this vision, the Australian Government should provide leadership and coordination of policy with a focus on consistency and interoperability between jurisdictions; facilitate the development of national standards based on relevant international standards; coordinate the development of relevant energy and communications infrastructure—including making provision for data management and sharing, and cybersecurity within automated transport networks; and facilitate the development of these new technologies through incentives, especially vehicle emission standards. Preparing road and rail networks for automation is essential to the smooth transition to the new technology. Governments need to commit to automation and alternative fuels by designing and building infrastructure around their requirements.

It is also important that governments engage in the art of transition in managing the introduction of automated and electric vehicles. Whether it is managing mixed fleets of vehicles of varying levels of automation, rolling out new forms of infrastructure, or reskilling the transport workforce, the transition to automation and electrification will place demands on individuals and organisations to adapt to a rapidly changing transport environment. Not least of the government's responsibilities in this regard will be to ensure compatibility and interoperability of charging infrastructure, making sure that there is a standard charging mechanism for all vehicles.

In conclusion, I would like to thank all those who have contributed to this inquiry. This was a short inquiry, limited by time constraints imposed by the electoral cycle. Nonetheless, the Committee received high quality evidence from a range of people and organisations dedicated to the improvement of our urban environment and transport networks. They provided clear evidence on the benefits of transport automation, mass transit and electrification, and the need to clearly define a pathway to an automated and electrified future. I also thank my Committee colleagues and the secretariat for their work during the inquiry and their contribution to the report.

Mr John Alexander OAM, MP, Chair

Members

Chair

Mr John Alexander OAM, MP

Bennelong, NSW

Deputy Chair

Hon Sharon Bird MP

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Members

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Lynley Ducker, Committee Secretary

William Pender, Inquiry Secretary

Tegan Scott, Researcher

Kelly Burt, Office Manager

Terms of Reference

The Committee to inquire into and report upon current and future developments in the use of automation and new energy sources in land-based mass transit, including:

Rail mass transit

Road mass transit

Point-to-point transport using automated vehicles

Commonwealth roles and responsibilities in the development of these technologies.

Abbreviations

ABS	Australian Bureau of Statistics
ACMA	Australian Communications and Media Authority
ACT	Australian Capital Territory
ADS	Automated Driving System
ADSE	Automated Driving System Entity
ADVI	Australian Driverless Vehicle Initiative
AEB	Advance Electric Bus
AEV	Autonomous/Automated Electric Vehicle
ANCAP	Australasian New Car Assessment Program
API	Application Programming Interface
ARA	Australasian Railway Association
ARCIA	Australian Radio Communications Industry Association
ATC	Automatic Train Control
ATO	Automatic Train Operation
ATP	Automatic Train Protection
AV	Autonomous/Automated Vehicle
BEV	Battery Electric Vehicle
BIC	Bus Industry Confederation
BITRE	Bureau of Infrastructure, Transport and Regional Economics
CAV	Connected and Automated Vehicle

CBD	Central Business District
CCS	Carbon Capture and Storage
CCTV	Closed-Circuit Television
CDMPS	Centre for Disaster Management and Public Safety
CEB	Conventional Electric Bus
CNG	Compressed Natural Gas
C-ITS	Cooperative Intelligent Transport Systems
COAG	Council of Australian Governments
CO ₂	Carbon Dioxide
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTP	Compulsory Third Party
DFSI	Department of Finance, Services and Innovation (NSW)
DIRDC	Department of Infrastructure, Regional Development and Cities
EA	Engineers Australia
EB	Electric Bus
ECS	Emergency Call Services
EV	Electric Vehicle
FCAI	Federal Chamber of Automotive Industries
FCEV	Fuel Cell Electric Vehicle
FY	Financial Year
GoA	Grades of Automation
HMA	Hydrogen Mobility Australia
ICE	Internal Combustion Engine
ICT	Information and Communications Technology
IEC	International Electrotechnical Commission
ISO	International Organisation for Standardisation
JTC 1	Joint Technical Committee of the IEC and ISO
KLIA	Kuala Lumpur International Airport

LCT	Luxury Car Tax
MaaS	Mobility as a Service
MCH	Methyl Cyclohexane
MSC	Marginal Social Cost
NEM	National Energy Market
NG	Natural Gas
NO _x	Nitrous Oxides
NSW	New South Wales
NTC	National Transport Commission
PEM	Proton Exchange Membrane
PIA	Planning Institute of Australia
PSAP	Public Safety Answering Point
PT	Public Transport
RSU	Road Side Units
RTBU	Rail, Tram and Bus Union
SAE	Society of Automotive Engineers
SCoTI	Standing Council on Transport and Infrastructure
SWE	Sensor Web Enablement
TfNSW	Transport for NSW
UITP	International Association of Public Transport
UK	United Kingdom
UN	United Nations
US	United States of America
UTO	Unattended Train Operation
WP	Working Party (UN)
4G	Fourth Generation
5G	Fifth Generation

List of Recommendations

Recommendation 1

- 2.119 The Committee recommends that the Australian Government develop its strategies and plans to address the development of transport automation and alternative fuel sources through the strategic framework set out in the Committee's report on the development of cities, *Building Up & Moving Out*, especially those relating to integrated and holistic planning, with a view to ensuring that transport automation takes place within a wider planning framework which integrates automated transport with the planning of the urban and regional environment to maximise liveability, sustainability and productivity, while acknowledging the different needs of greenfield and brownfield sites.

Recommendation 2

- 2.124 The Committee recommends that the Australian Government adopt as its goal support for the development of a new automated transport ecosystem, incorporating shared mobility based on: strong trunk routes provided by rail, light rail and buses, connected to smaller vehicles providing connectivity within cities and suburbs; active transport solutions; and strategies to manage the use of private automated transport and ridesharing in city centres and heavily congested areas and routes.

Recommendation 3

- 2.127 The Committee recommends that the Office of Future Transport Technology within the Department of Infrastructure, Regional Development and Cities undertake consideration of the benefits of automation and electrification for the transport of freight.

Recommendation 4

- 2.129 The Committee recommends that the Australian Government, in conjunction with State and Territory Governments, develop a strategy for managing the transition to full automation on roads, including mapping regulatory responses, vehicle specifications and driver training requirements.

Recommendation 5

- 3.53 The Committee recommends that the Australian Government facilitate the introduction and uptake of electric vehicles (both BEV and FCEV), especially mass transit vehicles, including through coordination and planning of the development of infrastructure to meet demand; ensuring that refuelling and recharging technology follows defined standards for compatibility and interoperability; and by promoting greater coordination between the transport and energy sectors.

Recommendation 6

- 3.55 The Committee recommends that the Australian Government, in conjunction with State and Territory Governments, develops a national hydrogen strategy that provides for the manufacture and transport of hydrogen in a safe, cost-effective and energy-efficient way; targets zero-emission production and distribution; provides for the energy needs of Australia's vehicle fleet; and, while providing for export opportunities, is focussed first and foremost on Australia's energy security.

Recommendation 7

- 3.57 The Committee recommends that the Australian Government maintain a close watch on the development of Hyperloop technology with a view to its development as a transport solution in Australia.

Recommendation 8

- 4.110 The Committee recommends that the Australian Government undertake a study to establish the national implications of Infrastructure Victoria's work on automated and zero emissions vehicles infrastructure, and the requirements its findings have for infrastructure policy and investment.

Recommendation 9

4.114 The Committee recommends that the Australian Government articulate a clear vision for cities and regions and the connectivity within and between them, including:

- A vision for and planning of the urban and regional environment incorporating automated mass transit and new energy sources.
- A clear articulation of the optimum design of the urban environment, including mass transit and active transport.
- A vision for shared mobility incorporating Mobility as a Service (MaaS).
- The goal of fuel security.

This vision should be articulated in an intergovernmental agreement focussed on consistency and interoperability between jurisdictions.

Recommendation 10

4.116 The Committee recommends that the Australian Government pursue an effective standards based approach to the development of transport automation and electrification, including effective use of international standards and engagement with international standards bodies, and the development of an integrated standards development roadmap to identify gaps in standards and evolving standards requirements.

Recommendation 11

4.118 The Committee recommends that the Australian Government undertake research to estimate the national requirement for electricity generation under an electric and automated transport future, with a view to ensuring that electricity generation will meet anticipated demand while adhering to national greenhouse gas abatement targets.

Recommendation 12

4.120 The Committee recommends that the Department of Infrastructure, Regional Development and Cities conduct an audit of Australia's existing transport communications infrastructure and requirements for automation at various stages, with a view to developing a national strategy for transport

communications infrastructure for full automation of land transport; this audit and strategy to be development in conjunction with the transport and infrastructure industries; and cover:

- ICT infrastructure requirements
- Data management and sharing
- Privacy
- Cybersecurity.

Recommendation 13

4.122 The Committee recommends that the Australian Government consider facilitating the transition to automated and electric vehicles by giving consideration to options such as:

- Subsidising zero-emission vehicles
- Promoting zero-emission vehicles through vehicle emission standards
- Implementing low- or zero-emission zones
- Providing public charging infrastructure
- Strengthening renewable energy targets
- Phasing out petrol and diesel vehicles over the long term.

Recommendation 14

4.124 The Committee recommends that the Australian Government assist in managing change in the transition to automation by making workforce training and development a condition of Commonwealth funding for relevant transport projects.

Recommendation 15

4.126 The Committee recommends that the Australian Government give early consideration to road pricing models, recognising the inevitable decline of fuel excise revenue due to the increase in alternative energy vehicles.

Recommendation 16

- 4.128 The Committee recommends that the Australian Government establish the statutory Office of a National Chief Engineer, to provide independent expert advice on the planning and development of Australia's infrastructure.

Recommendation 17

- 4.130 The Committee recommends that the Office of Future Transport Technology within the Department of Infrastructure, Regional Development and Cities be expanded to cover alternative energy sources such as battery electric power and hydrogen fuel cell power.

Executive Summary

Automated and electric mass transit will play a significant role in the connectivity of our cities and regions. But automated mass transit must be placed within the wider context of the optimum transport needs of those cities and regions—transport networks based on shared and multi-modal mobility. Realising the full potential of these networks will require sustained policy development and investment.

This report examines current and future developments in the use of automation and new energy sources in land-based mass transit, including rail and road mass transit, point-to-point transport using automated vehicles, and the role and responsibilities of the Commonwealth in the development of these technologies. It will analyse the opportunities and challenges presented by automation and new energy sources, and the role the Australian Government has to play in managing this transport revolution.

Automation

The automation of mass transit is a potentially revolutionary development in transport. Realising the potential benefits of transport automation will depend on the planning framework and policies that are put in place, and the vision underpinning those plans and policies. Transport automation should take place within a wider planning framework which integrates automated transport with the planning of the urban and regional environment to maximise liveability, sustainability and productivity.

Transport automation, especially when combined with alternative fuel sources, will have major implications for transport infrastructure. Automated vehicles will require a suitable environment in which to operate—one that they can read and communicate with. They will make demands on communications, the internet,

physical infrastructure and energy networks. Meeting these demands will require careful planning and significant investment.

Optimising automation will also demand a multi-modal response—creating a seamless transport network across a variety of transport modes, connected by information exchanges (such as mobile apps) and seamless ticketing—Mobility as a Service (MaaS). A systems approach, in which operators provide services across areas rather than modes, could transform urban transport. However, this will require coordination with private transport and rideshare operators and a commitment to social inclusion. Within this context, mass transit will provide high-volume trunk routes as the core of the transport network. The goal should be the creation of a new transport ecosystem. Consideration should be given to policies which promote the development of this ecosystem, including restrictions on private automated transport and ridesharing, and the encouragement of shared mobility.

The Committee recommends that the Australian Government develop its strategies and plans to address the development of transport automation and alternative fuel sources through the strategic framework set out in the Committee’s report on the development of cities, *Building Up & Moving Out*; adopt as its goal support for the development of a new automated transport ecosystem, incorporating shared mobility based on strong mass transit trunk routes; undertake consideration of the benefits of automation and electrification for the transport of freight; and develop a strategy for managing the transition to full automation on roads.

New energy sources

Electrification of transport has real potential to lower costs, reduce the environmental impacts of land transport and enhance national fuel security. By investing in zero-emissions technologies, Australia could eliminate greenhouse gas emissions related to transport, significantly reduce noise pollution associated with land transport, make vehicles simpler and safer to operate and maintain, and largely eliminate reliance on fuel imports. Battery electric and hydrogen fuel cell technology both offer solutions for electrification. The two technologies are complementary, with battery electric vehicles being well suited to short-range small-vehicle travel in an urban environment, and hydrogen power being suited to longer-range and heavy transport use. The Australian Government should look at how it can facilitate the introduction and development of these technologies.

The key to the implementation of new energy sources is the provision of charging and refuelling infrastructure. Coordination and planning is required to ensure that infrastructure meets demand and that refuelling and recharging technology follows defined standards for compatibility and interoperability. It is also essential

to explore the energy implications of new energy sources. Hydrogen power brings its own infrastructure demands. The Committee notes the work done by the Chief Scientist and CSIRO to investigate and promote the development of hydrogen power in Australia. This is now a mature technology and the challenge is to identify the optimum pathway to introducing and developing hydrogen powered transport in conjunction with battery electric vehicles. The production and transport of hydrogen in cost-effective and energy-efficient ways is essential to the development of hydrogen power. The Committee supports the development of a national hydrogen strategy.

The Committee recommends that the Australian Government facilitates the introduction and uptake of electric vehicles (both BEV and FCEV); develops a national hydrogen strategy; and maintains a close watch on the development of Hyperloop technology with a view to its development as a transport solution in Australia.

There is convergence between electrification and automation. The Committee is of the view that electrification and automation should be implemented and managed together.

Role of Government

The Australian Government, along with State and Territory Governments, has a significant role to play in the development of automated mass transit and new energy sources in Australia. The Australian Government has a central role in providing policy leadership and coordination nationally, especially through COAG and the work of agencies such as the National Transport Commission and Austroads. The Australian Government is already coordinating the development of policy through the Office of Future Transport Technology. In addition, the work done by Infrastructure Victoria to scope automation and alternative energy sources has national implications.

Perhaps the most important thing the Australian Government can provide to the future development of automated transport and new energy sources is vision. This national vision should encompass:

- A vision for and planning of the urban and regional environment incorporating automated mass transit and new energy sources.
- A clear articulation of the optimum design of the urban environment, including mass transit and active transport.
- A vision for shared mobility incorporating Mobility as a Service (MaaS).
- The goal of fuel security.

Within this vision, the Australian Government can provide leadership and coordination of policy with a focus on consistency and interoperability between jurisdictions; facilitate the development of national standards based on relevant international standards; coordinate the development of relevant energy and communications infrastructure—including making provision for data management and sharing, and cybersecurity within automated transport networks; and facilitate the development of these new technologies through incentives, especially vehicle emission standards.

Within this context, it is vital that we identify and overcome regulatory barriers to automated vehicles, particularly trains, trams and buses. The Committee believes that preparing road and rail networks for automation is essential to the smooth transition to the new technology and that governments need to commit to the automation and alternative fuels by designing and building infrastructure around those requirements.

The Committee recommends that the Australian Government undertake a study to establish the national implications of Infrastructure Victoria's work on automated and zero emissions vehicles; articulates a clear vision for cities and regions and the connectivity within and between them; pursues an effective standards based approach to the development of transport automation and electrification; estimates the national requirement for electricity generation under an electric and automated transport future; audits Australia's existing transport communications infrastructure and requirements for automation at various stages, with a view to developing a national strategy for transport communications infrastructure for full automation of land transport; facilitates the adoption of automated and electric vehicles through a range of incentives; assists in managing change, especially in the workforce, in the transition to automation; gives early consideration to road user pricing models as the principal funding mechanism for road transport infrastructure; establishes the Office of National Chief Engineer; and expands the Office of Future Transport Technology to cover alternative energy sources.

1. Introduction

- 1.1 Automated and electric mass transit has a significant role to play in the connectivity of our cities and regions. But automated mass transit must be placed within the wider context of the optimum transport needs of those cities and regions—transport networks based on shared and multi-modal mobility. Realising the full potential of these networks will require sustained policy development and investment, as well as research into future projections and the capacity they will require.
- 1.2 According to Engineers Australia (EA), ‘the future of transport is electric, connected, automated and shared’.¹ EA acknowledges the risks associated with automation and the fact that fully automated transport systems are still some time off becoming standard. However EA stated that transport automation ‘is set to become a reality and as such adequate research planning and preparation for an electric, connected future is a necessity’.² It recommended that that governments work towards ‘a regulatory environment that embraces this future’.³
- 1.3 Consultancy firm Arup agreed that ‘both transport autonomy and the application of new energy sources will significantly impact on our cities’. Whether the outcome was positive or negative would depend on how the new technologies were applied and how they operated. According to Arup:

The potential for positive outcomes comes from improvement of safety, accessibility costs for both government and individuals and air quality. Concurrently, the potential for poor outcomes arises from unconstrained use of personal autonomous mobility approaching and within the centres of our

¹ Engineers Australia, *Submission 37*, p. 3.

² Engineers Australia, *Submission 37*, p. 4.

³ Engineers Australia, *Submission 37*, p. 3.

cities. Although this also holds true for non-autonomous private vehicles, the outcomes for autonomous vehicles could be far worse.

Autonomous private vehicles have the potential for inducing travel demand and congestion, due to inexpensive and convenient travel choices and the creation of a market that will need to drive use up to maintain profitability. Many mobility gains have the potential to be undone by not considering the desirable attributes of places we want and the capacity of the road network feeding them.⁴

- 1.4 Arup argued that ‘automation and new energy sources bring compelling reasons to make these investments’. Automation and new energy sources provided ‘opportunities for improving road safety, air quality, operational costs and access to jobs, while also potentially changing travel behaviour and thus the structure of our city regions’. If applied effectively, ‘these technological advances can fundamentally improve current deficits of mobility and access in Australian cities and contribute to more liveable and economically stronger places’.⁵
- 1.5 Arup concluded that ‘there is no doubt that benefits can and must be realised from the automation of mass transit’, but that ‘Government needs to balance those benefits with protecting public value in the broader economy, society and the places we share’. Arup emphasised that the critical message for Parliament to consider ‘is that the technology itself is not new and should be seen as a secondary consideration’. It argued that ‘the focus should be on the total systemic opportunities to the economy, society and the environment’.⁶
- 1.6 This report examines current and future developments in the use of automation and new energy sources in land-based mass transit, including rail and road mass transit, point-to-point transport using automated vehicles, and the role and responsibilities of the Commonwealth in the development of these technologies. It will analyse the opportunities and challenges presented by automation and new energy sources and the role the Australian Government will play in managing this transport revolution.

Conduct of the inquiry

⁴ Arup, *Submission 32*, p. 4.

⁵ Arup, *Submission 32*, p. 2.

⁶ Arup, *Submission 32*, p. 2.

- 1.7 The inquiry was referred to the Committee by the Minister for Cities, Urban Infrastructure and Population, the Hon Alan Tudge MP, on 25 October 2018.
- 1.8 Over the course of the Inquiry, the Committee received 52 submissions. A list of submissions is at Appendix A. In addition, the Committee undertook a program of public hearings. In February 2019, the Committee held five public hearings, including hearings in Canberra, Melbourne and Sydney. Details of the public hearings, including a list of witnesses, are at Appendix B.

Structure of the Report

- 1.9 This report consists of four chapters.
- 1.10 Chapter 2 will explore the wider context of automation before examining the benefits of transport automation. It will then examine specific aspects of automated rail and road mass transit, before analysing the need to develop integrated transport systems joining mass transit system to the wider transport network. It will then consider some of the implications of the transition to automation.
- 1.11 Chapter 3 will examine the benefits of electrification (battery electric vehicles and hydrogen fuel cell electric vehicles) of the vehicle fleet and the convergence between electrification and automation, before looking at the infrastructure requirements of electric vehicles, including charging stations, and their interaction with the energy sector. It will then focus on hydrogen as a source of energy for the vehicle fleet and the particular infrastructure requirements of the hydrogen sector. Finally it will consider the benefits of the revolutionary Hyperloop transport technology.
- 1.12 Chapter 4 will identify what stakeholders see as the role of government in the development of automated mass transit and new energy sources, before giving an overview of current Australian Government activity in this area. It will then examine specific policy priorities related to the development of automated mass transit and new energy sources.

2. Automation

- 2.1 The automation of mass transit is a potentially revolutionary development in transport. However, it needs to be considered within the context of the planning of our cities and regions, and transport automation more generally. There are significant potential benefits in the automation of mass transit, but they will only be realised if we develop automation to meet the needs of our cities and regions.
- 2.2 This chapter will explore the wider context of automation before examining the benefits of transport automation. It will examine specific aspects of automated rail and road mass transit, before analysing the need to develop integrated transport systems joining mass transit systems to the wider transport network. It will then consider some of the implications of the transition to automation.

Context—planning

- 2.3 The Planning Institute of Australia (PIA) asserted that ‘the starting point for the Inquiry should be asking “*what performance do we want of our cities?*” — and thence: “*how can various transport / energy / digital innovations contribute to achieving these goals?*”’ The PIA was concerned that much of the current discussion around transport automation is ‘highlighting some mobility roles and benefits of connected and autonomous vehicles (AVs) in mass transit applications—but ignoring whether they help or hinder the achievement of broader liveability, accessibility and productivity expectations of our major cities and their communities into the future’. It urged an examination of automated transport within the context of ‘a national framework for infrastructure decision making and services investment based on a national vision for the performance of our cities and regions’, such as set out in the Committee’s recent report *Building Up & Moving Out*. The PIA sought ‘to

establish a strategic context for considering the role and impact of various forms of autonomous vehicles'. It was concerned that 'a forensic assessment of the transport task and the problems various AVs are intended to solve is lacking from the public discourse and is being lost in the hype generated by global vehicle makers'.¹

2.4 The Bus Industry Confederation (BIC) urged the pursuit of 'more compact settlement patterns, through strategic land use development directions, which forms essentially a *polycentric + corridors + neighbourhoods* development model'. It argued for 'spatially-oriented transport directions to support this land use direction', including:

- ensuring strong radial public transport to the centre, where capacity increases are required to cater for continuing strong growth (roads simply cannot carry the expected increased demands and have high external costs in/through central/inner areas)
- improving circumferential arterial roads. Road-based public transport and freight should be prioritized in use of these roads
- providing fast and frequent trunk public transport services supporting inner/middle urban nodes and development corridors, including for circumferential movement (particularly buses), linked to the cluster (node)/transit corridor development focus
- better public transport connections from outer suburbs to areas of employment/activity concentration, including the small number of high tech knowledge-based clusters
- upgraded trunk arterial roads in outer growth areas (to deal with the current backlog rather than encourage further sprawl)
- increased local public transport opportunities in outer neighbourhoods, to support delivery of 20 minute neighbourhoods
- improved walking and cycling opportunities throughout the whole city, with a particular focus on clusters/nodes and facilitating a city of 20-minute cities.²

2.5 The BIC concluded that 'the move to driverless vehicles needs to be understood in association with other transport changes taking place, such as shared vehicles and road pricing reform'. It argued that:

These matters must be treated in an integrated way, in the context of the broader societal trends and issues that have to be addressed – road safety,

¹ Planning Institute of Australia, *Submission 39*, p. 1.

² Bus Industry Confederation, *Submission 25*, p. 27.

personal safety and security, national security, social inclusion, population growth, urban sprawl, possible job losses with technology, climate change and the need to address greenhouse gasses and traffic congestion.³

- 2.6 In its study of the impacts of automated transport, Infrastructure Victoria identified significant implications with the new technologies for how cities might work. Infrastructure Victoria's modelling demonstrated changes in where people were likely to live and work due to automation providing 'greater accessibility in a transport sense to jobs and services'. As Dr Jonathan Spear, Executive Director and General Counsel at Infrastructure Victoria, noted, 'where you have good access to roads as well as public transport networks', those places are 'likely to become more attractive to live and work'.⁴

Context—automation

- 2.7 The automation of mass transit must also be seen within the broader context of transport automation more generally. The automation of personal passenger vehicles will impact the development of mass transit.
- 2.8 Infrastructure Victoria has conducted ground-breaking research into the 'impacts and potential outcomes of automated vehicles, vehicles on demand and zero emissions vehicles'. A range of scenarios was developed modelling 'impacts on road congestion, the size and efficiency of the vehicle fleet, physical activity and access to activities and services', and the 'impacts of new vehicle technologies on the transport network as a whole, considering both public and private transport'. Infrastructure Victoria found that 'under a future with automated on-demand vehicles, our findings point to a blurring of the traditional distinction between public and private transport as automated vehicles help supplement or fill gaps in the public transport network and improve access to services'.⁵
- 2.9 Different scenarios had different outcomes for public transport usage: under the 'Fleet Street' scenario, the entire vehicle fleet would be electric, automated and on-demand by 2046, 'with a cost per trip of approximately 30% of the cost of a current on-demand vehicle trip (such as an Uber)':

³ Bus Industry Confederation, *Submission 25*, p. 29.

⁴ Dr Jonathan Spear, Executive Director and General Counsel, Infrastructure Victoria, *Committee Hansard*, 27 February 2019, pp. 11–12.

⁵ Infrastructure Victoria, *Submission 16*, p. 2.

Under this scenario, the total number of vehicles in Victoria is projected to fall by 93% to just 260,000. This is the result of shared vehicles being utilised for 36% of the day (compared with the base case where traditional vehicles are used just 4.8% of the day). Total vehicle kilometres travelled in this scenario are projected to fall by 15% due to a mode shift from cars to public transport as a result of the higher perceived cost of using on-demand vehicles. In total, 72% of trips were made by car versus 28% by public transport.⁶

2.10 Under the ‘Private Drive’ scenario, all vehicles are ‘privately owned, electric and automated’:

In this scenario, private cars became even more ubiquitous, with 7% more cars than in the base case. Public transport use across all modes declined, falling from 19% of all trips in the base case to 14%. Buses were forecast to see the most significant fall in use (32%), but tram (28%) and train (22%) use also significantly declined. Despite this, overall public transport trips increased significantly compared to 2015 as a result of population growth, with nearly 3.7 million trips forecast in 2046 versus 1.7 million trips in 2015.⁷

2.11 Under the ‘more likely future’ scenario, Infrastructure Victoria ‘considered a mix of vehicle types and ownership models that reflect the differing needs and preferences of users in different places’:

From modelling this future we found that road congestion could fall considerably (average delays are projected at 90% less than in the base case) and the size of the vehicle fleet could be significantly smaller than the base case (30% less than base case). This future is also forecast to lead to an increase in public transport use across all modes. Public transport use is forecast to account for 22% of all motorised trips, compared to 19% in the base case. Buses and trams in particular are forecast to experience the strongest growth in demand. This is likely due to public transport use becoming more common for more trip types, other than travel to work, and the fact that buses and trams service a more diverse range of destinations.⁸

2.12 Infrastructure Victoria made ‘17 key recommendations which sought to help navigate through the inherent challenges and uncertainties that new technology brings, while maximising the benefits and minimising the risks associated with its introduction’. These were:

- Update Victoria’s roads

⁶ Infrastructure Victoria, *Submission 16*, p. 2.

⁷ Infrastructure Victoria, *Submission 16*, pp. 2–3.

⁸ Infrastructure Victoria, *Submission 16*, p. 3.

- Rethink road space
- Future-proof projects
- Plan for transport
- Manage before you build
- Integrate new transport options
- Boost ICT infrastructure
- Share more data
- Integrate transport management
- Transition to zero emissions
- Plan for energy changes
- Encourage demand management
- Rethink planning values
- Create planning flexibility
- Prepare for new waste
- Keep track of trends
- Lead and collaborate upgrades.⁹

2.13 Within this matrix of recommendations, Infrastructure Victoria identified a number of ‘low-cost, no-regrets actions’ that governments could implement now. Infrastructure Victoria also identified significant investments that will be required to maximise the benefits of automation, including:

- Up to \$1.7 billion to upgrade mobile networks
- Around \$250 million for improved line markings on roads
- At least \$2.2 billion for energy network upgrades.¹⁰

2.14 Infrastructure Victoria observed that there were many actions that governments could take ‘right now’ to prepare for new vehicle technologies:

These include integrating on-demand and mobility as a service offerings into the public transport mix, sharing transport data in real time and allowing flexibility in the planning regime to make it easier for people to charge their electric vehicles. All could have an immediate impact and deliver benefits, regardless of how new vehicle technologies roll out.¹¹

Benefits of automation

⁹ Infrastructure Victoria, *Submission 16*, Attachment 1, *Advice on Automated and Zero Emissions Vehicles Infrastructure*, October 2018, pp. 11–13.

¹⁰ Infrastructure Victoria, *Submission 16*, p. 1.

¹¹ Infrastructure Victoria, *Submission 16*, p. 1.

- 2.15 The benefits of automation were highlighted in a number of submissions. Infrastructure Victoria noted that its research ‘found that automated and zero emission vehicles could significantly reduce traffic congestion and greenhouse gas emissions, dramatically improve access to services, avoid car accidents caused by human error and add almost \$15 billion per year to the economy’.¹² The Department of Infrastructure, Regional Development and Cities (DIRDC) listed the benefits of automation as:

Safety

- ensuring safer travel through being equipped with collision avoidance technologies; and
- reducing personal safety risks, such as walking through unlit areas, by offering more convenient on-demand first and last mile transit options.

Efficiency

- making existing services more cost-efficient for operators and passengers;
- making new services more financially viable; and
- reducing the need for investment in new services and infrastructure through network efficiency gains.

Accessibility

- providing for new services in areas not linked by public transport and in areas of low patronage, particularly in regional centres;
- providing increased accessibility to existing services by providing more convenient first and last mile transit; and
- enabling greater mobility for people who may not currently be able to drive, such as people with a disability and older people.¹³

- 2.16 DIRDC cited research indicating that ‘human error may be a factor in more than 90 per cent of crashes, and that road user distraction or inattention is a contributory factor in around 10-30 per cent of road crashes’. DIRDC noted that ‘if automated technology reduces or eliminates human errors, as is generally expected, then benefits for road safety may be substantial’. The safety benefits would also ‘extend to other vulnerable road users, such as

¹² Infrastructure Victoria, *Submission 16*, p. 1.

¹³ DIRDC, *Submission 46*, p. 14.

pedestrians and cyclists, as vehicles with higher levels of automation will be able to detect their presence and take evasive action automatically'.¹⁴

2.17 Nonetheless, DIRDC highlighted the potential difficulties of the transition to automation. It cautioned that while the safety benefits of automation were likely to be significant, 'the effect of higher levels of vehicle automation on road safety remains untested at a large scale and may not be immediate or linear'. Moreover, 'complexities may also arise from how automated and non-automated vehicles co-exist with potentially different driving behaviours'. DIRDC noted that 'interactions between automated vehicles and vulnerable road users (primarily pedestrians and cyclists) pose potential risks, with scope for automated vehicles to fail to detect or accurately predict the behaviour of vulnerable road users'.¹⁵

2.18 DIRDC also noted that 'automated vehicles have the potential to reduce congestion and improve the efficiency and productivity of Australia's transport networks by':

- increasing average traffic speeds and safely reducing following distances (headway) between vehicles;
- optimising driving behaviours and routes, especially for trips involving multiple passengers with varying origin-destination needs;
- providing increased reliability of travel times;
- reducing stoppages and delays from traffic incidents;
- encouraging the use of public transport through low-cost, on-demand first and last mile connections; and
- facilitating more efficient movement of freight.¹⁶

2.19 DIRDC observed that the 'increased accessibility of transit services is likely to be particularly valuable in regional Australia':

Road crashes disproportionately impact regional Australians; 65 per cent of road fatalities occur in regional, rural and remote Australia (BITRE, 2017c). Available evidence suggests that human factors, such as distraction and alcohol, are the primary causes of these crashes (Siskind *et. al*, 2011). Given that automation could reduce or remove the human element of driving, the

¹⁴ DIRDC, *Submission 46*, p. 15.

¹⁵ DIRDC, *Submission 46*, p. 15.

¹⁶ DIRDC, *Submission 46*, p. 22.

potential to reduce crash rates is significant – particularly in regional Australia.¹⁷

- 2.20 The emergence of automated vehicles would also provide potential for older Australians to continue to engage with and participate in the community. According to DIRDC:

In 2015, there were an estimated 3.5 million Australians aged 65 and over, representing one in seven people (15.1 per cent). Older people may have mobility challenges and as a result, they are less likely to be able to own a private vehicle or be able to drive.

As automated vehicles become more sophisticated over time, it is likely that there will be a reduced or removed expectation that the occupant will need to be ready to take control of the vehicle if required. Highly automated vehicles will enable older people to continue to visit the doctor, do their shopping and participate in the community (Siorokos, 2016).¹⁸

- 2.21 There were significant potential benefits in vehicle automation for disabled Australians as well:

In 2015, almost one in five Australians reported living with a disability (18.3 per cent or 4.3 million people). 34 per cent of people with a disability report difficulties using public transport, with 14.7 per cent of people with a disability reporting inability to use any form of public transport (ABS, 2016).

Highly automated vehicles could mitigate these challenges by providing more convenient access to alternative transport options for people with a disability. Infrastructure Victoria (2018) has estimated that the economic benefit of increased transport accessibility created by the use of automated vehicles to be \$3.5 billion per year in today's terms. Trials of automated vehicles are increasingly considering the potential of automated technology to provide people with new mobility options.¹⁹

- 2.22 DIRDC observed, however, that the benefits of automation would be dependent on how it was managed:

Increasing the comfort of in-vehicle journeys and reclaiming commuting time for leisure, work or sleep in highly or fully automated vehicles is an important priority for commuters and hence for vehicle manufacturers. However, this could reduce the perceived cost of travel time and provide an incentive for

¹⁷ DIRDC, *Submission 46*, pp. 17–18.

¹⁸ DIRDC, *Submission 46*, pp. 17–18.

¹⁹ DIRDC, *Submission 46*, pp. 17–18.

longer commutes, with a flow-on impact for land use planning and infrastructure provision.²⁰

2.23 Arup highlighted both the benefits and potential problems of automated transport:

Already, cities worldwide are experiencing an increased number of trips using “ride-share” services, claiming even more space. The ease of access has created more demand in combination with a perceived improvement in customer service and value for money.

Autonomy would significantly reduce the cost per kilometre, creating a more competitive market focused on providing customer convenience. That customer convenience would be at the externalised cost of significantly more vehicles operating empty, taking space away from more productive uses. Their contribution to congestion could be significant if unconstrained, as fleets of competing and autonomous Mobility as a Service (MaaS) vehicles rove the streets, being available for potential customers. Consequently, this type of transport needs to be minimised in inner cities and spatially constrained spaces.²¹

2.24 The potential perils of shared mobility were highlighted by AECOM, who noted that ride sharing had actually increased congestion and seen lower public transport use in a number of markets. Mr Roger Jeffries, Technical Director, Transport Advisory and ANZ Technical Practice Leader, Transport Advisory at AECOM, explained:

New York City has seen a massive increase in congestion with the shared mobility market. What we've seen around the world with shared mobility — and we're talking about the likes of Uber and Lyft and other operators; it's not about any one operator; there's a whole range of operators — is that in the cities where there are advanced markets for those operators there has been an increase in congestion. What they've typically done is cannibalise the public transport market. As in the example of New York City, there were 30 million fewer subway trips in one year, related to the intervention of the ride-sharing market. That's not a market which is universally equitable to everyone in society; it tends to pick up the top 10 per cent of the public transport market. People who have the economic means to travel in a slightly more comfortable environment, one might say, for very little more — a marginal cost on top of what they might pay for public transport — can go in a private ride, or a near-private ride if it's shared with one or two other people, which will take them

²⁰ DIRDC, *Submission 46*, p. 23.

²¹ Arup, *Submission 32*, p. 10.

directly from point A to point B. Whereas if you ride the subway you may have to change once or twice, and that's maybe not quite as convenient.²²

- 2.25 Mr Jeffries stated that we ‘need to think about how those operators can be brought into the mobility mix—both to provide end-to-end journeys but also, potentially, to encourage them to supplement the mass transit network, as was alluded to earlier today—in a way that does actually support the city outcomes that we want rather than, as I said before, resulting in a perverse outcome for the city’. He noted that in New York, ‘the state or city government has introduced restrictions on the number of rideshare vehicles that can operate within Manhattan’. He highlighted New York as an example of ‘issues that have been caused by a lack of regulation’, and suggested that Australia could ‘learn from things that have happened in a much more advanced market’.²³
- 2.26 Arup noted that the ‘autonomy of small passenger vehicles appears to bring the largest opportunities in less densely populated areas’, a particular issue given Australia’s sprawling population:
- Not only because space is a more widely available resource here, but also because of large potential cost savings. Public transport is relatively expensive to deliver in suburbs, where revenue is small and bus drivers’ salaries make up the majority of operational costs. Driverless bus services could dramatically decrease public transport costs, creating opportunities for shorter local routes, less waiting time, distributed cross-regional connectivity, increased service frequency, more reliable networks and thus the promotion of more sustainable travel behaviour.²⁴
- 2.27 Monash University observed that ‘autonomous vehicles are projected to help alleviate congestion by reducing the overall number of vehicles on roads and parking spaces’. It suggested that ‘opportunities for speeding up traffic arise from autonomous vehicles to moving in platoons, optimising routes ad hoc and navigating intersections without traffic lights, especially if human driving can be made obsolete’.²⁵ It noted, however, that ‘the uptake of autonomous vehicles by people not currently driving, empty trips,

²² Mr Roger Jeffries, Technical Director, Transport Advisory; and ANZ Technical Practice Leader, Transport Advisory, AECOM, *Committee Hansard*, 28 February 2019, p. 44.

²³ Mr Roger Jeffries, Technical Director, Transport Advisory; and ANZ Technical Practice Leader, Transport Advisory, AECOM, *Committee Hansard*, 28 February 2019, p. 44.

²⁴ Arup, *Submission 32*, p. 10.

²⁵ Monash University, *Submission 10*, p. 10.

autonomous vehicles running errands and people currently using public transport is likely to increase traffic loads'. Monash found that fully automated self-driving point-to-point transport will increase the number of kilometres driven for the following reasons:

- Additional trips will be made by people unable to use existing transport
- Empty relocation trips have to be made
- The absence of a driver makes travel more affordable
- Removing the strain of driving frees up travellers to complete tasks during trips and makes longer trips more bearable
- Autonomous vehicles may also be used to run errands without passengers.

2.28 According to Monash, 'for point-to-point autonomous vehicle services to deliver on reducing congestion, trips have to be shared':

Simulations by the International Transport Forum (2016) of 8-seat and 16-seat on-demand minibuses demonstrate that a reduction in traffic loads is only possible if more than 60% of all private vehicles are replaced by the shared mode. Declining car ownership and the resulting reduction in the need for parking space has no impact on the total travel distance but can improve traffic flow (Rantasila, 2015).

Gruel and Stanford's interviews also suggest that increased efficiency of operation and the opportunity to share autonomous vehicles in addition to using them as a feeder service will help reduce congestion (Gruel and Stanford, 2016). Alessandrini *et al.* report findings from European studies on urban mobility, most notably the realisation that shared fixed-route 4-seater autonomous vehicles are only likely to be effective inside local and city centres. For most other transits between different service centres, inner and outer suburbs, individual use autonomous vehicles are likely to be effective, as are fixed-route bus services.²⁶

2.29 Monash concluded:

In contemporary Australian cities, many people travel from the suburbs to the city for work and therefore share a large part of their routes to work with other people. Diversity of trip demands is likely greatest at the start and end of the journeys, suggesting fewer and smaller vehicles are needed in these parts.

Rather than covering the joint part in between start and end with large point-to-point autonomous vehicles, it appears meaningful to retain fixed-route transport (bus and train-like services) along major corridors, with small

²⁶ Monash University, *Submission 10*, p. 11.

autonomous vehicles as feeder services that cover the first and last miles (Kelly *et al.*, 2015).

Alternatively, very small 'stackable' individual-use vehicles that can be assembled into larger 'trains' are a conceivable if radical and expensive option. Travellers are averse to mid-trip mode changes, and this option would eliminate a need for relocation and possible wait times.²⁷

- 2.30 The Bus Industry Confederation identified two potential scenarios surrounding transport automation. In the optimistic scenario, 'cheap, accessible, low/zero emission driverless vehicles are widely available on-call, either for single use or shared use but shared use predominates'. The 'availability, convenience and cost of accessing AEVs [Automated Electric Vehicles] are such that people see less need to own their own vehicles'. BIC concluded:

The cheaper cost of AEV travel, particularly by ride-sharing, and the opportunity for new vehicular trips by mobility/transport disadvantaged people will combine to mean that the number of person trips increases in the optimistic scenario. Given sufficient penetration of shared mobility choices, however, this higher number of person trips can be satisfied with a slower growth in vehicle *kilometres travelled*, even though autonomous shared vehicles need re-positioning movements.²⁸

- 2.31 Under the pessimistic scenario, BIC indicated that:

... the personal appeal of private ownership, reinforced by the perceived lower cost of AEVs and opportunity to use travel time productively lead to increased personal trips, with vehicle kilometres increasing at least as fast as personal trips but most probably much faster, as car owners avail themselves of the opportunity to call up their car when they want it ...²⁹

- 2.32 In addition:

The opportunity to work-in-vehicle, or rest/sleep while travelling, instead of having to deal with the driving task, will be seen by some people as an opportunity to change place of residence, most likely to consume additional space by moving to the peri-urban area or even beyond, extending urban sprawl.³⁰

²⁷ Monash University, *Submission 10*, p. 11.

²⁸ Bus Industry Confederation, *Submission 25*, pp. 6–7.

²⁹ Bus Industry Confederation, *Submission 25*, p. 10.

³⁰ Bus Industry Confederation, *Submission 25*, p. 10.

- 2.33 BIC saw ‘the consequences of greater urban sprawl as potentially the biggest single risk from widespread adoption’ of automated vehicles.³¹ It argued for an outcome based on the ‘substantial penetration of shared mobility’, indicating that success would be achieved ‘in part because policy settings explicitly target this outcome’.³² The BIC argued:

With vehicle use in the optimistic scenario now paid for on a more direct pay-by-use basis, active transport is likely to account for a higher mode share than in the pessimistic scenario, with multiple societal benefits (e.g., improved health, lower congestion). The higher mode shares for active travel will, in turn, be supportive of more compact settlement patterns than in the pessimistic scenario. One implication is likely to be relatively higher urban productivity from clustering in the optimistic scenario. Also, the more compact urban form will mean a lower level of infrastructure spend on the urban fringe and beyond, easing government borrowing requirements.³³

- 2.34 The BIC argued that:

The introduction of driverless vehicles should be seen as an opportunity to review mobility in general, reflecting on the whole mobility system, the purpose and value of mobility and how it can be accomplished better in social, environmental and economic terms, recognising the potential benefits and challenges associated with driverless vehicles.³⁴

- 2.35 It believed that ‘mass transit in the future could be very different depending on the policy setting of Governments’.³⁵

Automated rail mass transit

- 2.36 Train automation ‘refers to the process by which responsibility for operational management of a train transfers from the driver to the train control system’. Four grades of automation (GoA) are recognised internationally:

- GoA1 – Automatic Train Protection (ATP) with driver—driver controls starting and stopping of train, door closure and operation in event of disruption

³¹ Bus Industry Confederation, *Submission 25*, p. 9.

³² Bus Industry Confederation, *Submission 25*, p. 6.

³³ Bus Industry Confederation, *Submission 25*, p. 9.

³⁴ Bus Industry Confederation, *Submission 25*, p. 5.

³⁵ Bus Industry Confederation, *Submission 25*, p. 3.

- GoA2—ATP and Automatic Train Operation (ATO) with driver—starting and stopping of train is automatic; driver controls door closure and operation in event of disruption
- GoA3—driverless—starting and stopping of train is automatic; train attendant controls door closure and operation in event of disruption
- GoA4—Unattended Train Operation (UTO)—starting and stopping of train, door closure and operation in event of disruption is automatic.³⁶

2.37 The key elements for automated rail systems are:

Automatic Train Protection (ATP) is a system designed to avoid collisions, and help prevent red signal overrunning and exceeding of speed limits by applying brakes automatically. A line equipped with ATP corresponds (at least) to a GoA1.

Automatic Train Operation (ATO) insures partial or complete automatic train piloting and driverless functionalities. The ATO system performs all functions of the driver, except for door closing. The driver only needs to close the doors, and if the way is clear, the train will automatically proceed to the next station. This corresponds to a GoA2. Many newer systems are completely computer controlled, while still electing to maintain a driver or a train attendant of some kind to mitigate risks associated with failures or emergencies. This corresponds to a GoA3.

Automatic Train Control (ATC) automatically performs normal signaller operations such as route setting and train regulation. The ATO and the ATC systems work together to maintain a train within a defined tolerance of its timetable. The combined system will marginally adjust operating parameters, such as the ratio of power to cost when moving and station dwell time, in order to bring the train back to the timetable slot defined for it. There is no driver, and no staff assigned to accompany the train, corresponding to a GoA4. This Grade of Automation is also referred to as Unattended Train Operation (UTO).³⁷

2.38 Automation in the rail sector is not new. The development of automated systems and technology has been going on for decades and continues apace. DIRDC notes that ‘in the rail sector, automated transport is a proven technology, giving rail a head start over other land transport modes’:

Fully automated, driverless rail networks have been in operation for over 30 years, with the most advanced rail technology available today allowing for

³⁶ DIRDC, *Submission 46*, p. 48.

³⁷ DIRDC, *Submission 46*, p. 25.

unattended train operation with no staff on board. As of May 2018, there were 63 fully automated operational metro rail lines in 42 cities in 19 countries across the world, including major cities such as London, Paris, Lille and Singapore. The total line length of fully automated metros reached the milestone of 1,000km in 2018. Over the period 2015 –17, ten new metro lines designed to run with fully automated operation entered in service in ten cities (UITP, 2018).³⁸

2.39 DIRDC observed that ‘automated train technology continues to grow at a rapid rate. Current forecasts, based on confirmed projects, indicate that by 2025, there will be over 2,300 kilometres of driverless metro lines in operation worldwide’.³⁹

2.40 DIRDC highlighted the benefits of automation in rail, stating:

Within dense urban environments where new rail lines can have high upfront capital costs, technological advances and increased automation have the potential to improve the efficiency, capacity and utilisation of existing networks to help cater for expected growth in patronage and attract more people onto rail through customer focused initiatives.⁴⁰

2.41 The ways in which automation can transform the use of mass transit include:

- more trains, more often – automated rail systems allow operators to optimise the running of trains, increasing the average speed of the system, shortening headways and reducing dwell time in stations;
- greater reliability – driverless technology and advances in communication and control systems increase resilience by allowing dynamic, real time management of the network in the face of disruptions and enabling operators to allocate trains in response to sudden surges in demand. Automated, independent lines also help to improve the reliability of overall networks through untangling networks and better geographically containing network-wide delays;
- safety and accessibility – automated rail systems offer safer operations than conventional railways by reducing the human-risk factors and increasing reliability (UITP, 2011). Upgrading to a more modern system design also brings a number of added safety and accessibility benefits. For example, newer metro systems can be built to facilitate level access between platform and train, and platform screen doors can prevent passengers tripping or falling onto the tracks;

³⁸ DIRDC, *Submission 46*, p. 27.

³⁹ DIRDC, *Submission 46*, p. 27.

⁴⁰ DIRDC, *Submission 46*, p. 26.

- personalised journeys – technologies, including automation, create opportunities to provide customers with real time information and facilitate the use of public transport through on-demand first and last mile connections.
- improved energy performance – acceleration and deceleration patterns of automated rail are adjustable to reduce energy consumption and maximise energy recovery, therefore significantly reducing energy costs; and
- reduced operational costs – communications-based train control systems allow for the removal of traditional trackside infrastructure, such as track circuits and colour signals, and the associated costs of maintenance.⁴¹

2.42 DIRDC stated that as a ‘step towards greater automation, Automatic Train Protection (ATP) is increasingly being rolled out across Australian rail networks’. It noted that ‘in NSW, for example, ATP is being rolled out across the Sydney Trains and NSW TrainLink electrified network’. ATP is used to monitor train speed, distance and direction and ‘prevents the authorised line speed being breached due to driver error or if a driver becomes incapacitated’.⁴²

2.43 DIRDC highlighted the development of automated Metro as a significant development in automated rail systems:

Australia’s urban rail systems will undertake a step-change over the coming years with the completion of Stage 1 of Sydney Metro – the NSW Government’s \$8.3 billion Sydney Metro Northwest railway. Sydney Metro is an automated mass transit solution that will bring congestion busting and city-shaping benefits to Sydney, transform urban centres, and boost economic productivity by improving employment and education opportunities.⁴³

2.44 It observed that the Sydney Metro Northwest project ‘will be fully automated with no train attendants present’, with ‘controllers monitoring the entire system from an Operations Control Centre’. Nonetheless, safety and security was central to its design:

The Sydney Metro Northwest trains are being designed, built and operated to the highest safety standards, with more than 300 Australian and international safety standards stipulated in the operations contract for the trains and the associated equipment. High levels of security will prevent trespasser access, such as platform screen doors that keep people and objects away from the

⁴¹ DIRDC, *Submission 46*, p. 26.

⁴² DIRDC, *Submission 46*, p. 27.

⁴³ DIRDC, *Submission 46*, p. 28.

tracks and allow trains to enter and depart stations faster. Obstruction detectors will prevent trains departing stations if any door is not fully closed. An intrusion detection system will be a feature on Sydney Metro Northwest, designed to identify and report any track encroachments along the route.⁴⁴

- 2.45 DIRDC further noted that ‘Metro rail systems are often closed systems with access restricted to the automated vehicles and controlled access to other types of trains, road vehicles and pedestrians. This element of system design is linked to safety outcomes’.⁴⁵
- 2.46 The Australasian Railway Association (ARA) believed that the Sydney Metro would provide a model for future passenger rail development, illustrating ‘what is possible for automated mass transit systems in Australia’ and paving the way for ‘additional automated, driverless rail lines in Australia’. It noted that ‘projects such as the Melbourne Airport Link are also considering driverless automated trains’.⁴⁶
- 2.47 The ARA highlighted other important advances in automation including:
- Digital Signalling Systems / Automatic Train Control—which ‘removes the reliance on track-side signalling, using automated systems that allow passenger and freight operators to provide more services using existing infrastructure as trains can be run closer together’, thereby increasing ‘network capacity and improve the customer service offering by reducing wait times for customers and helping to manage station crowding’.⁴⁷
 - Automated asset monitoring for maintenance—informs and automates ‘maintenance decision making to maximise the use of high cost assets by reducing the impact and lost revenue of unavailable rolling stock or infrastructure. This smarter approach to monitoring and asset maintenance can also extend the lifecycle of parts with decision-making based on data analytics and insights’.⁴⁸
 - Smart Ticketing—which provides ‘many benefits including streamlined customer travel experience; negating the need for single, weekly or monthly use paper tickets; providing extensive customer travel insights

⁴⁴ DIRDC, *Submission 46*, p. 30.

⁴⁵ DIRDC, *Submission 46*, p. 27.

⁴⁶ ARA, *Submission 36*, pp. 3–4.

⁴⁷ ARA, *Submission 36*, p. 4.

⁴⁸ ARA, *Submission 36*, pp. 4–5.

for operators and Government alike, ensuring customers pay correct travel fares'; it is expected that the current systems will be succeeded 'by mobile phone or credit card ticketing systems' improving 'the accessibility of and integration of our transport systems'.⁴⁹

- iTRACE—an initiative 'implementing global data standards (GS1) in the rail industry to standardise the way all assets and materials in the rail industry are identified, barcoded and tagged'. Standardising the capture of data 'will help to improve efficiency, lower costs and deliver better customer service and bring industry-wide efficiencies by setting the foundation for automation'.⁵⁰

2.48 The ARA cited the industry's Smart Rail Route Map as a reflection of the 'shared desire to identify a long-term vision for technology in the rail sector through the establishment of a common view of priorities, themes, timelines and actions for the next 30 years'. It focused on the opportunities and challenges associated with ever increasing levels of automation in the Australasian railway industry, including:

- New technologies requiring a shift in the skill-sets in the rail sector towards automation, and that people management skills will move towards the interface between human and digital workplaces.
- Automation paving the way for greater simplification of journey planning, allowing greater access to a reliable, multimodal transport service, with improved last mile connections.
- Potential opportunities existing for greater integration of cloud-based computing, analytics and other systems to enable automation of traffic and network management systems.
- Complex systems will be simplified through automation, balancing capacity and flexibility, while humans will maintain supervisory control of technology.
- Developing an industry platform to monitor where the industry is heading with regards to automation, why the direction is important and the priority tasks, helping the workforce visualise the opportunities and potential pathways to the future.
- New systems, based on automation, allowing traffic management to progress to a role of train service optimisation and significantly improve track capacity and train safety.⁵¹

⁴⁹ ARA, *Submission 36*, p. 5.

⁵⁰ ARA, *Submission 36*, p. 6.

⁵¹ ARA, *Submission 36*, pp. 5–6.

- 2.49 The ARA cautioned, however, that achieving ‘interoperability between automated systems, particularly across State borders is integral to ensure the rail industry does not end up with another “break of gauge”’.⁵²
- 2.50 Another concern was raised by Monash University, which noted that ‘the quality and age of Australia’s rail and bus infrastructure’ was a barrier to automation—‘the larger Australian cities have very old legacy railways and unreliable infrastructure. This will have to be renewed to make automation possible.’⁵³ Nonetheless, Monash believed automated rail transport was the way of the future:

Automated driverless trains are becoming common in various countries. In Australia, the Office of the National Rail Safety Regulator recently approved Rio Tinto’s auto haul of 240 car heavy haul cars. There are a number of opportunities for Australia to lead in the development and implementation of new technologies that will assist operators where automated driverless trains are used, create greater efficiencies and improve safety. The scope includes light rail, passenger rail networks and in the heavy haul freight rail industry.⁵⁴

- 2.51 In its submission, Arup stated that ‘with more than 30 years of technology experience it is beyond debate that autonomous rail mass transit is safer, more reliable, cheaper to operate and can deliver more services per hour on the same infrastructure footprint, made possible by segregated infrastructure’. It urged the adoption of Automatic Train Operation and Automatic Train Protection in ‘all major city passenger rail networks in Australia as a step to full autonomy’. Arup noted that ‘autonomy of rail-based freight transport is not as far progressed as rail-based passenger transport, but has potential of equal measure’, stating:

The question where in the freight chain autonomy can best be applied is still largely unanswered and needs further investigation. Options include autonomy on trunk routes, terminal transshipment or last mile delivery.⁵⁵

- 2.52 Arup observed that ‘it is most likely that those parts that can be operated using electric motivation will become autonomous first’. It noted that ‘electric powered movement increases predictability, allows for smooth

⁵² ARA, *Submission 36*, p. 7.

⁵³ Monash University, *Submission 10*, p. 5.

⁵⁴ Monash University, *Submission 10*, p. 3.

⁵⁵ Arup, *Submission 32*, p. 7.

acceleration and deceleration and is easy in use, therefore lowering costs of automation and operation’.⁵⁶

- 2.53 The Bus Industry Confederation made s further observation about rail mass transit—the need to provide strong government control over a natural monopoly:

The high capital costs and associated high patronage of rail mass transit services to central cities provides them with significant natural monopoly characteristics, which suggests multiple sources of supply are unlikely. The agglomeration economies, congestion cost savings and environmental benefits (external benefits) associated with such services speak to the importance of strong governmental control over service provision, rather than leaving them to the dictates of the private marketplace, where under-provision would be expected, relative to the scale of external benefits. We conclude that these natural monopoly characteristics and external benefits are such that, in coming years, the Australian mass (trunk) transit market should remain as public transport as we currently understand it. There is a need to include these trunk services in MaaS bundles, for which they will provide a fundamental ingredient.⁵⁷

Rail v. Road

- 2.54 Despite the convenience and benefits of automated cars, there was a widespread belief that rail mass transit would continue to play an essential role in providing transport solutions. The ARA observed that while ‘automated, driverless cars provide an exciting revolution in transport and are a clear potential to provide the “first and last mile” for public transport, mass transport such as heavy and light rail will still be vital to provide the spines for seamless integrated mass transit systems’.⁵⁸

- 2.55 DIRDC observed that the mathematics of mass transit meant that rail would always be more efficient than road on trunk routes, stating:

On an arterial freeway, you’re looking at a little over 3,000 people per hour. If you’re talking about, say, a high-capacity metro train, it’s more like 34,000. With the Sydney Metro, it’s potentially over 40,000 people per hour. So, even if you do get a substantial improvement in your carrying capacity on a road because of autonomous vehicles, it’s pretty unlikely that they’re going to get to

⁵⁶ Arup, *Submission 32*, p. 7.

⁵⁷ Bus Industry Confederation, *Submission 25*, p. 12.

⁵⁸ ARA, *Submission 36*, p. 7.

that sort of level, because that's an order of magnitude more people being shifted on heavy rail options, for example.⁵⁹

- 2.56 The ARA noted that 'Australia's growing, aging and urbanised population is putting increasing pressure on our public transport systems, of which rail provides the backbone, moving the masses'. It stated that 'governments and rail organisations in Australia and around the globe are increasingly looking to automation to safely increase the capacity of existing infrastructure, improve the customer experience and ensure rail services modernise to meet the needs of Smart Cities of the future'. The ARA argued that 'more trains and more services are required today and into the future to meet the needs of our growing population to travel and move freight'. Automation would 'assist to provide the greater capacity required by passenger and freight rail networks'.⁶⁰
- 2.57 In its analysis, Monash University observed that 'metro rail systems have been the backbone for most smart cities'. It argued that while 'a bus can take up to 60 passengers', to replace it 'with cars, autonomous or not, it would require additional space on our roads'. But, 'if you substitute cars with a metro rail system, it will be significantly more efficient and more effective in reducing congestion'.⁶¹
- 2.58 Monash University also observed that 'there are some critical lessons to be learned about the design and management of passengers in driverless urban railways which are important to note for running driverless vehicles on streets'. These included:
- Driverless trains adopt platform doors to meticulously manage human interaction with entry/exit to vehicles
 - Rail platforms are generally underground or raised; and platforms do not permit any other vehicle or pedestrian interaction with trains
 - Streets where driverless buses or cars might operate have none of these protections and are far more complex locations; it is thus far more difficult to operate buses/cars without drivers safely in these places without a considerable degree of management of passenger interaction.⁶²

⁵⁹ Mr Andrew Hyles, General Manager, Rail Policy and Planning, Department of Infrastructure, Regional Development and Cities, *Committee Hansard*, 12 February 2019, p. 8.

⁶⁰ ARA, *Submission 36*, p. 2.

⁶¹ Monash University, *Submission 10*, p. 3.

⁶² Monash University, *Submission 10*, p. 3.

2.59 Engineers Australia urged priority for rail automation over road automation, stating:

A legal and regulatory framework exists for automated rail, so migration to driverless vehicles in closed systems such as rail networks should be prioritised. Full automation of our rail transport networks may be achievable sooner than automated road mass transit and public risk perception towards driverless vehicles may be tempered by a rail first approach.⁶³

Light rail

2.60 DIRDC noted the expansion of light rail in Australia's major cities. It observed that 'modern light rail systems are expected to increasingly adopt automation technologies that improve network safety and navigation', but that as light rail 'interacts with road traffic and pedestrians, it is less suitable for driverless automation than heavy rail'. DIRDC highlighted 'recent technological developments in road-based mass transit options include trackless trams':

Trackless tram technology varies, but generally involves a tram-style vehicle with rubber tyres that runs on markings on the road surface with the capacity for high levels of automation. Advantages of trackless trams, compared with traditional light rail, is that they can be significantly cheaper to deploy due to lower upfront infrastructure costs and much lower impact on the community during the construction process.⁶⁴

Automated road mass transit

2.61 There are six levels of road vehicle automation as defined by the Society of Automotive Engineers' (SAE) International Standard J3016. The classification is based in whether the system:

- manages steering, acceleration and braking on a sustained basis;
- requires a human driver to monitor the driving environment and respond as needed;
- can operate without handing over control ('falling back') to a human driver ; and
- can operate in all situations ('driving modes').⁶⁵

2.62 The six levels of automation are:

⁶³ Engineers Australia, *Submission 37*, p. 4.

⁶⁴ DIRDC, *Submission 46*, p. 31.

⁶⁵ DIRDC, *Submission 46*, p. 45.

- No automation (SAE Level 0)—human driver undertakes all aspects of the driving task.
- Driver assistance (SAE Level 1)—in some circumstances the system is capable of either steering or acceleration/deceleration (including braking), with the expectation that the human driver performs all remaining aspects of the driving task.
- Partial automation (SAE Level 2)—in some circumstances the system is capable of both steering and acceleration/deceleration. The human driver must monitor the driving environment and respond as needed.
- Conditional automation (SAE Level 3)—Level 2, but when the system is operating in automated mode the human driver is not required to monitor the driving environment. The human driver must respond to requests from the driving system to intervene.
- Highly automated (SAE Level 4)—Level 3, but no human monitoring or intervention is required when the system is operating in automated mode.
- Fully automated (SAE Level 5)—automated system in control all of the time, and in all road environments.⁶⁶

2.63 DIRDC observed that ‘the extent to which a vehicle is automated, and in particular, whether a human is required to monitor the road environment and/or be ready to take back control, has significant implications for the social, policy and regulatory impacts’.⁶⁷

2.64 In its submission, NRMA highlighted timelines for the introduction of automated vehicles developed by the Australian Driverless Vehicle Initiative (ADVI), stating:

With Level 3 technology already embedded in some light passenger vehicles, ADVI expects the arrival of Level 4 technology between 2020 and 2025, and Level 5 technology between 2026 and 2030. This view aligns with timeframes previously submitted by the NRMA in public papers, including *The Future of Car Ownership* (August 2017).⁶⁸

2.65 NRMA stated that ‘fully automated vehicle capability or “Level 5” automation—where no human driver is needed and vehicles do not possess a steering wheel or pedals—could be available as early as the mid-2020s. On-

⁶⁶ DIRDC, *Submission 46*, p. 45.

⁶⁷ DIRDC, *Submission 46*, p. 45.

⁶⁸ NRMA, *Submission 27*, p. 6.

demand shuttles and taxis capable of full automation could arrive even earlier.’⁶⁹

- 2.66 Infrastructure consultants Arup observed that the ‘increased productivity of road mass transit, including passenger buses, forms the largest and most important opportunity in Australia, due to the extensiveness of Australia’s road network and its low productivity’. It indicated that ‘automation of road mass transit can provide this increase in productivity, made possible by potential reductions of operational costs and safety improvements’.⁷⁰ To date, however, automated buses had enjoyed limited success:

Autonomy of buses has been hampered by high costs, low operating life, a small supply chain of electric buses and safety risks. Existing autonomous buses are operating in very low speed, highly controlled environments. Even those to be introduced shortly and touted as operating on the public road network have significantly lower operating speeds, much higher quality of infrastructure and constant human oversight. However, as autonomy improves and sensor technology combined with machine learning become more meaningful, the potential is significant.⁷¹

- 2.67 The Bus Industry Confederation also noted the limitations of automated buses to date:

The BIC would note however that the concept of a driverless bus, in particular large buses, may be technologically possible but the reality of mass transit and school bus services operating in this way are much less certain for a variety of operational and personal safety and societal issues. The unknown element from a bus perspective is if it is going to be accepted by users concerned about safety and security.⁷²

- 2.68 The BIC cited trials of automated buses in France, where buses operating with only passengers raised a number of concerns:

One factor that has been recognised after actual trials of driverless buses on guided busways in France is that passengers do have concerns of trust and safety when a driver is not aboard. In this example, drivers were returned to the bus to ease concern, despite the fact that the vehicle remained self-driven. The physical presence of the driver was an important psychological factor,

⁶⁹ NRMA, *Submission 27*, p. 6.

⁷⁰ Arup, *Submission 32*, p. 8.

⁷¹ Arup, *Submission 32*, p. 8.

⁷² Bus Industry Confederation, *Submission 25*, p. 4.

even if it was only for “override” capabilities if required. Trusting future technology will be a major challenge for many individuals.⁷³

- 2.69 Nonetheless, the BIC saw automated buses as the key to Australia’s urban transport future. Automated buses, ‘operating on bus priority infrastructure and dedicated bus rapid transit infrastructure such as the Brisbane Busways’, would lead mass transit services. They would ‘become the train of the future in an autonomous world where fixed infrastructure is no longer required’:

A train set of bus seats travelling along a transport corridor where individual bus carriages have the capacity to peel off as required to deliver passengers as close to their end destination as possible and connect to on demand services to complete the trip.⁷⁴

- 2.70 This was Mobility as a Service (MaaS—see below), with ‘a spine of mass transit that carries the bulk of the population most of the time’. The BIC concluded that the ‘bus is the workhorse of Australia’s mass transit systems today, carrying more passengers than rail each day and this will continue to be the case in an autonomous transport world’.⁷⁵

- 2.71 In its submission, DIRDC highlighted the various trials that have taken place with automated shuttle buses.⁷⁶ The Department stated:

The automated shuttle bus trials currently underway in Australia are demonstrating the longer term potential of highly and fully automated driving systems. Partially automated buses, which are likely to be available sooner, may also benefit bus drivers, operators and passengers.⁷⁷

Mobility as a Service

- 2.72 Mobility as a Service ‘is a framework which aggregates infrastructure, services, technology and information to suit the travel and lifestyle needs of individuals’. It ‘brings together transport operators and third parties, allowing a seamless provision of services, information, booking, payment and customer relationship management between transport modes’.

⁷³ Bus Industry Confederation, *Submission 25*, p. 21.

⁷⁴ Bus Industry Confederation, *Submission 25*, p. 22.

⁷⁵ Bus Industry Confederation, *Submission 25*, p. 22.

⁷⁶ DIRDC, *Submission 46*, pp. 18, 19.

⁷⁷ DIRDC, *Submission 46*, p. 15.

Engineers Australia notes that MaaS is ‘an emerging concept’, the definition of which ‘is not yet universal’.⁷⁸

2.73 MaaS has been identified as a key element of an integrated transport network in an automated transport future. Infrastructure Victoria observed that ‘on-demand public transport and mobility as a service (MaaS) solutions could make significant improvements to how we travel’. Infrastructure Victoria ‘found that on-demand, MaaS and integrated planning and payment for multi-modal trips are likely to supplement existing public transport services and pave the way for introducing on-demand automated vehicles’. It recommended ‘incorporating on-demand and MaaS into the public transport mix in preparation for automation, through the following actions’:

- Ensuring new contracts for public transport operators allow for changes to accommodate new market models.
- Plan for opportunities to develop open payment, ticketing, validation, third-party purchasing platform(s) and open/integrated barrier systems for public transport.
- Plan for changes to public transport hubs to accommodate pick-up and drop-off facilities, and other mobility options like active transport to encourage multi-modal trips.
- Review existing contracts and public transport franchise agreements, including fare structure, for opportunities to integrate automated vehicles into service planning.
- Transport services delivered directly by the government (such as community transport) should plan for potential changes to accommodate new market tools (for example, apps and on-demand services) and automated vehicles.
- Assess potential for automated vehicles to support demand-responsive transport services.
- Consider whether there is a role for government to incentivise or procure services from automated fleet operators to operate in regional and rural areas, if the market fails to do so.
- Consider how automated vehicles could be used to enhance public transport, especially to support people with mobility impairments and those currently on concession arrangements.⁷⁹

⁷⁸ Engineers Australia, *Submission 37*, p. 5.

⁷⁹ Infrastructure Victoria, *Submission 16*, p. 3.

- 2.74 Infrastructure Victoria's findings pointed to 'a blurring of the distinction between public and private transport':

In a future with automated vehicles, having simple and efficient interactions between private operators and public transport will be critical to unlock accessibility and community benefits.⁸⁰

- 2.75 Dr Jonathan Spear, Executive Director and General Counsel at Infrastructure Victoria, noted that their modelling 'shows that automated on-demand vehicles can be particularly complementary to public transport, because they have the opportunity to supplement and fill gaps in the public transport network and improve accessibility'. He continued:

If the fleet is made up of a mix of public transport vehicles in a traditional sense and different automated vehicle types that are both publicly and privately owned and deployed, then there's a possibility to cater for the different needs and preferences of different users.⁸¹

- 2.76 Dr Spear observed that while 'road based automated vehicles that are smaller than buses are unlikely to replace mass transit', they could 'help fill in some of those gaps of services that you do see beyond the CBD and some of our activity centres, and may well help people get to those activity centres and agglomerate there'.⁸²

- 2.77 The Bus Industry Confederation pointed to developments in the integration of public transport (PT) operations and MaaS as a key development for the future of automated transport, stating:

Whilst the suggested future of PT operators absorbing the MaaS broking role within their business model constitutes a longer term development, much innovation is already happening, with forays into intermediate modes and new models of providing local (coverage) transit. Whilst this is evident from the innovative work of multinational multimodal operators (e.g., Transdev, Keolis) in overseas markets, local Australian operators are also keenly exploring this space. In NSW, on demand services have been trialled since late 2017 in the form of government-led pilots, with various models deployed in Metropolitan Sydney, Outer Metropolitan Sydney and (from late 2018) in

⁸⁰ Infrastructure Victoria, *Submission 16*, p. 3.

⁸¹ Dr Jonathan Spear, Executive Director and General Counsel, Infrastructure Victoria, *Committee Hansard*, 27 February 2019, p. 8.

⁸² Dr Jonathan Spear, Executive Director and General Counsel, Infrastructure Victoria, *Committee Hansard*, 27 February 2019, p. 12.

Rural and Regional NSW. Existing PT operators are partnering with technology providers to deliver these new innovative services.⁸³

2.78 Within this scenario, ensuring universal access to the transport network was a priority. According to the BIC:

If social inclusion is seen as a societal priority, then some base level of shared mobility service to support or underwrite this outcome is warranted. We see no other way of assuring minimum local mobility opportunities are available to 'at risk' people. By implication, local shared mobility contracts should be developed to support provision of base social transit service levels, which would be expected to vary by demographic/land use setting. For example, expectations should realistically be for a lesser service level in a rural area than in a town.⁸⁴

2.79 The BIC preferred 'a subsidized minimum service level approach to shared mobility service (social transit), which supports individual capabilities and allows people to self-select on use, with existing fare concessions continuing'. It stressed that 'the subsidy for shared mobility service should be for service, not modes per se, and shared mobility contracts should reflect this focus'. BIC stated that 'shared mobility contracts are most relevant in rural, regional and outer urban settings, where they could be introduced now, given sufficient institutional will to pursue more integrated service offerings'.⁸⁵ It suggested that 'in a time of "disruption", the way we do mobility, the way we move people is changing, and a shared mobility future based around actual demand rather than latent demand is with us'.⁸⁶ The BIC concluded:

At State and Territory level, early development and implementation of service-focussed shared mobility contracts would be a positive supportive step along the transition pathway to future governance models that are better suited to emerging technological opportunities, while delivering immediate benefits from realizing a more integrated service delivery model. Integrated app-based booking/ticketing systems, with a range of on-demand service options, are fundamental to the prospects for MaaS and for shared mobility

⁸³ Bus Industry Confederation, *Submission 25*, p. 16.

⁸⁴ Bus Industry Confederation, *Submission 25*, p. 20.

⁸⁵ Bus Industry Confederation, *Submission 25*, p. 21.

⁸⁶ Bus Industry Confederation, *Submission 25*, p. 21.

service in the immediate future and should be a requirement of shared mobility contracts.⁸⁷

2.80 The Department of Infrastructure, Regional Development and Cities held a similar view. It stated:

Public transport is moving away from a means of simply commuting along fixed routes. A convergence between automated driving technology and emerging data and connectivity-driven technologies may support more cost-efficient, on-demand on-road mass transit services. On-demand services would offer flexible routing and timing to better meet commercial and passenger needs. New business models and digital platforms, such as Mobility-as-a-Service (MaaS) are likely to provide real-time information about demand to transport operators, enabling the more efficient provision of services.⁸⁸

2.81 The Department observed that ‘on-demand services using small or medium size automated buses with lower operating costs could significantly improve service coverage, including in both urban and regional centres’. It indicated that ‘this type of automated transport could be cost competitive with regional rail links or traditional bus services, or could fill last-mile service gaps’.⁸⁹ The Department noted that New South Wales was conducting trials of on-demand bus services—allowing people ‘to book a vehicle via an online app or over the phone, representing a shift away from the concept of fixed transport routes’. The trial, ‘rolled out in locations such as Eastern Suburbs, Manly, Northern Beaches, Woy Woy and the Illawarra’, had seen over 150 000 customer trips taken in its first two years. The Department observed that:

The cost of on-demand services through the pilot program is comparable to a one-way bus ticket and it allows people to access public transport when and where they need it, enhancing the existing public transport network. This trial is an example of how smart planning and applying technology in an innovative way to transform existing services can not only make delivering transport more efficient for operators but also provide better services for the community.⁹⁰

The First & Last Mile

⁸⁷ Bus Industry Confederation, *Submission 25*, p. 29.

⁸⁸ DIRDC, *Submission 46*, p. 16.

⁸⁹ DIRDC, *Submission 46*, p. 16.

⁹⁰ DIRDC, *Submission 46*, p. 16.

- 2.82 One of the biggest challenges for automated mass transit is the problem of the first and last mile—the gap between mass transit services and home or destination. Mr Ian Christensen, Managing Director of iMove Australia, told the Committee:

We would also highlight that automation, while important in its own right, delivers substantially greater benefits if it's augmented by considerations of connectivity at the same time—'connectivity' meaning that one automated vehicle can interact effectively with both automated and non-automated vehicles in its surroundings and with which it interconnects in the transport systems of which it's a part. For instance, we can think of mass transport services as arteries in the transport network. But, like any organism, arteries only work well if the contents can actually get to the arteries. So we would say that mass transport and automation of mass transport is good, but it needs to be augmented by interconnection or interoperability with the distribution services—the 'last mile' services, so to speak—for the people who are using those services. Otherwise, we might have wonderful mass transport systems that run sub-optimally, or which are in fact potentially empty because people cannot get to them.⁹¹

- 2.83 Mr Christensen observed that 'across the whole of the personal transport system there is a progressive trend and need to transition from a modal focus—that is, the train, the tram or the bus—to a traveller focus, so that we concentrate on the experience of the traveller rather than just the efficiency or frequency of the transport service'. He believed that the main imperative is 'to mitigate congestion, to reduce the burden of congestion on our productivity'. To do this, 'we actually then need to encourage a better spread of transport demand across the available services and capacities'. This required behavioural change on the part of the travelling public, which could only be achieved 'when travellers perceive the alternative modes of behaviour as being attractive'. There was 'an absolute requirement that we migrate to a traveller-centric focus on the performance of our transport network, with a view to encouraging behaviour change to the extent necessary to reduce congestion'.⁹²

- 2.84 Mr Christensen argued for a shift away from a focus on modes of transport to a 'systems approach', providing 'appropriate transport services to a geography, to a region, to a locality in which the bus operator provides part

⁹¹ Mr Ian Christensen, Managing Director, iMove Australia, *Committee Hansard*, 28 February 2019, p. 12.

⁹² Mr Ian Christensen, Managing Director, iMove Australia, *Committee Hansard*, 28 February 2019, p. 12.

of the solution'. He noted that this would require 'an evolution, at least in some jurisdictions, of the nature of the contract between the state and the operator as to the performance they're required to deliver and what they're trying to optimise'. He noted that 'in some jurisdictions there is no incentive to the operator to increase patronage and yet, overall, the system would benefit strongly, up to a limit, if the patronage on public transport were actually able to be increased or people could be attracted from their single occupancy cars into multiple occupancy public transport vehicles'.⁹³

- 2.85 DIRDC noted that the first/last mile 'is often disproportionately inconvenient when compared to other parts of the journey and may have a negative impact on public transport patronage – frequently it is too far to walk, too close to drive (and find parking)'. Increasingly, mass transit users are 'using ride-hailing and bike-sharing services for the first and last mile of their journey'. The Department cited figures that indicated '15 per cent of Uber rides in Western Sydney are to or from train stations, with this figure reaching 25 per cent in some cities in the United States'. It noted that:

Small and medium size automated vehicles could provide more cost-efficient and convenient first and last mile services to and from public transport hubs, or connect people to and from regional heavy rail services. Trials of automated vehicles are increasingly testing this proposition by deploying automated shuttle buses on fixed routes between mass transit hubs and key origin/destination points.⁹⁴

- 2.86 MaaS, combining 'public and private transport options in a single app', combining integrated planning, booking and payment options, was seen as the way forward. The Department noted:

New business models such as these could accelerate long-term trends away from car ownership, and impact on travel patterns and infrastructure use. If this model matures in Australia, it could provide an incentive for travellers to move away from private vehicle ownership and make increased use of automated vehicles and public transport as part of a new, flexible approach to travel.

Our cities need to be well connected and integrated to support changing consumer expectations of rapid, just-in-time and distributed mobility. Australia, with its high concentration of urban populations and long, narrow

⁹³ Mr Ian Christensen, Managing Director, iMove Australia, *Committee Hansard*, 28 February 2019, p. 13.

⁹⁴ DIRDC, *Submission 46*, pp. 19–20.

linkages between them, is well placed to take full advantage of the efficiencies services like MaaS bring.⁹⁵

- 2.87 NRMA observed that ‘growing trends around the world point to increasing levels of ride sharing, bike sharing, carpooling, on-demand services and public transport use’:

Many vehicle manufacturers, technology companies and governments view sharing via subscription to be the most logical future for the automobile. While Australians have revered the very existence of the automobile since the early 1900s, for the first time in Australia’s history, young adults are less likely to hold a driving licence than their parents.⁹⁶

- 2.88 NRMA expected ‘private car ownership to decline as time progresses’, stating that ‘mobility will no longer be a privately-funded undertaking, but an evolving and efficient service underpinned by CAVs [connected and automated vehicles] and interconnected modes of transport’.⁹⁷ Realising this future mobility model and its benefits required ‘integration of CAVs and traditional transport services like trains, buses, light rail and ferries’.⁹⁸ NRMA concluded:

An automated and shared mobility future will also likely reduce congestion on Australian roads by shrinking the size of the private vehicle fleet and improving efficiency. Greater numbers of car sharing vehicles, ride sharing vehicles and on-demand taxis and shuttles will improve productivity and increase mass transport use, provided they are seamlessly integrated into existing and new services.⁹⁹

- 2.89 Transdev saw shared mobility—‘that’s really what we believe in’—as ‘crucial to realising the full range of benefits of autonomous ecofriendly vehicles’. Mr David Le Breton, representing Transdev Australasia, told the Committee:

We want to avoid a future of automated single-passenger vehicles on the roads. This would just increase congestion, put more pressure on public space and reduce connection and livability in our cities. This is a pressing concern in Australia given the high level of car ownership, as we heard before; a

⁹⁵ DIRDC, *Submission 46*, p. 17.

⁹⁶ NRMA, *Submission 27*, p. 6.

⁹⁷ NRMA, *Submission 27*, p. 6.

⁹⁸ NRMA, *Submission 27*, p. 7.

⁹⁹ NRMA, *Submission 27*, p. 7.

longstanding preference for cars over public transport; and the high incidence of single-traveller journeys within relatively short distances.¹⁰⁰

Integrated transport

2.90 The key to managing the first and last mile, according to Transdev, was integrating autonomous vehicles ‘within existing public transport systems and networks—as the first mile and last mile’:

Our view is that traditional mass modes—such as rail, core bus routes and ferries—will remain the backbone of our cities' transport networks in the short to medium term. We also believe that shared autonomous vehicles will be a reality on Australia's road before single operated driverless cars. First mile, last mile autonomous shuttle services can be integrated into those existing routes to make public transport more attractive to passengers and more accessible to communities in suburban and rural areas and to community members with special mobility needs as well. As an added benefit to cities, the use of shared autonomous shuttles also reduces the demand for parking, freeing up land for more productive development.¹⁰¹

2.91 Uber saw first and last mile solutions ‘as an important part of the future transport mix’, envisioning ‘a multi-modal transport ecosystem whereby passengers leverage point to point transport for first/last mile travel to complement their public transport journey’. Uber emphasised that ‘this integrated transport model relies heavily on strong partnerships between governments and point to point transport providers’. Uber provided examples of where it had formed partnerships with governments and other providers to provide integrated transport solutions. These included:

- Partnerships with the transit authorities in Atlanta, Los Angeles and Minneapolis to provide a discount to commuters using Uber to complement public transport.
- Programs such as ‘guaranteed ride home’ in Washington DC offer commuters who regularly use pooling (twice a week) reimbursement for emergency travel outside of peak hours.
- In Malaysia, Grab (a regional rideshare company) partnered with the airport train service, Kuala Lumpur International Airport (KLIA) Express, to offer discounts for passengers who use Grab to reach their

¹⁰⁰ Mr David Le Breton, Business Development Manager, New Mobility, Transdev Australasia, *Committee Hansard*, 27 February 2019, p. 58.

¹⁰¹ Mr David Le Breton, Business Development Manager, New Mobility, Transdev Australasia, *Committee Hansard*, 27 February 2019, p. 57.

final destination after disembarking from KLIA Express Station in the city.

- Partnerships with Mobicia, London's leading bus times app with almost one million users per month. Uber is now integrated into the Mobicia experience, enabling customers to order a ride via the Uber app to the nearest convenient bus stop for their onward journey, improving access to public transport, especially in areas that are beyond an easy walk to the bus.
- In Australia, Uber has collaborated with Transport Canberra to provide Late Night Rapid passengers with \$10 discount if they used Uber to travel to and from bus stops. This was launched over the 2016 New Year period and will operate for its third year at peak times over the New Year period in 2018.¹⁰²

2.92 Mrs Natalie Malligan, Head of Cities, Australia and New Zealand at Uber, highlighted a recent development in Sydney, where 'Uber was recently selected as a successful incubatee as part of the Transport for New South Wales Mobility as a Service Innovation Challenge':

As part of this initiative, Uber, in conjunction with TfNSW [Transport for NSW], is piloting a program where riders who take an UberPool trip to or from the Manly ferry wharf within a defined geofence receive a flat \$5 fare in addition to a 20 per cent discount on a connected Captain Cook ferry trip. This means riders can leave their car at home and save time trying to find a parking spot, helping reduce emissions and congestion.¹⁰³

2.93 Uber has also expanded its focus to new modalities. In San Francisco Uber has given people the option 'to book a JUMP bike—an electric-assist smart bike—using the Uber app. For the first time, riders could choose seamlessly between two very different transportation modes in our app.' Uber was also 'working with government partners to explore JUMP bikes and micro-mobility solutions in Australia'.¹⁰⁴ Uber was also exploring the development of Uber Air, 'an initiative with the aim to create on-demand, urban aviation options via all-electric aircraft on the Uber network'. Riders 'will push a button and get a flight via Uber Air. Uber Air will be a mass-market product serving daily and casual commuters as an alternative to driving into and out of congested urban areas'. Uber believed that 'on-demand aviation has the

¹⁰² Uber, *Submission 38*, p. 12.

¹⁰³ Mrs Natalie Malligan, Head of Cities, Australia and New Zealand, Uber, *Committee Hansard*, 28 February 2019, p. 19.

¹⁰⁴ Uber, *Submission 38*, p. 11.

potential to change the way we think about urban transportation, and radically improve urban mobility by giving people back time lost in their daily commute'.¹⁰⁵

- 2.94 Mrs Malligan noted that Uber was 'focused on developing what we call Uber as a platform, our plan for an integrated future of transport where someone can push a button and get from A to B through multiple modes':

For example, a customer journey in the Uber app could be the booking of a shared e-bike to the train station, the booking and payment of public transportation within the app, and an UberPool scheduled to pick you up at the other end. We believe integration of these public, active and shared modes of transport can offer a better journey than choosing to drive yourself.¹⁰⁶

- 2.95 Uber was focused on 'asking ourselves some of the bigger picture questions about the future of transport in Australia':

... for example, what happens if we apply innovative technology to existing transport networks? How can we extend the reach of fixed public transportation, complementing rather than cannibalising public transportation? Can tech like ours help solve the first mile, last mile problem by taking people to and from transport nodes? The short answer is that we see ourselves as part of the solution for each of these challenges, and we are also pleased to see support for transport innovations across a number of other submissions made to this inquiry.¹⁰⁷

- 2.96 Uber believed 'on-demand services can also help governments provide better access to transport in a cost-effective way'.¹⁰⁸

- 2.97 Other groups had similar visions for integrated multi-modal transport and shared mobility. Mr Jeffries (AECOM), suggested that 'in the centre of urban conurbations like Sydney's CBD ... I think we would generally all agree that we would like to create desirable, walkable environments where people can get around on foot'. He observed that 'in the more challenged environments, where we have a mixture of modes and a strong desire for movement and land use as well, often it comes down to very difficult and challenging

¹⁰⁵ Uber, *Submission 38*, p. 14.

¹⁰⁶ Mrs Natalie Malligan, Head of Cities, Australia and New Zealand, Uber, *Committee Hansard*, 28 February 2019, p. 18.

¹⁰⁷ Mrs Natalie Malligan, Head of Cities, Australia and New Zealand, Uber, *Committee Hansard*, 28 February 2019, p. 18.

¹⁰⁸ Mrs Natalie Malligan, Head of Cities, Australia and New Zealand, Uber, *Committee Hansard*, 28 February 2019, p. 19.

decisions around how you might actually prioritise certain modes on certain streets'.¹⁰⁹

- 2.98 Mr Gabriel Metcalf, Chief Executive Officer of the Committee for Sydney, suggested that:

It may be that the way to transition is to do things like take a part of a city that has low rates of transit ridership, and buses that are not very well used because they don't run very often, and put in a program where you subsidise people's trips to get to the train station and you let all comers provide that service and use the subsidy – taxis, Uber, new companies that don't exist yet, shuttles. You begin to experiment with reorienting the capillary network, if you will, toward the trunk transit lines.¹¹⁰

- 2.99 He observed that 'it may be that experimenting with reorienting those patterns is more on the path than experimenting with the technology itself'.¹¹¹

- 2.100 Dr Allison Stewart, Project Director with Infrastructure Victoria, highlighted that refining the mix of services would result in different market models to meet different demands. She noted that Infrastructure Victoria had come across 'quite a few different types of applications in our research in which people might still require private vehicles – parents with young children, for example'. She continued:

People who are visually impaired told us that they prefer to have a vehicle which they know is parked in a certain spot and where they can access it reliably. Tradespeople might need to keep their tools in vehicles. There are a lot of different scenarios in which you might need to have a privately owned vehicle, but particularly in urban areas there are a lot of reasons why you might not want to own your own vehicle.¹¹²

- 2.101 She also highlighted the 'move towards different types of vehicles and more flexibility in terms of how people, and particularly youth today, are thinking

¹⁰⁹ Mr Roger Jeffries, Technical Director, Transport Advisory; and ANZ Technical Practice Leader, Transport Advisory, AECOM, *Committee Hansard*, 28 February 2019, p. 46.

¹¹⁰ Mr Gabriel Metcalf, Chief Executive Officer, Committee for Sydney, *Committee Hansard*, 28 February 2019, p. 38.

¹¹¹ Mr Gabriel Metcalf, Chief Executive Officer, Committee for Sydney, *Committee Hansard*, 28 February 2019, p. 38.

¹¹² Dr Allison Stewart, Project Director, Infrastructure Victoria, *Committee Hansard*, 27 February 2019, p. 13.

about the purchase of vehicles’. This approach was ‘quite different to those that have been made by more traditional generations’. She concluded:

It's quite interesting to think about how these futures might evolve with automated vehicles and with zero emissions vehicles, and how all of those different revolutions are going to change the way that we think about moving more generally—we talk about mobility solutions and we talk about that whole variety of things all happening, potentially, at the same time.¹¹³

2.102 Dr Jonathan Spear (Infrastructure Victoria) emphasised that ‘different people have different preferences and needs, in terms of how they are mobile’. He observed that policy makers had ‘some choices to make about how easy we make it for people to move between different modes and to make those choices and which choices we incentivise’.¹¹⁴

2.103 The Bus Industry Confederation issued a caution about how the mix of services was managed. A major risk of inappropriate management was social exclusion if low cost public transport was replaced by higher cost on-demand options. The BIC stated:

Roll out of MaaS and AEVs can be expected to put increased pressure on the better patronized local transit services, where demand is strongest, probably replacing them with shared car/small bus-based services, particularly when these become driverless and lower cost ... This development direction reflects a blurring of the boundaries between PT as we have known it and private transport. Local transit services that have low patronage levels are at risk of losing all or most service in this context, particularly if governments rely on the market to provide most local PT-like services, expecting this to be at low cost (through MaaS with AEVs). We see this as a major risk exposure in terms of social exclusion: governments seeing MaaS/AEVs as almost the ultimate deregulation, with the market providing services to all at a very low cost. This greatly overestimates, we believe, what might be possible in terms of commercially-based service offerings in low volume markets. Risks are less if service delivery agreements are used to assure service continuity in some form, as discussed below. Fare discounts may remain for some types of passengers but there may be fewer services available locally, if patronage levels are poor, on which to take advantage of these discounts.¹¹⁵

¹¹³ Dr Allison Stewart, Project Director, Infrastructure Victoria, *Committee Hansard*, 27 February 2019, p. 13.

¹¹⁴ Dr Jonathan Spear, Executive Director and General Counsel, Infrastructure Victoria, *Committee Hansard*, 27 February 2019, p. 14.

¹¹⁵ Bus Industry Confederation, *Submission 25*, p. 13.

- 2.104 The BIC emphasised that ‘if service provision at the low patronage local end is left entirely to the private market place, then exclusion risks will increase, particularly in fringe urban/regional areas and in rural/regional settings, where demand densities are least supportive of commercially viable offerings for shared mobility’.¹¹⁶

Freight

- 2.105 In discussions with the Committee, Mr Terry Lee-Williams, Strategic Transport Advisor with Arup, highlighted the advantages to the transport network and the urban environment of automation and alternative fuels in managing the freight task. He noted that ‘one of the great benefits of new technology is that freight and logistics can be moved in time and can be made much quieter, which means you can start to exploit the existing capacity of networks far better than we currently do’.¹¹⁷ He envisioned a future where light freight delivery and people movement could take place simultaneously in shared vehicles:

Instead of having little white vans running around, you'll just have collection centres at reasonable points, probably in underused underground car parks. You'll drop in, pick up the bunch of goods that have been deposited there by the robot to put in the back of your vehicle and, as you're going to your next customer, you drop them off. That'll lower the cost of goods but also use less space.¹¹⁸

- 2.106 Heavy freight would also be revolutionised by technology:

For heavy goods, on the other hand, when you're taking pallets of food to shops and servicing the inner cities, that often rubs into the peak now. The reason for that is that they're big and noisy vehicles. I'm not a betting man, but I wouldn't mind betting that we'll get to hydrogen for heavy vehicles quicker than we'll get to battery. It's silent; there are no emissions — well, a bit of water vapour. It is feasible so long as we also take the next step and take all of those safety technologies that we're putting in vehicles right now, such as proximity sensors, automatic braking and anti-collision protection, put those in trucks and get rid of reversing beepers. Reversing beepers are another thing that'll stop deliveries occurring outside of ordinary hours because they are just so piercing and they drive people insane. You don't need them because you can't

¹¹⁶ Bus Industry Confederation, *Submission 25*, p. 14.

¹¹⁷ Mr Terry Lee-Williams, Strategic Transport Advisor, Arup, *Committee Hansard*, 27 February 2019, p. 42.

¹¹⁸ Mr Terry Lee-Williams, Strategic Transport Advisor, Arup, *Committee Hansard*, 27 February 2019, p. 44.

actually reverse over anything now. The vehicle will not allow you to do it. It's like an old technology that's clinging on pointlessly as we move forward. So you wipe that out and have silent vehicles. They're cheaper to operate. All the freight movement should be happening at night in populated areas. With heavy freight, say you've got a port on one side of town and a logistics centre on the other side of town. Why can't you run a B-double through the city at 2 am if it's quiet? Why not have 100 of them running through, all platooned and talking to the traffic signals? Rather than spending multiple billions on tunnels to separate these things, just separate by time, because you can be smarter about how you do those things, and then take the money you save on that and have really good passenger transport, please. Trying to squeeze the most out of every asset that we have is something we kind of forget. We always jump to the next big solution. This technology allows you to get so much more out of your existing networks.¹¹⁹

The transition to automation

2.107 As ANCAP noted in its submission, the transition to full automation would be gradual and would involve a period of transition where vehicles with different levels of automation would share the road.¹²⁰ DIRDC believed that operating in mixed traffic environments was inevitable and hesitated to put a timeline on achieving full automation. Mr Roland Pittar, General Manager of the Office of Future Transport Technology, DIRDC, stated:

If we look at the sensors and the processing capacity of road based vehicles, and we think of that in the context of, say, light vehicles and heavy vehicles such as buses, manufacturers are indicating to us that they feel that that sort of technology around, if I can call it conditional automation—that is not full automation in all circumstances—is probably something that will be available around the early to mid-2020s, but still requiring drivers to operate in more complex traffic environments.¹²¹

2.108 Mr Pittar continued:

A business model could well be that the driver is responsible for taking the vehicle through the more complex city environment until they get to, say, a dual carriageway, and then the vehicle can undertake more of the driving task and operate in an autopilot situation. The driver might still be required by the

¹¹⁹ Mr Terry Lee-Williams, Strategic Transport Advisor, Arup, *Committee Hansard*, 27 February 2019, pp. 44–5.

¹²⁰ ANCAP, *Submission 12*, p. 4.

¹²¹ Mr Roland Pittar, General Manager, Office of Future Transport Technology, Department of Infrastructure, Regional Development and Cities, *Committee Hansard*, 12 February 2019, p. 3.

system to take back control if there are some roadworks or if weather conditions aren't suitable, and that sort of thing. Then, at the end of the dual carriageway — the last mile, as it's often called — the driver would need to take back control to get from the dual carriageway into the next town or city at which they are dropping off or picking up passengers. That is a business model that is described to us by potential providers.¹²²

- 2.109 The development of automation could not be separated from the environment in which it was taking place, and policy responses needed to account for that. Ms Gayle Milnes, Executive Director, Portfolio Coordination and Research, DIRDC, advised that:

... there could be a range of different environments and a range of different policy options or tools that you could use — lane preferencing, for example, might be one tool — and you would have to think about that within a particular environment. The solution for Melbourne, for example, could be quite different to the solution for a regional centre like Wagga, for example. So it is likely that we are going to have to see how those different technologies play out or anticipate how those different technologies play out and think through what policy instruments you might use in the different types of environments. So it is not necessarily a one-size-fits-all thing.¹²³

- 2.110 Mr Pittar observed also that there was a need to place vehicle automation within the context of other technologies using 'a "whole-of-system" approach'.¹²⁴ Ms Milnes explained that the future of transport was not just about automation:

... it's the combination or potential combination of automation of data and connectivity, of the different types of energy technologies and the shared economy. Often they have got common drivers. A common driver is the data, but it is not limited to that. Certainly the energy implications are driven by a different technology.¹²⁵

- 2.111 Mr Ian Christensen, Managing Director of iMove Australia, observed that 'most of the technology development in that space is occurring overseas, but

¹²² Mr Roland Pittar, General Manager, Office of Future Transport Technology, Department of Infrastructure, Regional Development and Cities, *Committee Hansard*, 12 February 2019, p. 3.

¹²³ Ms Gayle Milnes, Executive Director, Portfolio Coordination and Research, Department of Infrastructure, Regional Development and Cities, *Committee Hansard*, 12 February 2019, p. 6.

¹²⁴ Mr Roland Pittar, General Manager, Office of Future Transport Technology, Department of Infrastructure, Regional Development and Cities, *Committee Hansard*, 12 February 2019, p. 6.

¹²⁵ Ms Gayle Milnes, Executive Director, Portfolio Coordination and Research, Department of Infrastructure, Regional Development and Cities, *Committee Hansard*, 12 February 2019, p. 6.

it is happening at all levels, from footpath delivery robots through to small trucks, through to drones, through to automated delivery, through to automated lockers, either in building basements or on the porch of your house or things like that'. He explained that there was so much diversity in the area of automation because 'it hasn't resolved to a dominant mode of solution yet' — 'We haven't worked out yet what the optimal configuration is, nor who is going to pay for it.' Mr Christensen noted that:

There is serious effort being made in industry to do the quantum leap, but it's difficult. In the meantime, plan B is to progressively increment the capability of vehicles as each generation of vehicles comes out, given increasing features. Both development strategies are well and truly underway.¹²⁶

- 2.112 Mr Mark Rowland, Associate, Transport and Cities Planning with Arup, highlighted one of the perils of a mixed fleet—the loss of productivity in road transport. He explained:

Some connected and autonomous vehicles that are out there now will be very conservative, so a human driver on the Monash will potentially follow another vehicle within a second. So, you imagine that brings that gap down, but what would a computer do? It would, say, 'Give them three seconds,' so then a car pulls in and then it backs off another three seconds. So, through this transition phase, you may actually end up losing capacity of your freeways when I'm talking about the mix because everybody's going to have their own risk profile. Our lanes on the Monash, for example, on a busy morning can get up to 2,400 vehicles per lane. The way to think about that is that, if every vehicle actually had a two-second gap—so, 3,600—the maximum capacity of that lane is 1,800. So, we're already driving over the 1,800. We've already got 2,400 cars an hour. So, if you add an automated vehicle in there with a three-second—and we've found this in the trials—and you back them all up, you could lose 20 to 25 per cent overnight. We've just got to be bit careful that we are going to get these amazing road safety benefits, but—this is what I mean—we're in the transition phase. We need to do trials. We need to do testing.¹²⁷

- 2.113 Mr Stephen McDonald, General Manager Strategic Initiatives with Transurban, agreed, stating that 'a mixed fleet, in its early days, could potentially also increase congestion, as the vehicles would be more cautious in their interactions with other vehicles and that sort of thing, as opposed to

¹²⁶ Mr Ian Christensen, Managing Director, iMove Australia, *Committee Hansard*, 28 February 2019, p. 14.

¹²⁷ Mr Mark Rowland, Associate, Transport and Cities Planning, Arup, *Committee Hansard*, 27 February 2019, p. 49.

how our drivers are at the moment, and I think we have to bear that in mind'. He indicated that Transurban was already looking at 'how we prepare for some of these vehicles and how we think about our management system'. He noted that Transurban's 'roadways and motorways in general are well-suited to the early adoption of some of those levels [of automation] because they're nice and controlled. There aren't a lot of pedestrians, we hope, on our roads, and it's a good way to take those up.'¹²⁸

- 2.114 Dr Allison Stewart countered that Infrastructure Victoria's research indicated that even a mixed fleet would have productivity benefits. She told the Committee that 'in one of our scenarios, where we looked at a mixed fleet of human driven vehicles that we see on our roads today and automated vehicles of the future, we did find that overall network efficiency could potentially be improved when those two types of vehicle fleets are mixed'. She indicated that:

Even a 50 per cent penetration of those automated vehicles could result in a 70 per cent improvement in network efficiency, again, depending on how closely automated vehicles can travel to each other and how connected they are and, also, how we look at network management as a whole, in terms of where people are moving on different types of modes of transport. We expect all of those things to come together in the future, in terms of determining appropriate road space allocation on our roadways, and in terms of those connections into multimodal hubs as well.¹²⁹

- 2.115 Automation would also demand adjustments in the way drivers approached the driving task. Mr Rowland used the analogy of airline pilots to describe the adjustment that was required:

There's the automation of the airline industry. How do we learn from past examples and how would that apply in the future? We've got a lot of great examples that we can apply and learn from. Think about a pilot in the seventies and how they would have flown an aircraft. It would have been very hands-on, very direct. They would have had to interpret, but now the job of a pilot has changed. They now watch a system. They're now observing a system and how it drives on the road. Our drivers are going to have to start doing that as we move from level 1 autonomy to levels 2, 3, 4 and 5. Especially level 3

¹²⁸ Mr Stephen McDonald, General Manager Strategic Initiatives, Transurban, *Committee Hansard*, 27 February 2019, p. 19.

¹²⁹ Dr Allison Stewart, Project Director, Infrastructure Victoria, *Committee Hansard*, 27 February 2019, p. 14.

autonomy is going to be really interesting in that the job of the driver is to observe the systems; it's not to participate in the driving action.¹³⁰

- 2.116 His colleague, Mr Lee-Williams, cautioned that while the process of transition might be gradual—it might also be faster than we think:

We're still in the realm of fantasy, mostly, with people trying to prove their technologies. But remember how quickly we move with technology. An electric vehicle even three years ago was something that was for, really, high-end people with a lot of money wanting to wear a green credential. It wasn't a practical choice at all. Next year there will be practical choices available in the Australian market at price points that middle-income Australian families could easily afford. Five years from now, it'll be pretty hard to buy any mid-price vehicle that won't be electric, and internal combustion engines will be in the very low-price vehicles. So you're seeing, in a decade, a total shift in motor capacity.¹³¹

Committee conclusions

- 2.117 The automation of transport—including mass transit—will have revolutionary implications for the way people move about. It has the potential to significantly improve mobility, especially for isolated and vulnerable people; improve accessibility to employment and services; significantly improve transport safety; and make transport networks more efficient and cost effective.
- 2.118 However, realising the potential benefits from transport automation will depend on the planning framework and policies that are put in place, and the vision underpinning those plans and policies. In that sense, the Committee is conscious that the recommendations of its report on the development of cities, *Building Up & Moving Out*, especially those relating to integrated and holistic planning, are relevant to the automation of transport. Transport automation should take place within a wider planning framework which integrates automated transport with the planning of the urban and regional environment to maximise liveability, sustainability and productivity, while acknowledging the different needs of greenfield and brownfield sites.

¹³⁰ Mr Mark Rowland, Associate, Transport and Cities Planning, Arup, *Committee Hansard*, 27 February 2019, p. 43.

¹³¹ Mr Terry Lee-Williams, Strategic Transport Advisor, Arup, *Committee Hansard*, 27 February 2019, p. 44.

Recommendation 1

- 2.119 The Committee recommends that the Australian Government develop its strategies and plans to address the development of transport automation and alternative fuel sources through the strategic framework set out in the Committee's report on the development of cities, *Building Up & Moving Out*, especially those relating to integrated and holistic planning, with a view to ensuring that transport automation takes place within a wider planning framework which integrates automated transport with the planning of the urban and regional environment to maximise liveability, sustainability and productivity, while acknowledging the different needs of greenfield and brownfield sites.**
- 2.120 Transport automation, especially when combined with alternative fuel sources, will have significant implications for transport infrastructure. Automated vehicles will require a suitable environment in which to operate—one that they can read and communicate with. They will make demands on communications, the internet, physical infrastructure and energy networks. Meeting these demands will require careful planning and significant investment.
- 2.121 Optimising automation will also demand a multi-modal response—creating a seamless transport network across a variety of transport modes, connected by information exchanges (such as mobile apps) and seamless ticketing. Mobility as a Service will combine access to a variety of transport modes within a single journey, including mass transit, shuttles and active transport. To achieve this, we must rethink how public transport is organised and contracted. The concept of a systems approach, in which operators provide services across areas rather than modes, with shared mobility contracts and app based booking, could transform urban transport. However, this will require coordination with private transport and rideshare operators and a commitment to social inclusion.
- 2.122 Within this context, mass transit has an important role to play providing high-volume trunk routes as the core of the transport network. There are significant opportunities for the use of automation in the provision of rail, light rail and buses services. The automation of rail is already well advanced and the development of autonomous trains should be continued. The automation of buses is well advanced as a technology, but its development as an operating system in a real-world environment is still in its infancy. The possibility of using automated buses in dedicated busways should be explored as a key first step to wider automation. The Committee notes that

governments are already involved in the trial of shuttle buses to improve mobility and first and last mile transport situations, and supports this work being advanced.

- 2.123 Achieving the benefits of automation will require explicitly targeted policy responses. If the ideal is compact and accessible urban environments and well connected regional areas, then policies around transport automation need to explicitly support these outcomes. The goal should be the creation of a new transport ecosystem. Consideration should be given to policies which promote the development of this ecosystem, including restrictions on private automated transport and ridesharing, and the encouragement of shared mobility based on strong trunk routes provided by rail, light rail and buses, connected to smaller vehicles providing connectivity within cities and suburbs. There also needs to be a deliberate effort to incorporate active transport into the network. Achieving coordination between different organisations and modes is essential.

Recommendation 2

- 2.124 The Committee recommends that the Australian Government adopt as its goal support for the development of a new automated transport ecosystem, incorporating shared mobility based on: strong trunk routes provided by rail, light rail and buses, connected to smaller vehicles providing connectivity within cities and suburbs; active transport solutions; and strategies to manage the use of private automated transport and ridesharing in city centres and heavily congested areas and routes.**

- 2.125 Further recommendations regarding these issues are presented in Chapter 4.
- 2.126 While this has not been a central theme of the inquiry, the Committee is also aware of the potential for automation and electrification to substantially improve the management and handling of freight—light freight becoming integrated with shared mobility passenger movement and heavy freight transport becoming quieter and more efficient thanks to electric motors and platooning of vehicles. Alongside passenger transport, the benefits of automation and electrification of freight transport should be considered by governments.

Recommendation 3

- 2.127 The Committee recommends that the Office of Future Transport Technology within the Department of Infrastructure, Regional**

Development and Cities undertake consideration of the benefits of automation and electrification for the transport of freight.

- 2.128 The art of transition will be a key factor in the success of automation. The transition to automation will involve mixed fleets of vehicles of varying degrees of automation travelling together. Managing this transition will require regular assessment and adjustment of the regulatory environment surrounding road transport, vehicle specifications (e.g. safety distances between vehicles) and driver behaviour. Public understanding of the changing road environment is essential to a safe and successful transition to automation.

Recommendation 4

- 2.129 The Committee recommends that the Australian Government, in conjunction with State and Territory Governments, develop a strategy for managing the transition to full automation on roads, including mapping regulatory responses, vehicle specifications and driver training requirements.

3. New energy sources

- 3.1 Hydrogen Mobility Australia (HMA), the peak body for hydrogen powered transport, noted that ‘while the central focus of this Inquiry is automated mass transit, HMA commends the Committee for incorporating consideration of alternative fuels within its terms of reference’. HMA did this because ‘automation and connectivity as well as electric drivetrains represent the most significant trends facing the automotive sector and are inextricably linked in that they are complementary technologies which can work together to minimise the environmental footprint of transport through reduced congestion and vehicle emissions’. HMA believed that ‘the full benefits of automation can only be realised with a zero-emission drivetrain’, and that therefore ‘both technologies be considered in parallel’.¹
- 3.2 This chapter will examine the benefits of electrification (battery electric vehicles and hydrogen fuel cell electric vehicles) of the vehicle fleet and the convergence between electrification and automation, before looking at the infrastructure requirements of electric vehicles, including standardised charging stations, and their interaction with the energy sector. It will then focus on hydrogen as a source of energy for the vehicle fleet and the particular infrastructure requirements of the hydrogen sector. Finally it will consider the benefits of the revolutionary Hyperloop transport technology.

Electric vehicles

- 3.3 Electric powered vehicles are set to become the principal mode of powered transport in the foreseeable future. Looking forward, toll road operator Transurban stated:

¹ Hydrogen Mobility Australia, *Submission 24*, p. 1.

While uptake of electric vehicles in Australia has lagged behind global leaders such as China, Norway and Japan, there is growing momentum in the local market as consumers and governments recognise the benefits of electric vehicles and their inevitable role in future transport. Electric vehicle sales increased by 67 per cent from 2016 to 2017 and now make up 0.2 per cent of the Australian market.

Looking ahead, total electric vehicles on the road are forecast to reach over 2.56 million or 13.2 per cent of total new Australian vehicle sales by 2036, moving to 13.63 million or 61.5 per cent of all new vehicle sales by 2050.²

3.4 In a similar vein, NRMA stated:

The rise of future mobility will progressively displace traditional engine and drivetrain technologies. Many current internal combustion car models will soon be substituted with an electric or hybrid equivalent – or withdrawn from market altogether. With Australian vehicle manufacturing now ceased, we are beholden to the choice of models manufactured in international markets, and it is clear that many of these will be electric.³

3.5 NRMA took the view that Australia was ‘at a significant juncture relating to the future of mobility’, and strongly believed ‘that encouraging the electrification and automation of transport, in particular the vehicle fleet, will create profound positive change’. Alternatively, ‘failure to readily embrace transformative technologies will risk Australia falling behind the rest of the world when it comes to choice and the adoption of autonomous safety devices and features’.⁴

3.6 NRMA also highlighted the link between electric vehicles and automation:

Electric vehicle drivetrains are currently being combined with connected and automated features by a range of manufacturers, including General Motors, Volvo, Volkswagen, Ford, Tesla and Waymo (Google). Autonomous technology has already started to appear in existing vehicles to assist drivers, and higher levels of vehicle autonomy are on track to arrive over the coming months and years.⁵

3.7 NRMA is directly involved in the introduction of this technology, ‘through a number of projects, including NSW’s first automated vehicle trial and the

² Transurban, *Submission 17*, ‘Inquiry into Transport Technology’, p. 5.

³ NRMA, *Submission 27*, p. 1.

⁴ NRMA, *Submission 27*, p. 1.

⁵ NRMA, *Submission 27*, p. 2.

roll-out of Australia's largest electric vehicle fast charger network'.⁶ NRMA noted that 'the benefits of progressively transitioning to electric and automated transport include lower costs, strengthened national fuel security, enhanced environmental conditions, and improved light vehicle and mobility choice for the consumer'.⁷

- 3.8 Transurban highlighted the environmental benefits of electric vehicles, including zero emissions and noise reduction.⁸ NRMA regarded 'the uptake of electric road vehicles, in particular, is likely to provide the greatest opportunity for Australia to reduce transport pollution while ensuring the lowest possible cost to consumers'. It also observed that 'in addition to fuel savings, battery electric vehicles are considerably cheaper to maintain due to possessing far fewer moving parts';⁹ and that 'transitioning transport to electric propulsion will help to curtail Australia's ever-increasing reliance on imported, oil-derived products'.¹⁰ Moreover, the purchase price of electric vehicles was steadily coming down, and was expected to achieve price parity with 'petrol/diesel equivalents from 2024'. NRMA stated:

This forecast reduction will primarily be attributable to the rapidly falling cost of vehicle batteries, which currently account for a highly significant portion of overall cost. Since 2010, the cost of vehicle batteries has decreased by around 80 per cent, and prices are forecast to continue to fall significantly. In parallel to these cost reductions, battery capacity is projected to double, vastly extending vehicle driving range and efficiency as a consequence.¹¹

- 3.9 Engineers Australia observed that the 'main barriers to greater adoption of EVs [electric vehicles] in Australia are a lack of understanding of the range required of vehicles, and price anxieties':

Most EVs marketed in Australia have a range between 100km and 500km. A Victorian travel survey of over 700,000 car trips taken in one year, found that almost half of the surveyed trips were less than 5km, more than 90% were less

⁶ NRMA, *Submission 27*, p. 2.

⁷ NRMA, *Submission 27*, p. 1.

⁸ Transurban, *Submission 17*, 'Inquiry into Transport Technology', p. 5.

⁹ NRMA, *Submission 27*, p. 2.

¹⁰ NRMA, *Submission 27*, p. 3.

¹¹ NRMA, *Submission 27*, p. 3.

than 30km and less than 1% were greater than 120km. The survey highlighted that most EVs have sufficient range to cover a majority of urban car trips.¹²

Charging infrastructure

- 3.10 The need for the development of charging infrastructure was also highlighted. Engineers Australia noted:

In June 2017, there were 476 dedicated electric vehicle public charging stations in Australia. As the volume of electric cars increases in Australia, this number will be insufficient.

The Queensland Government in collaboration with local councils created the world's longest electric super highway in a single state and indeed, the rest of Australia is well supported. The Australian Electric Vehicle Association recently published *Around Australia Electric Highway – now complete!* which provides a digital snapshot of electric charger and service stations around Australia.

For the majority of the time, cars are parked. Providing greater access to charging infrastructure in carparks and existing service stations will assist in alleviating range anxieties.¹³

- 3.11 The NRMA was funding the development of charging infrastructure, committing \$10 million to the construction of 'Australia's largest electric vehicle fast charger network, suitable for a range of electric vehicles and free for NRMA Members'. NRMA stated:

This foundational investment was designed to address one of the key barriers to the adoption of electric vehicles in Australia – access to charging infrastructure away from the home.

Through locating this charging infrastructure to support current vehicle range capabilities on key road corridors between Sydney, Western NSW, Canberra, Melbourne, Brisbane and other destinations, the NRMA will unlock the east coast of Australia, providing millions of people across the country with access to an alternative form of mobility.¹⁴

Battery Electric Buses

¹² Engineers Australia, *Submission 37*, p. 7.

¹³ Engineers Australia, *Submission 37*, p. 6.

¹⁴ NRMA, *Submission 27*, p. 5.

3.12 While electric vehicles generally are widely regarded as the way of the future, Monash University highlighted the limitations of current battery electric technology in buses. Monash observed that

In general current battery electric bus technology is not practical for day to day mass transit operations because:

- Battery recharge times are too long
- The range of distance provided by battery electric power are too short for typical day operations of buses.¹⁵

3.13 Monash noted 'that common deployment of even the most advanced current electric bus designs would roughly double the bus fleet requirements in cities to provide the same service levels, largely because two buses are required to replace a current diesel bus'.¹⁶ Monash instead highlighted the need to 'focus on new designs with integrated purpose-made chassis and fast-charging lightweight battery packs'.¹⁷ Monash highlighted research that found that:

- Current Conventional Electric Bus [CEB] designs are impractical in cost-effectiveness terms compared to diesel buses; fleet size increases of 38-82% are found; these are not economically sustainable.
- An Advanced Electric Bus (AEB) design using a bespoke chassis represent a significantly better fleet resource impact but still incur fleet size increases of around 10% compared to diesel.
- Overall all Electric Bus (EB) designs improve ride/noise quality with benefits valued at 26c/passenger trip. Most EB options tested increase ridership; by 1.9% for CEB from ride/noise quality improvements over diesel buses. Most AEB options also have a net ridership increase but this is a net effect balancing ridership decline through in-route recharge delay balanced by ridership growth from ride/noise quality benefits.
- Air conditioning operation significantly increases energy requirements, reducing operating range and requiring greater en-route recharging.¹⁸

Electric vehicles and the electricity network

¹⁵ Monash University, *Submission 10*, p. 6.

¹⁶ Monash University, *Submission 10*, p. 6.

¹⁷ Monash University, *Submission 10*, p. 10.

¹⁸ Monash University, *Submission 10*, p. 9.

- 3.14 There were significant implications in the electrification of the vehicle fleet as well as benefits. As part of its research into the impacts of automation and zero emissions vehicles, Infrastructure Victoria commissioned modelling into ‘the impacts to the Victorian electricity system resulting from the co-emergence of zero emissions vehicles (either battery electric vehicles and hydrogen fuel cell vehicles) and automated vehicles’:

The results showed that if zero emissions vehicles replace conventional vehicles, there will be substantial impacts for both Victorian generation capacity and transmission and distribution networks. If all vehicles were battery electric, electricity consumption would roughly double and generation upgrades could cost at least \$2.2 billion. If all vehicles were fuelled by zero emissions hydrogen, electricity consumption would increase by almost 150%. However, it is important to note that this was based on a scenario with 100% hydrogen vehicle take-up, which is unlikely. If hydrogen were used in certain specific applications, such as to fuel heavy vehicles and buses, the impact would be far lower. Buses and other heavy vehicles could lend themselves to a potential model of industrial-scale hydrogen generation and use, as current battery technologies are generally considered too heavy to be a commercially viable solution for some payload-sensitive uses.¹⁹

- 3.15 Infrastructure Victoria found that ‘the actual demand for electricity generation and distribution will depend upon a wide range of factors, including potential incentives to charge outside of peak times and the composition of the vehicle fleet’:

For example, under our ‘Fleet Street’ scenario where all vehicles are electric, on-demand and automated, charging would be likely to occur outside of peak travel (and energy) time periods. However, fleet charging could have a significant localised impact on the electricity distribution network if large numbers of vehicles charge at fleet depots. In contrast, under the ‘Private Drive’ scenario, where all vehicles are electric, privately-owned and automated, peak energy demand could be worsened if all drivers plug in to charge when they get home from work, unless there are centralised controls, or incentives or other mechanisms to encourage off-peak charging.²⁰

- 3.16 Infrastructure Victoria noted that ‘while the significant increases in electricity use shown through our modelling were largely caused by zero emissions rather than automated vehicle uptake, it has direct implications for automated vehicle planning’. This was because of the convergence in

¹⁹ Infrastructure Victoria, *Submission 16*, pp. 3–4.

²⁰ Infrastructure Victoria, *Submission 16*, pp. 3–4.

automated and electric vehicle technologies meaning that it was ‘highly likely that the driverless vehicles of tomorrow will be zero emissions’. Infrastructure Victoria stressed that ‘if these significant increases in electricity consumption eventuate, energy and transport policy and planning will need to be coordinated more than ever before’. It noted that ‘to plan appropriately, energy departments will need clear visibility of transport technology developments and future plans for the transport network’. Likewise, ‘transport will need to work closely with energy to understand how our energy supply could impact an electric or hydrogen vehicle fleet’.²¹ According to Dr Jonathan Spear, ‘there is very much a need to integrate planning of transport and energy policy investments’.²²

- 3.17 NRMA also observed that ‘transitioning the vehicle fleet to electric propulsion will undoubtedly be reliant on the capacity of the electricity grid to support consumer usage patterns’. It noted however, that:

If properly managed, electric road vehicles can support the resilience and reliability of the National Energy Market (NEM) and help to better manage household electricity costs. Electric vehicles by their very nature are batteries on wheels, and could potentially provide power to the electricity grid during periods of peak demand. Charging would mostly occur overnight in the home during off-peak periods.

According to the Australian Energy Market Operator, electricity consumption by electric vehicles is estimated to be less than four per cent of total electricity demand by 2036. With consumption forecasts remaining relatively flat for the next 20 years, future demand is small compared to the impact of other changes expected to take place, such as investment in renewable energy technologies, the restructuring of the Australian economy, and the energy efficiency improvements of major appliances.²³

- 3.18 Engineers Australia also highlighted the implications of electric vehicles for electricity generation and emissions reductions, stating:

Recent research conducted for the City of Melbourne demonstrated that due to the carbon intensity of electricity production in certain Australian states, operating an electric vehicle in Australia can sometimes be dirtier than many of the most popular petrol cars.

²¹ Infrastructure Victoria, *Submission 16*, p. 4.

²² Dr Jonathan Spear, Executive Director and General Counsel, Infrastructure Victoria, *Committee Hansard*, 27 February 2019, p. 9.

²³ NRMA, *Submission 27*, p. 4.

In order to fully realise the benefits associated with the electrification of our transport networks, focus upon emissions reductions for the entire electricity network must occur concurrently.²⁴

Hydrogen power

- 3.19 The potential for hydrogen power to play a significant role in the future of Australian land transport was set out by Hydrogen Mobility Australia. It was confident that Hydrogen Fuel Cell Electric Vehicles (FCEV) would play an important role in the development of the mass transit sector. HMA highlighted the Chief Scientist's *Hydrogen for Australia's Future* report to the COAG Energy Council, which 'recommends as a critical first step the development of an overarching national hydrogen strategy, which will define the role for government and industry in':
- International agreements and regulations, including shipping, to position Australia as the world's leading hydrogen exporter
 - Standards to ensure safety in all aspects of the hydrogen sector
 - Regulations to enable the addition of hydrogen to existing domestic gas supplies
 - Refuelling infrastructure and regulations for hydrogen vehicles.
- 3.20 HMA noted that a national hydrogen strategy would be considered by the Council of Australian Governments' (COAG) Energy Council in December 2018.²⁵ At this meeting, the COAG Energy Council formed a Hydrogen Working Group to formulate a National Hydrogen Strategy by the end of 2019. Chaired by the Chief Scientist, the Working Group will have six work streams: hydrogen exports; hydrogen for transport; hydrogen in the gas network; hydrogen for industrial users; hydrogen to support electricity systems; and cross-cutting issues.²⁶
- 3.21 Engineers Australia also encouraged 'the government to recognise the value of fostering our hydrogen energy power', in conjunction 'with the incentives and deployment of infrastructure policies required for the electrification of our transport networks'.²⁷ Engineers Australia highlighted the work the

²⁴ Engineers Australia, *Submission 37*, p. 7.

²⁵ Hydrogen Mobility Australia, *Submission 24*, p. 6.

²⁶ <<http://www.coagenergycouncil.gov.au/publications/establishment-hydrogen-working-group-coag-energy-council>> viewed 21 March 2019.

²⁷ Engineers Australia, *Submission 37*, p. 8.

Chief Scientist in identifying the ‘broad social and economic benefits of hydrogen production for Australia’, including three main drivers:

- 1 Energy export. Nations like Japan and South Korea that import most of their energy in the form of coal, oil and natural gas need cleaner energy to meet their CO₂ emissions reduction targets. Clean hydrogen is ideal. Japan has already declared it will be a large-scale hydrogen user. As yet, there are no large-scale exporters. This is a significant opportunity for Australia, given our ample renewable energy and convertible fossil-fuel reserves.
- 2 Domestic economy. Hydrogen can heat our buildings, power our vehicles and supply our industrial processes. These applications represent opportunities to expand manufacturing and generate spill over innovation and jobs while lowering our CO₂ emissions.
- 3 Energy system resilience. Hydrogen production from electricity and water is a flexible load that can respond rapidly to variations in electricity production and can contribute to frequency control in the electricity grid.²⁸

3.22 Engineers Australia noted that ‘with an increased demand for zero emissions transport options, hydrogen fuel cells can provide a reasonably priced, rapid refuel and long range alternative’, and that ‘as hydrogen has the capacity to store energy and flexible load, grid resilience is increased’. EA noted, however, that ‘despite the benefits outlined above, hydrogen is still expensive to produce and unless it is produced using renewable sources, cannot be considered renewable’.²⁹

Hydrogen fuel cell technology

3.23 An important alternative to battery electric vehicles (BEV) is hydrogen fuel cell electric vehicles. Battery electric vehicles draw their electricity from external sources and store it in an on-board battery. Hydrogen fuel cells produce electricity on board, on demand, using hydrogen as fuel. Hydrogen Mobility Australia stated that both technologies ‘are zero emissions technologies, and are equally expected to play significant roles in the decarbonisation of the transport sector’.³⁰ Nonetheless, HMA identified specific benefits related to FCEV technology, including:

²⁸ Engineers Australia, *Submission 37*, pp. 7–8.

²⁹ Engineers Australia, *Submission 37*, p. 8.

³⁰ Hydrogen Mobility Australia, *Submission 24*, p. 1.

- Long travel range – Similar range delivered to an internal combustion engine (ICE) and a greater range than a BEV (i.e. up to 800km for a FCEV which is two to three times the range of a BEV)
- Fast refuelling time – Similar refuelling process and time to a petrol or diesel vehicle (i.e. 3-5 minutes for a passenger car)
- Smooth and quiet operation – Electric drivetrains make significantly less noise than ICE
- Heavy payload capability – Hydrogen storage and fuel cell technology is easily scalable meaning its suitable for heavier vehicles and loads
- Reduced maintenance costs – Due to the smaller number of moving parts versus ICE
- Zero harmful emissions while driving – No damaging pollutants or carbon dioxide is emitted by the vehicle when in use.³¹

3.24 HMA observed that due to the special characteristics of FCEVs, ‘particularly range, refuelling time and payload capability, hydrogen is being recognised as having the potential to play a significant role in heavier and long-range transport segments’. HMA cited figures from the Hydrogen Council (the global industry advocate for the hydrogen sector) indicating ‘that 5 million trucks (~30%), and more than 15 million buses (~25%) will be running on hydrogen in the year 2050’. The Hydrogen Council also forecast ‘that 20 per cent of today’s diesel trains will be replaced with hydrogen-powered trains’ by 2050.³² HMA noted the Chief Scientist’s *Hydrogen for Australia’s Future*, which forecast ‘future domestic demand for hydrogen powered long-haul heavy transport such as buses, trucks, trains and ships due to the above characteristics’. The report found that ‘the greater range and quicker refuelling times of FCEVs will translate to higher vehicle availability and productivity compared to BEVs’:

It is expected these advantages will make FCEVs of more value to fleet operators through lower idle time for refuelling and higher utilisation of vehicles therefore reducing the number of vehicles required in the total fleet. This could be significant in the longer-term where car ownership declines and individuals and businesses subscribe to mobility services provided by fleets. Further, autonomous vehicle fleets can be programmed to return to a single refuelling base, reducing the need for refuelling infrastructure.³³

³¹ Hydrogen Mobility Australia, *Submission 24*, pp. 1–2.

³² Hydrogen Mobility Australia, *Submission 24*, p. 2.

³³ Hydrogen Mobility Australia, *Submission 24*, p. 2.

- 3.25 HMA also observed that ‘the integration of hydrogen fuel cell vehicles into Australian mass transit also presents opportunities for local manufacturing of both vehicles and supportive infrastructure’:

This potential is being seen through examples such as the recently announced SEA Electric EV factory in the Latrobe Valley. The facility is expected to create 500 jobs and assemble 2,400 vehicles a year – specialising in the production of electric delivery vans and minibuses.³⁴

Hydrogen and mass transit

- 3.26 HMA highlighted the benefits of hydrogen fuel cell technology in buses. It noted that hydrogen fuel cell buses represent a direct one for one replacement with diesel and compressed natural gas (CNG) buses. Other benefits included:

- Operating performance and refuelling time comparable to diesel and CNG buses
- Climbing and cold weather performance similar to diesel and CNG buses
- No additional curb weight to maximise passenger capacity
- Long-range up to 450 kilometres between refuelling
- Route flexibility (depot refuelling means there is no need for en-route charging infrastructure)
- Reduced maintenance and repair costs due to fewer moving parts versus their ICE counterparts
- Significant opportunities for emissions reductions.³⁵

- 3.27 HMA observed that ‘fuel cell buses have been proven in real-world conditions and are a fully commercialised technology’:

Hydrogen-powered buses are one of the most mature fuel cell technologies with bus fleets currently operating throughout the European Union, Asia and the United States supporting city emission reduction objectives (CO₂ and NO_x) and Paris accord commitments.

European Union fleets alone have travelled almost 10 million kilometres and refuelled with more than 1.1 million kilograms of hydrogen since introduction. In London for instance, eight fuel cell buses have been operating on the RV1 –

³⁴ Hydrogen Mobility Australia, *Submission 24*, pp. 2–3.

³⁵ Hydrogen Mobility Australia, *Submission 24*, pp. 3–4.

Covent Garden to Tower Gateway station line since 2010 travelling over one million kilometres to date with a reliability of 98 per cent.³⁶

- 3.28 Hydrogen fuel cell technology is also suitable for trains. Hydrogen fuel cell powered trains ‘represent a direct replacement for diesel rolling stock’, and also ‘require significantly less infrastructure investment than electric trains where the electrification of existing train lines is needed to enable their introduction’. HMA suggested that:

Similar to buses, hydrogen trains represent a standout technology for the introduction of clean mobility in public transit, with no sacrifice to operability or performance while delivering an enhanced customer experience through improved air quality and noise reduction.³⁷

- 3.29 HMA noted that ‘the first hydrogen fuel cell trains, manufactured by French company Alstom, went into commercial service in September 2018 in Lower Saxony, Germany’; and that other countries were actively investigating hydrogen powered trains.³⁸

Hydrogen infrastructure

- 3.30 Hydrogen fuel cell technology requires supporting infrastructure, particularly refuelling stations. HMA noted that:

Hydrogen refuelling stations can be integrated onto the forecourt of petrol stations adjacent to other fuel bowsers or alternatively can be installed at the premises of fleet operators for the purposes of back to base refuelling. The hydrogen itself can either be generated on site through electrolysis or delivered via tube trailer or gas pipelines. Refuelling equipment is consistent across transport modes, for instance a single refuelling station can supply hydrogen to a car, a truck or a bus from any vehicle manufacturer.³⁹

- 3.31 At this stage, access to hydrogen refuelling is limited, but ‘both Hyundai and Toyota also have their own private hydrogen refuelling stations to service their vehicles in Australia in Sydney and Melbourne respectively’; and ‘projects are currently in progress in the ACT, New South Wales and Victoria’. The cost of refuelling stations was expected to come down as the technology becomes more widespread. HMA noted that ‘the consistent

³⁶ Hydrogen Mobility Australia, *Submission 24*, pp. 3–4.

³⁷ Hydrogen Mobility Australia, *Submission 24*, p. 4.

³⁸ Hydrogen Mobility Australia, *Submission 24*, p. 4.

³⁹ Hydrogen Mobility Australia, *Submission 24*, p. 4.

routes of mass transit vehicles make them suitable for back to base refuelling with infrastructure investment thereby minimised through the utilisation of a single refuelling site'.⁴⁰

- 3.32 In its submission, CSIRO dealt at length with the development of hydrogen fuel infrastructure in Australia, both for domestic use and as potential major export. CSIRO stated:

Deployment of hydrogen technology systems and infrastructure is gaining considerable momentum globally. As part of many global initiatives for emissions reduction from the energy sector, North Asia and Europe in particular are aggressively investigating adoption of hydrogen-based transportation and energy systems. If produced and transported at scale, hydrogen could be integrated into the future energy value chain to support power generation, transport, food and agriculture, water, resources, heavy industry and more.⁴¹

- 3.33 CSIRO observed that 'to develop an impactful hydrogen export industry, supply chains must be developed to produce hydrogen from a range of processes including':

- decarbonised fossil fuel sources (coal gasification or natural gas reforming with CCS [Carbon Capture and Storage])
- biomass and waste conversion
- water electrolysis driven by renewable electricity from solar PV, solar thermal, wind and hydro
- thermal water decomposition processes using technologies such as catalytic solar thermal technologies.⁴²

- 3.34 CSIRO indicated that research and development activities are being currently undertaken by CSIRO and its partners to increase the efficiency of hydrogen production, storage, transport and utilisation, including:

- 1 Developing new materials and technologies for reducing the cost of hydrogen (or carrier) production from renewables and low emissions fossil fuel pathways;
- 2 Identifying and applying novel, hybrid pathways (biological, chemical, physical) allowing integration of production processes with intermittent, distributed renewables;

⁴⁰ Hydrogen Mobility Australia, *Submission 24*, pp. 4–5.

⁴¹ CSIRO, *Submission 42*, p. 5.

⁴² CSIRO, *Submission 42*, p. 5.

- 3 Creating technologies to effectively extract hydrogen from relevant carriers at the point of use;
- 4 Generating the scientific knowledge required to support direct use of ammonia (and other hydrogen carriers) in engines, gas turbines, and fuel cells;
- 5 Understanding environmental, social, and practical implications of new renewable energy systems. For example, using new atmospheric and environmental chemistry and physics to support identification and management of potential impacts associated with increased uptake of new chemicals and fuels.⁴³

Hydrogen production

3.35 CSIRO noted that ‘global hydrogen production is currently 55 million tonnes per year ... and it is mostly used to refine oil, produce ammonia and methanol, and for metallurgical applications and food production’. It observed that ‘only around a million tonnes is used for energy applications’ and that most of the hydrogen produced comes ‘from natural gas (NG), oil and coal’. Around 50% was produced by natural gas steam reforming. Hydrogen produced from fossil fuels was carbon intensive, requiring ‘carbon capture and storage (CCS) to achieve zero CO₂ emissions’. Hydrogen produced by electrolysis (splitting of water into hydrogen and oxygen) would require renewable sources of electricity to avoid direct CO₂ emissions.⁴⁴ CSIRO noted that:

Hydrogen production is currently dominated by fossil fuel energy based routes, but will shift towards more renewable routes as renewable electricity is harnessed to drive electrolysis processes and other renewable energy sources, such as biomass and waste streams are processed to produce hydrogen.⁴⁵

- 3.36 At this point in time, however, hydrogen production from fossil fuels is cheaper than hydrogen produced by electrolysis. In addition, hydrogen for automotive fuel faces additional costs for fuel compression.⁴⁶
- 3.37 CSIRO noted that there are already a number of large scale CCS projects globally and that the ‘technology around pipelines and transport is well

⁴³ CSIRO, *Submission 42*, pp. 5–6.

⁴⁴ CSIRO, *Submission 42*, p. 8.

⁴⁵ CSIRO, *Submission 42*, pp. 6–7.

⁴⁶ CSIRO, *Submission 42*, p. 8.

understood, as is CO₂ injection'.⁴⁷ Estimates of the potential cost of CCS varied widely:

The most recent estimates come from the Australian Power Generation Technology Report (CO₂CRC, 2015), which states "the cost for CO₂ transport, injection and monitoring is likely to vary between \$5/t and \$14/t injected for cases involving short transport distances to storage formations with good characteristics". This increases to be "almost \$70/t injected for cases involving the transport of small volumes of CO₂ over long distances to storage formations with poorer characteristics". These estimates will vary according to the specifics of each project. The estimates exclude the cost of capture and compression, but include the cost of monitoring and verification.⁴⁸

- 3.38 CSIRO stated that 'CarbonNet are examining a number of injection sites. The costs for each site have been estimated as between \$6 and \$24/t CO₂ injected (CO₂CRC, 2015)'.⁴⁹

Transporting hydrogen

- 3.39 CSIRO noted that the 'transport of hydrogen to distant markets represents a major challenge'.⁵⁰ It stated that 'liquefied hydrogen, ammonia and methyl cyclohexane (MCH) are examples of compounds that are being considered as suitable carriers of hydrogen for transport of hydrogen over long distances (by road or intercontinental transport)'.⁵¹ Liquid hydrogen requires extremely low temperatures (-253°C at ambient pressure). 'This incurs a significant energy penalty, and places great demands on materials.'⁵² Ammonia is carbon free, '17% hydrogen by weight, and in liquid form, contains 120 kg/m³ by volume of hydrogen'. Ammonia production and distribution is already in place. Ammonia's drawback is 'the relative paucity of technologies which enable it to be used directly as a fuel, or converted back to hydrogen for proton exchange membrane (PEM) fuel cells such as those used in commercial fuel cell electric vehicles'. CSIRO observed that while there 'are advanced programs developing direct-ammonia fuel cells for high-efficiency stationary power generation and large scale internal

⁴⁷ CSIRO, *Submission 42*, p. 10.

⁴⁸ CSIRO, *Submission 42*, p. 10.

⁴⁹ CSIRO, *Submission 42*, p. 10.

⁵⁰ CSIRO, *Submission 42*, p. 7.

⁵¹ CSIRO, *Submission 42*, p. 9.

⁵² CSIRO, *Submission 42*, p. 7.

combustion engine technologies capable of being fuelled directly with ammonia', it was 'necessary to extract high-purity hydrogen from ammonia close to the point of use' in order to provide for the fuel requirements of the hydrogen fuel cell vehicle fleet.⁵³ CSIRO noted that:

CSIRO's membrane technology potentially has a key enabling role in this value chain as it can be used to purify hydrogen from ammonia (and potentially other hydrocarbon-derived feedstocks) to meet the stringent purity requirements of proton exchange membrane (PEM) fuel cells which are used in hydrogen fuel cell vehicles.⁵⁴

3.40 CSIRO concluded by stating:

Deployment of hydrogen systems and infrastructure is gaining considerable momentum globally. CSIRO and other research and industry groups are exploring and developing new technologies across the hydrogen value chain to support rapid expansion of the opportunity for the development of internationally traded renewable energy through hydrogen energy systems.⁵⁵

Hyperloop

- 3.41 Another transport solution proposed to the Committee was the Hyperloop. It is 'a tube-based inter and intra-city transportation system for passengers and goods'. It uses 'proprietary passive magnetic levitation and a linear motor combined with a tube environment in which air pressure has been drastically reduced to allow the capsules to move at high speed with nearly zero friction'. It is 'powered by a combination of alternative energy sources to ensure sustainability and low cost'.⁵⁶ As described by Mr Bibop Gresta, Chairman and Co-Founder of Hyperloop Transportation Technologies, 'the Hyperloop is a simple concept with a very complex set of technologies to guarantee safety and reliability'.⁵⁷

⁵³ CSIRO, *Submission 42*, p. 7.

⁵⁴ CSIRO, *Submission 42*, pp. 7–8.

⁵⁵ CSIRO, *Submission 42*, p. 11.

⁵⁶ Hyperloop Transportation Technologies, *Submission 44*, p. 6.

⁵⁷ Mr Bibop Gresta, Chairman/Co-Founder, Hyperloop Transportation Technologies Inc., *Committee Hansard*, 28 February 2019, p. 1.

- 3.42 Hyperloop Transportation Technologies believed that the Hyperloop system would be ideal for connecting Australia's eastern cities and major regional centres.⁵⁸ It was equally useful in the movement of passengers and cargo.⁵⁹
- 3.43 As envisaged, the Hyperloop has significant advantages over competing transport modes. It has 'a projected maximum speed of about 1,223 km/h', and even at half this speed 'would be far faster than any ground transportation now in existence and would be faster than air travel over target routes with far less delay'. It could 'carry more goods and people than other forms of transportation. Hyperloop capsules 'with 38 passengers, a 40-second maximum potential departure rate from the station, within a 2 tube system would yield 164,160 persons a day and nearly 60 million people a year at full capacity for one route'. The Hyperloop would have lower capital and operating costs, smaller land requirements and less environmental impacts than other transport modes.⁶⁰ It also offered a more positive passenger experience:

By offering on-demand trips with limited time between departures, HyperloopTT resolves many of the ticketing issues faced by airline customers. Instead of having groups of people arriving at one time for the same flight, HyperloopTT has a steady stream of passengers arriving and departing. The HyperloopTT station design limits security wait times by using biometric security systems. Given the heavy travel demand between medium distance city pairs, there is a large, unsatisfied demand for this type of speedy, low hassle service. Moreover, the travel experience between destinations is seamless by removing the need for paper ticketing systems.⁶¹

- 3.44 Hyperloop Transportation Technologies is currently exploring or engaging in feasibility studies with governments and organisations in a number of countries and has agreements for the commencement of commercial projects in Abu Dhabi and China.⁶²
- 3.45 Hyperloop Transportation Technologies argued that the 'current interstate transportation system in Australia is broken like other parts of the world – inefficient, environmentally unfriendly and expensive'.⁶³ It stated that:

⁵⁸ Hyperloop Transportation Technologies, *Submission 44*, pp. 12–13.

⁵⁹ Hyperloop Transportation Technologies, *Submission 44*, p. 17.

⁶⁰ Hyperloop Transportation Technologies, *Submission 44*, p. 24–5.

⁶¹ Hyperloop Transportation Technologies, *Submission 44*, p. 25.

⁶² Hyperloop Transportation Technologies, *Submission 44*, p. 32–4.

⁶³ Hyperloop Transportation Technologies, *Submission 44*, p. 8.

There is no High Speed Rail capability in Australia currently — the costs have always been prohibitive. Nothing has changed and HSR has become obsolete technology against Hyperloop. What has changed is that Australia has become increasingly desperate for a rapid fix.⁶⁴

3.46 Hyperloop recommended that the Australian Government:

- 1 Takes an urgent and leading role in evaluating and regulating these emerging autonomous standards.
- 2 Funds a comparative study of autonomous modes (high speed and other).
- 3 Invests in an Innovation Hub on Australian soil, to prove that this step-change in technology is realizable, safe and efficient, and uniquely solves Australia's main transport challenges.⁶⁵

3.47 Describing what Hyperloop Transportation Technologies would need from government to commence work, Mr Wesley Heron, Lead, Business Development Australia with Hyperloop Transportation Technologies, stated:

We'd require a mandate from government that says government is happy to invest in Hyperloop feasibility studies and Hyperloop innovation hubs. Give us the opportunity for, let's say, two-hundredths of the cost that is being allocated to things like high speed rail to quote to you what a feasibility study would cost on the corridor of choice. You might like us to look at Melbourne-Sydney or Sydney-Brisbane. You might like us to help state governments and ask the state governments to support us and to give us an opportunity to work alongside their project people that are already doing work in these corridors. We need to move quickly, because these studies are here and now. There are two big airport studies that are going on — one in Victoria and one in New South Wales. There is a Hyperloop solution in both those areas as well.⁶⁶

Committee Conclusions

3.48 The Committee agrees that the electrification of transport is the way of the future. Electrification will lower costs, reduce the environmental impacts of land transport and enhance national fuel security. By investing in zero-emissions technologies, Australia could eliminate greenhouse gas emissions related to transport, significantly reduce noise pollution associated with land

⁶⁴ Hyperloop Transportation Technologies, *Submission 44*, p. 9.

⁶⁵ Hyperloop Transportation Technologies, *Submission 44*, p. 7.

⁶⁶ Mr Wesley Heron, Lead, Business Development Australia, Hyperloop Transportation Technologies Inc., *Committee Hansard*, 28 February 2019, p. 5.

transport, make vehicles simpler and safer to operate and maintain, and largely eliminate reliance on fuel imports. If done right, the electrification of the vehicle fleet could even enhance the electricity network through battery storage or hydrogen fuel cell technology.

- 3.49 The Committee is also conscious of the convergence between electrification and automation—the fact that the electrification of vehicles has synergies with the development of vehicle electronics. The Committee agrees with the evidence presented that the development of government policy in these areas should also converge. Ideally both electrification and automation should be managed together within the same office within the Department of Infrastructure, Regional Development and Cities (see Chapter 4).
- 3.50 The Committee notes the work done by the Chief Scientist and CSIRO to investigate and promote the development of hydrogen power in Australia, and the work being done by auto companies, particularly in Korea and Japan, to develop hydrogen powered vehicles. This is now a mature technology and the challenge is to identify the optimum pathway to introducing and developing hydrogen powered transport in conjunction with battery electric vehicles. The evidence presented to the Committee is that the two technologies are complementary, with battery electric vehicles being well suited to short-range small vehicle travel in an urban environment, and hydrogen power being suited to longer-range and heavy transport use. Hydrogen fuel cell technology is particularly well-adapted to trucks, buses and even trains. The Australian Government should look at how it can facilitate the introduction and development of these technologies.
- 3.51 The key to the implementation of new energy sources is the provision of charging and refuelling infrastructure. Work is already being done in several jurisdictions to introduce electric charging stations or hydrogen refuelling stations. Coordination and planning is required to ensure that infrastructure meets demand and that refuelling and recharging technology follows defined standards for compatibility and interoperability.
- 3.52 It is also essential to explore the energy implications of new energy sources. Battery electric and hydrogen fuel cell technology both have the potential to significantly increase demands for electricity, with implications for the supply of electricity and greenhouse gas emissions. Infrastructure Victoria's report provides clear evidence that the introduction of new energy sources will demand greater coordination between the transport and energy sectors. Achieving this coordination should be a priority for government.

Recommendation 5

- 3.53 The Committee recommends that the Australian Government facilitate the introduction and uptake of electric vehicles (both BEV and FCEV), especially mass transit vehicles, including through coordination and planning of the development of infrastructure to meet demand; ensuring that refuelling and recharging technology follows defined standards for compatibility and interoperability; and by promoting greater coordination between the transport and energy sectors.**
- 3.54 Hydrogen power brings its own infrastructure demands. The production and transport of hydrogen in cost-effective and energy-efficient ways is essential to the development of hydrogen power. The Committee supports the development of a national hydrogen strategy that provides for the manufacture and transport of hydrogen in a safe, cost-effective and energy efficient way; targets zero-emission production and distribution; provides for the energy needs of Australia's vehicle fleet; and, while providing for export opportunities, is focussed first and foremost on Australia's energy security.

Recommendation 6

- 3.55 The Committee recommends that the Australian Government, in conjunction with State and Territory Governments, develops a national hydrogen strategy that provides for the manufacture and transport of hydrogen in a safe, cost-effective and energy-efficient way; targets zero-emission production and distribution; provides for the energy needs of Australia's vehicle fleet; and, while providing for export opportunities, is focussed first and foremost on Australia's energy security.**
- 3.56 Hyperloop is a concept with significant potential. If it lives up to its promise it will revolutionise inter-city transport. While the Committee believes that a formal commitment to the development of Hyperloop technology in Australia is a little premature, it nonetheless believes that the Australian Government should keep abreast of developments in this technology, with a view to exploiting its potential in the future once that potential begins to be realised.

Recommendation 7

- 3.57 The Committee recommends that the Australian Government maintain a close watch on the development of Hyperloop technology with a view to its development as a transport solution in Australia.**

4. Role of government

- 4.1 The Australian Government has a critical role to play in the development of automated mass transit—and automated transport generally. According to the Bus Industry Confederation ‘land passenger transport seems destined to confront major technological disruption over coming decades’. As a consequence, ‘policy will need to address a wide range of matters’.¹ According to the Hon. Justin Madden, Principal—Cities Leader, Victoria and South Australia with Arup, change was inevitable. He thought it better to ‘initiate that through good policy and good principles—or principles that the policies are established on, particularly in terms of urbanisation—rather than wait for industry to want to make this shift later on’. The great risk he saw was that ‘unless the policymakers start to establish some parameters and some controls and give signals to the market sooner rather than later, what’s likely to happen is maintaining the pre-existing business model for as long as possible before the quantum leap is made’.²
- 4.2 This chapter will identify what stakeholders see as the role of government in the development of automated mass transit and new energy sources, before giving an overview of current Australian Government activity. It will then examine specific policy priorities related to the development of automated mass transit and new energy sources.

The role of government

- 4.3 The evidence presented to the Committee emphasised the important role of the Australian Government in the development of automated vehicles and

¹ Bus Industry Confederation, *Submission 25*, p. 24.

² The Hon. Justin Madden, Principal—Cities Leader, Victoria and South Australia, Arup, *Committee Hansard*, 27 February 2019, pp. 48–9.

the transition to new energy sources. Arup argued that ‘Government is responsible for taking a holistic view in understanding the effects of these technologies on people and their lives, as it is Government that has the perspective beyond trade, commercial return and competition’.³

- 4.4 Arup stated that ‘as automation and new energy sources offer unique opportunities to shape more liveable cities, it is the role of governments to accelerate, frame and guide innovations in technology, law and society’. It argued for a strategic approach ‘to set the vision of our cities and define typologies of desired uses of automation’; and for governments to encourage the private sector to ‘bring innovations in transport motive technology and automation to Australia’. Arup observed that ‘an Australian Government approach can reduce friction and waste between competing state guidelines and regulation in what, in global terms, is a small market’. Government needed to provide ‘a known operating environment, regulatory pricing and safety standards, insurance status, requirement for interoperability, communications spectrum availability and privacy protocols among many other layers of certainty’ to ‘lower risk of private investment and ensure that innovation is delivered within the public interest’.⁴
- 4.5 Arup also urged the creation of a strategic pathway to automation ‘to allow for rapid innovation in transit autonomy while protecting the public good’. It argued that ‘the true opportunities and constraints of these technologies can only be understood through trials on public roads’. Arup observed that ‘various conditions can be identified for successful transition to greater autonomous operations:

From a technical perspective, this includes electric vehicle power sources and adequate vehicle-to-vehicle connectivity. From a social perspective, this includes building trust with passengers, who would no longer rely on bus drivers for a sense of oversight and security.⁵

- 4.6 Arup concluded that while all levels of government have a role to play in capturing the benefits of transport autonomy—‘with state agencies having the largest operational and implementation roles, with much regulation and benefits realisation for places being captured by local governments’—to attain ‘the most rapid escalation of benefit capture, the Australian Government can have the greatest effect through influence, setting national

³ Arup, *Submission 32*, p. 2.

⁴ Arup, *Submission 32*, p. 6.

⁵ Arup, *Submission 32*, p. 9.

standards and guidelines and using its taxation and funding activities to incentivise delivery'. These tasks included:

- Identification of strategic innovation pathways that realize benefits of new transport technology as early as possible. Prioritising technological innovations in rail and freight could be part of this pathway.
- Encouragement of private businesses to bring innovations in transport motive technology by reducing friction and waste between competing guidelines and regulation.
- Identification of locations and use cases where autonomous (and non-autonomous) point-to-point transport will deliver the largest benefits, taking into account the spatial constraints and congestion in our inner cities and opportunities in suburban and rural Australia.
- Protecting public safety and public good in the rapid development of transport technology.
- Identification of opportunities to improve land use configurations in order to create more liveable and sustainable Australian cities using autonomy and new energy sources in transport. An integrated approach of land use and transport planning is required for this.⁶

4.7 Infrastructure Victoria's recommendations to the Victorian Government also touched upon areas of Commonwealth responsibility, 'particularly in the areas of ICT [Information and Communications Technology] and automated vehicle standards and regulations'. It highlighted the need for ongoing Commonwealth participation 'in the development of national principles, standards and regulations for automated vehicles', including 'work on cyber security, the National Transport Commission's work on regulations for automated driving systems and Austroads' work on line marking and signage to support the introduction of automated vehicles'. Infrastructure Victoria noted the importance of 'continuing the Mobile Black Spot Program with a focus on improving cellular data coverage for automated vehicles in rural and regional areas'; and urged that 'greater cooperation between state and Commonwealth governments is also needed to implement the appropriate energy and emissions policies and settings, including vehicle emissions standards, to enable zero emissions vehicles'.⁷

4.8 Engineers Australia believed that the Commonwealth had a 'responsibility to the states and territories to support sophisticated research and

⁶ Arup, *Submission 32*, p. 11.

⁷ Infrastructure Victoria, *Submission 16*, p. 4.

development of automated transport technology and alternative fuel sources'. It argued that the Australian Government must 'promote greater uptake of shared, electric, connected and automatic vehicle use through tax incentives and allay public fears regarding autonomous vehicles through education and training'. The Commonwealth also had 'a responsibility to assist the states and territories in managing employment transitions and consider how to re-skill drivers and other roles made redundant by AVs'. Engineers Australia urged the creation of 'a regulatory environment which encourages high occupancy AVs and keeps empty AVs stationary and ensuring cohesive and consistent testing and implementation of connected vehicle software to ensure connectivity is supported across all states and territories'. EA advocated 'government prioritisation of a regulatory environment to support a healthy market for MaaS to emerge'.⁸

4.9 In its submission, NRMA identified a series of reforms focussed on making Australia ready for connected and automated vehicles (CAVs). These were:

1 Road rules and other laws should be amended to accommodate automation

To allow fully automated vehicles to operate seamlessly on Australian roads, all legislation that refers to the "driver" of a vehicle will require amending. There are more than 50 federal and state/territory pieces of legislation that are impacted in addition to the model road rules.

2 Australian governments should promote Australia as a destination of choice for CAVs

To demonstrate and communicate the potential benefits of automation, companies should be encouraged to conduct trials, including citizen focused trials, in specifically defined areas (sandboxing), as well as across the broader road network (road network testing).

3 The future prudential framework to regulate liability and capital requirements for automated vehicle insurance should be considered by an appropriate body

Victims of personal injury caused by accidents should not be worse off as a consequence of a vehicle being controlled by an automated driving system. Future compensation schemes for personal injury should ensure premiums are appropriately funded by responsible parties.

⁸ Engineers Australia, *Submission 37*, p. 9.

4 An industry-wide agreement for the sharing of vehicle telematics data should be established, along with a specific set of principles to guide data availability and use

Users of CAVs should have access to the data generated as a result of undertaking a journey, and maintain the right to control its availability and use whenever reasonably practical, including provision to third parties and data custodians.

5 Governments should implement strategies that match service objectives and consumer preferences in readiness for a shared mobility model

Australian governments should establish a working group, with representation from industry and consumers, to seamlessly coordinate the transition to electric vehicles to ensure that Australia is ready for the future of mobility, including electrification and automation.⁹

4.10 NRMA also observed that the ‘transition to this new technology must be considered alongside an emphasis on safety to build trust and consumer confidence, and to deliver positive road safety outcomes’.¹⁰

4.11 In its submission, Monash University argued that ‘there is an opportunity for a nationally coordinated approach to enhance Australian cities through policy, regulation and standards to encourage mass transit as a response to Australia’s urban population growth’.¹¹

4.12 Siemens Mobility Limited saw a role for the Australian Government in accelerating the uptake of automation and new energy sources through ‘policy and planning, particularly to integrate the provision of automated mass transit into the design of the urban environment; and investment and facilitation of pilot projects for new technologies’. The critical issue for Siemens was the promotion of standards. Mr Charles Page, Head, Business Development and Strategy at Siemens Mobility Limited, told the Committee:

We really need to adopt international standards without modification. We will slow down the introduction of this technology and deny local companies the ability to invest in R&D that makes the global market accessible if we do something different. There is no justification — there's no market size here to

⁹ NRMA, *Submission 27*, p. 8.

¹⁰ NRMA, *Submission 27*, p. 8.

¹¹ Monash University, *Submission 10*, p. 3.

justify a unique solution. And we need it to make sure that these systems are integrated into this mobility-as-a-service environment.¹²

- 4.13 Mr Page also highlighted the problem of each agency and jurisdiction seeking proprietary solutions to technological innovation:

You can't have proprietary systems messing around trying to all work together; integration is essential to creating that environment. We've already seen in the rail environment opportunities being lost where, in standards based systems like the European Rail Traffic Management System, people are trying to customise it locally, which destroys the benefits of standardisation. We see some cities going for proprietary mass transit solutions. This sort of generational change in technology is an opportunity to standardise to get that volume and get the benefits of lower cost and a supply market.¹³

- 4.14 Mr Page hoped that 'the government will intervene to make sure that standards don't diverge and that people don't go off and do their own thing'.¹⁴

- 4.15 Mr Michael Apps, Executive Director of the Bus Industry Confederation, argued for the Australian Government having a 'strategic and national leadership role', and emphasised the need for 'long-term strategic land use planning, with integrated transport and infrastructure investment'.¹⁵ In its submission, the BIC identified four policy priorities:

- 1 Implementing mandatory emissions standards for motor vehicle greenhouse gas emissions, to help drive technological change in a climate friendly direction, supported by behaviour change measures that reduce motor vehicle use.
- 2 Ensuring that transport users meet the social costs attributable to their road use, while ensuring affordable access is available to all at a reasonable level.
- 3 Managing land use to ensure that urban sprawl is tightly contained and that opportunities are used to increase the supply of open space within the built-

¹² Mr Charles Page, Head, Business Development and Strategy, Siemens Mobility Limited, *Committee Hansard*, 15 February 2019, p. 7.

¹³ Mr Charles Page, Head, Business Development and Strategy, Siemens Mobility Limited, *Committee Hansard*, 15 February 2019, p. 7.

¹⁴ Mr Charles Page, Head, Business Development and Strategy, Siemens Mobility Limited, *Committee Hansard*, 15 February 2019, p. 7.

¹⁵ Mr Michael Apps, Executive Director, Bus Industry Confederation of Australia, *Committee Hansard*, 15 February 2019, p. 28.

up area, an issue highlighted in the recent report by Infrastructure Australia (2018).

- 4 Developing new shared mobility governance (including data availability) and strategic planning arrangements and associated service delivery contracts for provision of local public/private mobility options that support social inclusion and are integrated with mass transit offerings.¹⁶

4.16 Mr Apps suggested there was 'scope for an intergovernmental agreement that tries to look at how we move people in our cities and regions and what that means in the context of long-term integrated land use and transport and infrastructure plans'. He proposed '40-year plans that lock states and local government into meeting a range of commitments'.¹⁷ Mr Apps elaborated:

Those kinds of conditions can be applied as part of a City Deal or part of the infrastructure funds that are going to be provided. You only get the dough if you make sure that in peak hours in these major cities the services are every 10 minutes or every five minutes or whatever it is. We have developed what we see as the minimum service levels for services, depending on where they operate, that we think all state governments should be required to meet. Once you get frequency and span of hours right and people know that they don't need a timetable, and that they can leave work at eight o'clock at night, because the last bus doesn't leave at six, all of a sudden the dynamic changes and people are more willing to use these types of services. Mass transit in bus and rail is going to be at the spine of our transport networks of the future. We just have to get the model right that delivers the right customer outcomes.¹⁸

4.17 He concluded:

When it comes to mass transit, an intergovernmental agreement that makes those connections between service delivery, land use, planning and infrastructure investment is important. I think the City Deals arrangements have got some scope to do that. Infrastructure Australia and the prioritisation of infrastructure projects and sticking to those priorities based on a process that's got some integrity is important moving forward, and I think this committee has got some scope to look at that.¹⁹

¹⁶ Bus Industry Confederation, *Submission 25*, p. 24.

¹⁷ Mr Michael Apps, Executive Director, Bus Industry Confederation of Australia, *Committee Hansard*, 15 February 2019, pp. 28–9.

¹⁸ Mr Michael Apps, Executive Director, Bus Industry Confederation of Australia, *Committee Hansard*, 15 February 2019, p. 33.

¹⁹ Mr Michael Apps, Executive Director, Bus Industry Confederation of Australia, *Committee Hansard*, 15 February 2019, pp. 28–9.

- 4.18 Mr Page agreed with the idea that Commonwealth funding should come with strings attached. He told the Committee:

[The Commonwealth] inject funds, or partial funding, into these projects and get them off the ground so that must give you a say in some of the decisions that are made. I strongly believe that urban planning and these sorts of decisions about standardisation should be part of the criteria for these projects. You should be saying, 'If we're going to support you in your project, how have you addressed these issues?'²⁰

Current Australian Government Activity

- 4.19 Through the Department of Infrastructure, Regional Development and Cities, the Australian Government is actively involved in the development of automated transport. DIRDC 'works with other Commonwealth agencies, the Transport and Infrastructure Council, state and territory governments, and other bodies, to invest in new infrastructure and put the right transport policy settings in place, including through the development and deployment of new transport technology'.²¹

- 4.20 The Australian Government is currently funding transport infrastructure to meet future needs through a range of initiatives under a '10-year \$75 billion investment in transport infrastructure'. This includes a \$10 billion National Rail Program, 'designed to help make our cities more liveable and efficient as they grow, reduce the burden on our roads, provide more reliable transport networks and support our efforts to decentralise our economy and grow regional Australia'.²² In its submission, DIRDC noted that:

Building better transport links using existing technologies must also be supplemented by a view to the future of transport to ensure they meet the needs of tomorrow. Opportunities such as demand-responsive transport, automation, new fuels and connected cities can enhance governments' investment in fixed infrastructure by increasing efficiency, enhancing the user-experience, improving the environment or reducing cost.²³

- 4.21 The Government is pursuing these opportunities through its *Smart Cities Plan* and City Deals. The Smart Cities and Suburbs Program allows local

²⁰ Mr Charles Page, Head, Business Development and Strategy, Siemens Mobility Limited, *Committee Hansard*, 15 February 2019, p. 9.

²¹ DIRDC, *Submission 46*, p. 32.

²² DIRDC, *Submission 46*, pp. 32–3.

²³ DIRDC, *Submission 46*, p. 33.

governments to explore how best to integrate smart technologies into their areas.²⁴ In October 2018, the Australian Government established the Office of Future Transport Technology within DIRDC. The Office is responsible for leading and coordinating Australian Government work to prepare Australia for emerging transport technology, including:

- leading policy development within the Infrastructure, Transport, Regional Development and Cities portfolios on automated vehicles and Cooperative Intelligent Transport Systems, including with regard to infrastructure readiness, vehicle safety, network impacts, accessibility and disability standards, and future implications for urban and regional Australia;
- collaborating with other Australian Government agencies on cross-portfolio issues, which include cyber security, critical infrastructure resilience, consumer and competition issues, future workforce and skills needs;
- working with states and territories to support the Transport and Infrastructure Council through implementation of the *National Policy Framework for Land Transport Technology*;
- engaging with state and territory and international colleagues to ensure consistency of domestic and international approaches;
- enabling industry innovation by identifying options to remove regulatory barriers where appropriate and supporting research, trials, investment and commercialisation; and
- consulting with the community to understand expectations and communicate opportunities.²⁵

4.22 The Government has also made a \$55 million investment in the iMove Cooperative Research Centre (CRC). This investment is matched by \$179 million of cash and in-kind support from industry and academic institutions. The iMove CRC brings together government, industry and academia for applied research into new mobility technology, including connected and automated vehicles. Key research priorities for the iMove CRC include:

- intelligent transport systems and infrastructure
- end-to-end freight solutions
- enhanced personal mobility.

4.23 iMove's work includes piloting emerging transport technologies and researching new business models and systems.²⁶

²⁴ DIRDC, *Submission 46*, pp. 33–4.

²⁵ DIRDC, *Submission 46*, p. 33.

²⁶ DIRDC, *Submission 46*, p. 34.

COAG

- 4.24 In addition to the work being done directly by the Australian Government, it plays a significant role in the development of the transport system through the Council of Australian Governments. The COAG Transport and Infrastructure Council ‘brings together Commonwealth, State, Territory and New Zealand ministers with responsibility for transport and infrastructure issues, as well as the Australian Local Government Association’. The Council ‘plays a key role in delivering national reforms to improve the efficiency and productivity of Australia’s infrastructure and transport systems, and ensuring these systems drive economic growth, increase employment opportunities, support social connectivity and enhance quality of life’.²⁷
- 4.25 The COAG Transport and Infrastructure Council has been active in the development of new transport technology. In August 2016, the Council agreed to the *National Policy Framework for Land Transport Technology*. The framework ‘takes a principles-based approach to facilitate the efficient, effective and consistent implementation and uptake of transport technology across Australia’, and identifies four roles for government:
- Policy leadership – providing a clear, nationally coordinated approach across different levels of government, being responsive to changes in the technological environment
 - Enabling – ensuring that the private sector is able to bring beneficial new technology to market
 - Supportive regulatory environment – ensuring that community expectations of safety, security and privacy are appropriately considered in new technology deployments
 - Investment – investing in research, development and real-world trials that benefit the entire transport network customer base or provide a sound basis for government decision-making (including collaboration with the private sector).
- 4.26 The framework operates in conjunction with a three-year action plan, ‘which identifies national, short and medium term priorities, with a particular focus on connected and automated vehicles’. According to DIRDC, ‘a future iteration of the action plan is expected to be considered by the Council in 2019 and is anticipated to include actions to support alternative fuelled vehicles, amongst other matters’. In November 2018, the Council ‘discussed

²⁷ DIRDC, *Submission 46*, p. 37.

the opportunities and benefits for Australia from a coordinated national approach to encourage the introduction of low and zero emission vehicles, particularly electric vehicles'. It agreed that 'the Transport and Infrastructure Senior Officials' Committee would develop a program of work to address the barriers and challenges impeding the uptake of these vehicles for Council consideration in the first half of 2019'.²⁸

National Transport Commission

4.27 The National Transport Commission is playing a vital role in the development of policy around vehicle automation, and has 'a comprehensive national reform program for automated vehicles'.²⁹ It is leading the 'regulatory reform process for automated road vehicles in Australia', working closely 'with state, territory and federal agencies along with Austroads to ensure a national approach'. State and Territory governments are 'collaborating with the NTC on the development of regulatory reform for automated vehicles including legislation to allow for automated vehicle reform'.³⁰ The NTC's reform program 'is intended to provide a regulatory framework that is sufficiently flexible to support a variety of potential applications and business models'. This encompasses 'a safety assurance approach for ensuring that automated vehicles used for mass transit and point-to-point are safe at first supply and in-service'.³¹ Mr Marcus Burke, Director, Automated Vehicles at the NTC, explained that:

The National Transport Commission has a comprehensive national reform program, with the goal of developing end-to-end regulation for automated vehicles that can support a variety of technologies and applications, including mass transit applications and point-to-point transport. We're aiming to develop a framework that supports both safety and innovation to ensure that we cover the life cycle of the vehicle from first supply to on-road operation to the end of life of the vehicle.³²

4.28 Mr Burke noted that 'our initial work in 2016 identified over 700 regulatory barriers in different state, territory and federal laws, and we developed a

²⁸ DIRDC, *Submission 46*, p. 38.

²⁹ National Transport Commission, *Submission 6*, p. 1.

³⁰ National Transport Commission, *Submission 6*, p. 9.

³¹ National Transport Commission, *Submission 6*, p. 2.

³² Mr Marcus Burke, Director, Automated Vehicles, National Transport Commission, *Committee Hansard*, 27 February 2019, p. 1.

road map of reform, which ministers endorsed at the end of 2016 and which we see as leading the way from our existing regulation to having that full end-to-end regulatory framework'. He also observed that:

There is significant complexity to this reform, and it touches on a wide range of laws, from laws around vehicles and drivers to criminal law and laws related to point-to-point transport. We currently regulate very separately for vehicles versus drivers, and that separation now has some challenges as we look at vehicles that can do the driving themselves.³³

4.29 The NTC's reform program has four streams of work aimed at identifying and addressing 'potential gaps and barriers in Australia's regulatory system to the safe introduction of automated vehicles':

- 1 Driving responsibility—ensuring that there is a legal entity accountable for the automated vehicle when the automated driving system (ADS) is performing the driving task and clarifying the relevant responsibilities of various entities.
- 2 Assuring the safety of the vehicle—ensuring that automated vehicles can operate safely on Australian roads from first supply to end of life and corporate responsibilities are appropriately allocated to the automated driving system entity.
- 3 Insurance—ensuring that someone injured in an accident with an automated vehicle is not disadvantaged compared to someone in an accident with a conventional vehicle who is covered by compulsory third party (CTP) insurance.
- 4 Government access to data—ensuring that privacy and surveillance protections around government access to data are appropriate for the new and increased types of data generated by automated vehicles.³⁴

4.30 As of December 2018, key milestones in the program included:

- In May 2017, transport ministers endorsed the NTC *National Guidelines for Automated Vehicle Trials* (a joint publication with Austroads). All state and territory governments are using these guidelines for the testing of automated vehicles.
- In November 2017, ministers endorsed NTC *National Enforcement Guidelines for Automated Vehicles*, providing greater certainty to industry and consumers on the application of current Road Rules.

³³ Mr Marcus Burke, Director, Automated Vehicles, National Transport Commission, *Committee Hansard*, 27 February 2019, p. 1.

³⁴ National Transport Commission, *Submission 6*, p. 3.

- In May 2018, ministers agreed to recommendations on *Changing driving laws to support automated vehicles*. Transport ministers agreed to remove barriers to automated vehicles in Australia through the development of a purpose-built national law. The national law will allow an automated driving system to drive and ensure there is always a legal entity responsible when a system in an automated vehicle, rather than a human, is driving. The NTC's work on changing driving laws was shortlisted for the ITS Australia National Awards 2018.
- In November 2018, ministers endorsed the safety assurance approach for the first supply of automated vehicles. This approach uses the existing certification framework for vehicles introduced into the Australian market. It includes mandatory self-certification by the company bringing the technology to market (the Automated Driving System Entity or 'ADSE') and a clear set of performance-based safety criteria against which companies must provide evidence. The NTC published a *Safety assurance for automated driving systems: decision regulation impact statement* (Decision RIS) outlining the key risks that need to be addressed to ensure the safe commercial deployment of automated vehicles in Australia.³⁵

4.31 In addition, the NTC has recently published the following papers for public consultation:

- A discussion paper on privacy challenges associated with government access to information generated by automated vehicles (September 2018). The paper focuses on the new privacy challenges of these technologies and whether additional privacy protections are needed to protect users' data. The NTC's aim is to balance road safety and network efficiency outcomes and efficient enforcement of traffic laws with sufficient privacy protections for Cooperative Intelligent Transport Systems (C-ITS) and automated vehicle users. The consultation period has recently closed and the NTC is reviewing submissions.
- A discussion paper examining whether there is a need to change existing legislation around motor accident injury insurance schemes (October 2018). The paper identifies barriers to accessing compensation under existing Motor Accident Injury Insurance schemes and seeks views on whether such schemes or other insurance options should provide cover for injuries caused by an automated system. The consultation period for this reform closes on 12 December 2018.³⁶

³⁵ National Transport Commission, *Submission 6*, p. 3.

³⁶ National Transport Commission, *Submission 6*, p. 4.

- 4.32 In November 2018, ‘transport ministers agreed that the NTC would lead further work to determine appropriate safety obligations once vehicles are on the road’:

The NTC will work closely with stakeholders to ensure that any new safety obligations in an automated vehicle national law interact appropriately with existing legislation. This will be the next steps for the NTC in developing the purpose-built national law agreed to by transport Ministers in May 2018.

The new purpose-built national law needs to work with existing legislation that regulates vehicles and drivers. Figure 1 outlines some of these interactions. In addition to the types of interactions outlined below in Figure 1, a new national law will also need to work with point-to-point legislation and other passenger transport legislation, which is found in state and territory law.³⁷

- 4.33 In its submission, the NTC noted that while it leads the regulatory reform for automated vehicles, ‘the Commonwealth government is responsible for leading and coordinating Australian Government work to prepare Australia for emerging transport technology’.³⁸ The NTC monitors ‘international regulatory development by the UN Global Forum for Road Traffic Safety (WP.1) and the UN World Forum for the harmonization of vehicle regulations (WP.29)’. The NTC noted that DIRDC ‘participates in the development of United Nations vehicle standards through the UN World Forum for the harmonization of vehicle regulations (WP.29)’.³⁹
- 4.34 The NTC concluded that ‘a collaborative approach is being taken at a national level towards achieving a consistent and timely regulatory framework to support automated vehicles’. It noted that ‘a clear regulatory framework is a prerequisite for commercial deployments of automated vehicles on Australian roads, including for mass transit’ and that ‘the NTC continues to consult closely with governments, industry and other stakeholders as reforms are developed’. The NTC is also working ‘to align reforms with evolving technology’.⁴⁰ The NTC is not actively involved in the automation of rail transport, having found in 2016 that “‘There are no

³⁷ National Transport Commission, *Submission 6*, p. 4.

³⁸ National Transport Commission, *Submission 6*, p. 9.

³⁹ National Transport Commission, *Submission 6*, p. 10.

⁴⁰ National Transport Commission, *Submission 6*, p. 11.

regulatory barriers to automated rail (including light rail) in Australia, and the NTC project will not be considering automated rail further.”⁴¹

- 4.35 Mr Marcus Burke updated the Committee on the NTC’s work regarding insurance. He told the Committee:

On the insurance side we have also done a piece of work looking at options for how you would manage motor accident injury insurance for automated vehicles. We had a discussion paper out late last year. The majority of submissions to that paper supported keeping automated vehicles within existing compulsory third party insurance schemes, in order to ensure that you’re providing the best support to injured parties, and making use of existing processes and schemes when the initial number of vehicles is likely to be quite small. We will be making recommendations on that topic to transport ministers at the first meeting in 2019.⁴²

Austroads

- 4.36 Austroads, the peak organisation of Australasian road transport and traffic agencies, is also playing a prominent role in preparing the road network for automation. Austroads ‘provides evidence-based policy and guidance on the design, construction and management of the road network and associated infrastructure’. The deployment of automated vehicles ‘is a strategic priority for Austroads’, which has ‘established a Connected and Automated Vehicle Program addressing operational and technical frameworks for connected and automated vehicles’.⁴³ Austroads has published reports on *Implications of traffic sign recognition systems for road operators*, ‘which indicates a potential need for greater consistency in road traffic signage to support more automated systems’, and *Future data requirements for automated vehicles*, assessing digital infrastructure requirements.⁴⁴

Other government action

- 4.37 Other work occurring across the Government to support the deployment of automated transport systems include:

⁴¹ National Transport Commission, *Submission 6*, p. 1.

⁴² Mr Marcus Burke, Director, Automated Vehicles, National Transport Commission, *Committee Hansard*, 27 February 2019, p. 7.

⁴³ DIRDC, *Submission 46*, p. 39.

⁴⁴ National Transport Commission, *Submission 6*, p. 9.

- allocating radiofrequency spectrum for train control systems and Intelligent Transport Systems in road networks;
- enhanced satellite positioning systems, which will enable more accurate positioning of vehicles and trains; and
- enhanced cyber security approaches for connected and automated vehicles.⁴⁵

Policy priorities

Vision and planning

- 4.38 Arguably the most important aspect of mass transit automation is the underpinning vision of how it will fit in with and meet the needs of our cities and communities. Arup called for ‘a strategic approach ... to set the vision of our cities and define typologies of desired uses of automation’.⁴⁶ Mr John Brockhoff, from the Planning Institute of Australia, suggested that ‘we want to move towards an autonomous vehicle future where we can reclaim streets as places, improve mass transit catchments and reinforce accessible centres as places for living, improved housing and improved access to work’. We also needed to coordinate a range of policy measures, such as ‘our regulatory and economic systems around road pricing and an improved regulatory environment for mobility as a service, expand renewables and electric vehicle energy storage grids’, to ‘end up with a set of principles that we can use as a lens when we’re considering new transport disruptions’. We also wanted to ‘avoid an autonomous vehicle nightmare, with private autonomous vehicle congestion, poor road capacity and loss of road capacity driving perverse investments’. Mr Brockhoff argued that ‘we want to start with a question about what goals we have for our cities and regions as places and not what attributes autonomous vehicles offer in isolation’.⁴⁷
- 4.39 Mr Ian Christensen, Managing Director of iMove Australia, highlighted the practical steps required to implement a coherent vision covering such a complex matrix of interrelated issues, stating:

There are many steps along this path and, to find our way, it’s very helpful when the relevant jurisdiction—in this case, it’s very often a state jurisdiction—envisages a future that will work well as a system, that aims to

⁴⁵ DIRDC, *Submission 46*, p. 39.

⁴⁶ Arup, *Submission 32*, p. 6.

⁴⁷ Mr John Brockhoff, Principal Policy Officer, New South Wales and National, Planning Institute of Australia, *Committee Hansard*, 28 February 2019, p. 24.

serve the community that it addresses well and, then, that steps forward with all the range of component parts that need to be brought into play. It can align them each time as and when the opportunity comes. So bus contracts might only turn up every five years, but if the government of the day has a vision or a sense of the nature of the transport system they want to create, then that's very helpful in guiding the next generation of contract with, in this case, the bus operators. But you could say the same about information provision. You could say the same about the flow of people in and out of our major nodal centres. You could say the same thing about the time at which people are obliged to start work. There are short-term, medium-term and long-term initiatives that can be taken and, to encourage the stakeholders to take those initiatives, it helps very strongly if there is a community dialogue or a community perspective about the nature of the city or the nature of the community that we aspire to create.

4.40 He continued:

We could spend a day listing out all the different things that need to be brought to bear, but over and above all of that I would say that the first and most important thing is the sense of and articulation of a degree of vision of where we want the city to get to and, then, how the different technologies can contribute to that vision.⁴⁸

4.41 Mr Christensen observed that 'all jurisdictions wrestle with the interaction between their transport planning and their land use planning'. He told the Committee that the Queensland Government 'have just initiated a project to develop a joint transport and land use planning model, which to our knowledge will be the first time that's been done in Australia, and all the other states are looking on with great interest'. He also suggested the Western Sydney Airport precinct and its surrounding area as a potential test site, stating that 'Western Sydney actually presents us with an opportunity to do it right this time':

The lesson for us in Sydney, then, is to be quite insightful about the nature of activity that we want to have happen in that precinct and, therefore, the flow of people and goods and services that are going to be needed, in a sense, to support that central activity.⁴⁹

⁴⁸ Mr Ian Christensen, Managing Director, iMove Australia, *Committee Hansard*, 28 February 2019, p. 15.

⁴⁹ Mr Ian Christensen, Managing Director, iMove Australia, *Committee Hansard*, 28 February 2019, p. 16.

- 4.42 Mr Madden (Arup) believed that ‘the critical consideration for state and federal governments is responsibilities in relation to policy’ that is ‘proactive and sets out some fundamental principles of how you want communities and cities to operate, rather than having a community that is reliant on the technology because that’s been the precursor to everything’. He argued that ‘you need a policy that directs the relevant technology to complement that’:

If you want cities to be safer and more walkable, neighbourhoods in closer proximity and streets not filled with empty cars waiting to collect somebody, because they’re automated, then that requires some degree of consideration, some policy settings and probably some regulatory controls around that, rather than just letting the industry turn up and put the hard word on government to deliver critical bits of infrastructure to make it work. The government has to really think long and hard about how cities operate, how are they made better, and what’s the policy role of government in setting the parameters for either the industry or the technology?⁵⁰

- 4.43 He noted that:

The issue, particularly around autonomous vehicles, is that we have lots of cities very eager to get the technology in sooner rather than later, but there’s still a critical need to give detailed consideration to the policy settings and the implications of those policy settings, including whether they’re social policy settings or whether they’re safety settings or whether they’re balanced decisions around who gets priority, in what way and how? They’re all major considerations. One of those other issues is car parking. Where does car parking sit within all this? There are critical land use issues. The last thing you want is autonomous vehicles filling the streets without any people in them waiting to collect somebody because it’s cheaper for them to be on the road rather than in the car park.⁵¹

- 4.44 Dr Jonathan Spear, Executive Director and General Counsel with Infrastructure Victoria, emphasised the ‘need to continue national coordination’. He observed that ‘on the principles, the standards and the regulations of automated vehicles, the National Transport Commission, Austroads and many jurisdictions are doing really good work, but this is moving very quickly’. He concluded that the opportunity and need to

⁵⁰ The Hon. Justin Madden, Principal – Cities Leader, Victoria and South Australia, Arup, *Committee Hansard*, 27 February 2019, p. 43.

⁵¹ The Hon. Justin Madden, Principal – Cities Leader, Victoria and South Australia, Arup, *Committee Hansard*, 27 February 2019, p. 43.

coordinate both law reform and some of the operational infrastructure challenges, was essential.⁵²

- 4.45 Mr Brockhoff stated ‘that the economy of the future is one where people have the opportunity to mix together, to do business together in really well-designed liveable groupings’:

Sure they might live in a whole range of settings but they tend to work and group in different places. To have those nodes work as part of a transport network doesn't work as well in a spread-out sprawling city. That said, you're going to get your nodes where the high volumes of people are coming together in a transport network and there's always going to be a role for private transport whether it be autonomous vehicles or some other form of private independent transport in the diffused transit task. But if you want to create a city with strong nodes, drive agglomeration economies that come out of people working together, as we are here in Sydney CBD, then you do need the heavy lifting off opportunities from a mass transit network.⁵³

- 4.46 The vision of the future of our cities and regions for most participants in the inquiry was ‘shared, electric and automated’.⁵⁴

Standards

- 4.47 The importance of adopting consistent national standards for vehicles and infrastructure—closely related to international standards—for automation technology and new energy sources was highlighted in the evidence presented to the Committee. Mr Daniel Chidgey, Head of Stakeholder Engagement at Standards Australia, told the Committee:

Standards help to take industry, government and the Australian community forward and address the challenge. Standards should not be an optional afterthought. All levels of government and industry should work together to ensure we have the right infrastructure and regulatory systems in place to facilitate the deployment of automated mass transit and ensure they are integrated into the planning process for transport and urban developments.⁵⁵

⁵² Dr Jonathan Spear, Executive Director and General Counsel, Infrastructure Victoria, *Committee Hansard*, 27 February 2019, p. 9.

⁵³ Mr John Brockhoff, Principal Policy Officer, New South Wales and National, Planning Institute of Australia, *Committee Hansard*, 28 February 2019, p. 26.

⁵⁴ Mrs Natalie Malligan, Head of Cities, Australia and New Zealand, Uber, *Committee Hansard*, 28 February 2019, p. 18.

⁵⁵ Mr Daniel Chidgey, Head of Stakeholder Engagement, Standards Australia, *Committee Hansard*, 28 February 2019, p. 8.

4.48 In its submission, Standards Australia highlighted the work already being done in this space, particularly at the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), noting that it has:

1. Led the development of Electric Vehicles Operations Standards to support the sustainable market adoption of Electric Vehicles in Australia.
2. Constituted a Mirror Committee to develop standards for Intelligent Transport Systems (ISO/TC 204) which uses advanced technologies to promote safe and sustainable transport solutions.
3. Constituted a Mirror Committee in the area of Internet of Things and related technologies (ISO/IEC/JTC1/SC41) to provide standardisation guidance for Australian and international entities who may be developing Internet of Things (IoT) related technologies and applications.
4. Constituted a Mirror Committee to provide Australia's voice and vote to International Standardisation work in the area of Artificial Intelligence (ISO/IEC/JTC1/SC42).
5. Worked with Infrastructure NSW and the Department of Finance, Services & Innovation (DFSI) to support the development of a Smart Places Strategy for NSW, and to demonstrate the importance of standards as foundational elements of smart cities infrastructure.⁵⁶

4.49 Standards Australia noted that its technical committee on electric vehicles 'has published and adopted 20 standards for road vehicles totally or partially electrically propelled from self-contained power sources, and for electrical industrial trucks'. It also observed that 'the committee responsible for developing the content of the Wiring Rules standard has included advisory information to provide guidance for the installation location of electric vehicle socket outlets and charging stations, giving industry direction for this new technology'.⁵⁷

4.50 In addition, Standards Australia 'recently convened a forum on hydrogen, with partners, to explore the standardisation needs in this area':

As with any emerging area of activity, the safe storage, transportation and adoption of hydrogen, including in relation to mobility solutions, will

⁵⁶ Standards Australia, *Submission 7*, p. 2.

⁵⁷ Mr Daniel Chidgey, Head of Stakeholder Engagement, Standards Australia, *Committee Hansard*, 28 February 2019, p. 7.

necessitate some form of industry-driven standards activity. Standards Australia has recently published an outcomes report 'Hydrogen Standards Forum' to help inform stakeholders of the strategic direction of future standards development and international participation in the hydrogen sector.

The Hydrogen Roadmap will inform the future of standards activities in the hydrogen sector, ensuring there are appropriate standards in place to support the development of each stage of the hydrogen supply chain. Through international standards harmonisation, Australia will be able to achieve business efficiencies and enable international trade. Standards serve as a vital public policy and regulatory tool in the sector, to support its evolution.⁵⁸

- 4.51 Standards Australia noted that 'a recommendation of the forum was that Australian stakeholders should proceed to adopt all of the standards currently published by the hydrogen technologies international committee, which include standards for land vehicle fuelling systems and vehicle refuelling connection devices'. It was currently working with stakeholders to deliver on this outcome, and observed that 'this international harmonisation will also provide Australia with a better understanding of future developments and opportunities in the industry'.⁵⁹
- 4.52 Standards Australia is also responsible for coordinating the attendance of Australian experts at the ISO and IEC, including the following technical committees:
- IEC/TC 69 – Electric road vehicles and electric industrial trucks. This Committee is charged with developing international standards for road vehicles, totally or partly electrically propelled from self-contained power sources, and for electric industrial trucks.
 - ISO TC 197 – Hydrogen technologies. This Committee is concerned with systems and devices for the production, storage, transport, measurement and use of hydrogen.
 - ISO/IEC/JTC1/SC42 – Artificial Intelligence, which co-ordinates activity across IEC and IEC concerning AI.⁶⁰
- 4.53 It emphasised the growing importance of international standards to the adoption of technology and the development of trade, stating:

⁵⁸ Standards Australia, *Submission 7*, p. 3.

⁵⁹ Mr Daniel Chidgey, Head of Stakeholder Engagement, Standards Australia, *Committee Hansard*, 28 February 2019, p. 7.

⁶⁰ Standards Australia, *Submission 7*, p. 4.

With growing cross-country digital connections in the globalisation of production, we are seeing the importance of international standards increasing. Countries are operating in the global market. International standards help to break down trade barriers and further world trade.⁶¹

- 4.54 Standards Australia also highlighted the growing importance of standards in relation to data sharing and privacy preservation. Mr Chidgey told the Committee:

We also see an increase in standards work being done around security and privacy. The development of connected and automated mass transit and smart infrastructure will most likely generate an increasing quantity of data use, raising potential privacy challenges. Having increased connections to different networks lends the situation well to using artificial intelligence to make sense of the big data while, at the same time, managing the increase in cybersecurity risk. Therefore, standards on data privacy and data security can become essential. We are in the early stages of developing international standards frameworks for data sharing and privacy preservation through the international standards committees, and we look forward to the government's continued support in this regard.⁶²

- 4.55 Standards Australia recommended that 'any strategic Australian Government response to automated mass transit should consider an integrated standards development roadmap, including International Standards participation through ISO and IEC'.⁶³ Mr Chidgey explained that 'the aim of such a road map is to identify gaps as well as Australian industry strengths':

We can stay ahead of issues and opportunities in this space. As part of this approach, we should look to address both vertical and horizontal priorities in new and emerging areas of work. Where activities reach across sectors, it is important for us not to work in silos. Standards Australia has established broad communities of experts needed to better understand both the technical elements and use cases. Not only do our experts span industries, but many are deeply entrenched into the international community and highly regarded in their field. Finally, don't reinvent the wheel. There is an opportunity to

⁶¹ Mr Daniel Chidgey, Head of Stakeholder Engagement, Standards Australia, *Committee Hansard*, 28 February 2019, p. 7.

⁶² Mr Daniel Chidgey, Head of Stakeholder Engagement, Standards Australia, *Committee Hansard*, 28 February 2019, p. 7.

⁶³ Standards Australia, *Submission 7*, p. 4.

participate in and adopt appropriate international standards where possible, reducing the need for government intervention.⁶⁴

4.56 As Scott McGrath, Public Affairs Officer at Standards Australia, concluded, ‘standards being at the forefront means that—as with the term before, interoperability—everyone’s talking to each other from the start, and we’re not operating multiple networks with different languages. Standards are a common language’.⁶⁵

4.57 The importance of international alignment was also stressed by the NTC, especially given that ‘Australia represents a small proportion of the global vehicle market’.⁶⁶ Dr Kirsten McKillop, Acting Director of the NTC, told the Committee:

We have heard very clearly from industry on the need for national consistency. Industry has emphasised the importance of Australia continuing to be a single market for vehicles and the need to be consistent with international standards and approaches. National consistency will provide certainty and reduce costs to industry and government. It will also help ensure that Australians have early and safe access to automated vehicles.⁶⁷

4.58 She explained that the NTC closely monitors ‘international regulatory developments and liaise with our international colleagues’:

The NTC attended the Global Forum for Road Traffic Safety, also known as WP.1, a United Nations working party, in September 2018, and we will attend again this year, in March, as part of an Australian delegation. WP.1 administers the Geneva Convention on Road Traffic 1949 and the Vienna Convention on Road Traffic 1968. The conventions aim to increase international road safety by establishing standard traffic rules among contracting parties. Australia is a contracting party to the Geneva convention. WP.1 has recognised that the Geneva and Vienna conventions create barriers to the deployment of automatic vehicles because they both have an implicit assumption that motor vehicles have a human driver. WP.1 has been working actively to resolve these issues.

⁶⁴ Mr Daniel Chidgey, Head of Stakeholder Engagement, Standards Australia, *Committee Hansard*, 28 February 2019, p. 8.

⁶⁵ Mr Scott McGrath, Public Affairs Officer, Standards Australia, *Committee Hansard*, 28 February 2019, p. 10.

⁶⁶ Mr Marcus Burke, Director, Automated Vehicles, National Transport Commission, *Committee Hansard*, 27 February 2019, p. 1.

⁶⁷ Dr Kirsten McKillop, Acting Director, National Transport Commission, *Committee Hansard*, 27 February 2019, p. 2.

International vehicle standards are developed through another UN working party. The World Forum for Harmonization of Vehicle Regulations, known as WP.29. It aims to ensure that the benefit of new technologies, such as automated driving, can be captured without compromising safety. As a United Nations member state, Australia has committed to harmonising its regulations with these international standards. The Department of Infrastructure, Regional Development and Cities regularly attends and contributes to WP.29 meetings. The NTC works closely with the department to ensure that the NTC understands changes coming through WP.29 and that the development of a regulatory framework aligns with the international approach to vehicle standards.⁶⁸

Promoting new technology—incentives and emission standards

- 4.59 Energy policy was seen as a major factor in the development of energy efficient vehicles and new energy sources, with ‘the lack of a longstanding energy policy at the federal level’ seen as ‘a barrier to confidence for investment in R&D’. Engineers Australia noted that ‘Australia’s minimum emission standards for vehicles are much more lax than those in most other places’. EA though it would ‘make sense to at least have stricter emission standards vehicles’.⁶⁹
- 4.60 Vehicle emission standards were seen as an important factor in delivering alternative fuel technologies. Mr Leigh Obradovic, Policy Director for the Federal Chamber of Automotive Industries (FCAI), noted that ‘the FCAI’s members are progressively introducing zero-emission vehicle technologies to the Australian market’. He stated that ‘zero emission vehicle technologies are, in effect, the endgame in a transition in power trains towards more efficient, lower-emission propulsion’; and that ‘the FCAI supports introduction of all types of low emission vehicles as a means to reducing CO2 emissions across Australia’s vehicle fleet’. Mr Obradovic observed that the FCAI’s members sought ‘a realistic and achievable CO2 emission standard which will enable individual member companies to plan their future fleet mix, including zero-emission vehicles’.⁷⁰ He argued that ‘a CO2

⁶⁸ Dr Kirsten McKillop, Acting Director, National Transport Commission, *Committee Hansard*, 27 February 2019, p. 2.

⁶⁹ Mr Jonathan Russell, National Manager, Public Affairs, Engineers Australia, *Committee Hansard*, 15 February 2019, p. 26.

⁷⁰ Mr Leigh Obradovic, Policy Director, Federal Chamber of Automotive Industries, *Committee Hansard*, 19 February 2019, p. 1.

standard is a critical component to help aid the transition of Australia's passenger vehicle fleet towards our emission technologies'.⁷¹

4.61 The BIC advocated mandatory vehicle emissions standards as a basis for introducing new energy sources. It noted, however, that 'mandatory emissions standards need to be complemented by the kinds of incentives that countries which already have these emissions standards use to further incentivize increased electro-mobility, such as lower sales taxes, lower road taxes, access restrictions on dirtier vehicles, education and awareness programs and roll-out of charging infrastructure'. It noted that 'longer term, mandatory emissions standards plus comprehensive marginal social cost road pricing (which benefits clean technologies) are likely to be the most effective way to 'encourage' greater penetration of EVs, from a level playing field starting point'.⁷²

4.62 Hydrogen Mobility Australia also sought a suite of complementary incentives for the adoption of new energy sources, highlighting the links between procurement policies, emissions standards, purchasing incentives, infrastructure provision and public education. It urged collaboration between Australian Government and state and territory governments on the following:

Private and public fleet procurement policies

- Federal Government coordination of joint procurement activities across public and private mass transit operators to enable cost savings through mass purchase and stimulate demand for refuelling infrastructure
- Review and redesign of government mass transit contracting and procurement policies to promote the integration of zero emission vehicles and infrastructure into fleets
- Introduction of zero emission vehicle targets for public operated or contracted mass transit fleet to support development of an initial customer base

Vehicle emissions policy

- Commencement of a national light and heavy vehicle CO₂ emission standard to encourage zero-emission technology purchase and accelerate the supply of these vehicles to Australia

⁷¹ Mr Leigh Obradovic, Policy Director, Federal Chamber of Automotive Industries, *Committee Hansard*, 19 February 2019, p. 3.

⁷² Bus Industry Confederation, *Submission 25*, p. 25.

Vehicle incentive measures

- Introduction of financial support measures to stimulate the uptake of zero emission vehicles including income tax credits on vehicle purchase, stamp duty exemptions and registration discounts
- Consideration of road user charging as the Australian fleet's fuel usage evolves, while ensuring that hydrogen powered vehicles are not unfairly penalised versus battery electric vehicles through any additional charges, such as the application of excise tax

Infrastructure support measures

- Development of a zero-emission vehicle infrastructure strategy and development of suitable funding models, including approaches for the deployment of hydrogen refuelling stations to support back to base mass transit operators
- Initial co-investment with industry to support capital and operational costs associated with hydrogen refuelling infrastructure

Consistent regulations, codes and standards

- Introduction of consistent regulations, codes of standards both internationally and between Australian jurisdictions to enable streamlined introduction of technologies to support innovation and change in the supply chain and associated infrastructure
- Undertaking of a review into existing Australian Design Rules to remove unnecessary barriers to entry for international vehicles, including a focus on buses and trucks in particular where prescriptive rules regarding dimensions and weight can inhibit the entry of product manufactured overseas

Information and education

- Government delivery of targeted education campaigns in collaboration with industry to increase consumer understanding and acceptance of zero-emission technology in fleets
- Government support for zero-emission vehicle trials and demonstrations to demonstrate the suitability of the technology, its potential applications and benefits with mass transit fleet operators.⁷³

4.63 Claire Johnson, Chief Executive Officer of Hydrogen Mobility Australia, emphasised the importance of fleets to the introduction of hydrogen fuel cell vehicles, observing that fleet purchases would provide the critical mass

⁷³ Hydrogen Mobility Australia, *Submission 24*, pp. 5–6.

which made the introduction of hydrogen fuel infrastructure viable. She stated:

Fleets are where we're going to establish the customer base first. It's not going to be individual consumers; it's going to be fleets. And it's governments that can make those sorts of fleet decisions. Where the economics may not stack up initially, they can take that leadership position and integrate these vehicles into their fleets.⁷⁴

- 4.64 She noted, for example, that the ACT Government had committed to the purchase of twenty hydrogen cars:

They're progressing with the building of a station in Fyshwick. That will be a public station because they don't want to just service their own vehicles; they want to build a sector so individuals can go and buy hydrogen cars as well. But they realise that they need to be the starting point to make that happen.⁷⁵

- 4.65 Ms Johnson also argued for a vehicle emission standard as 'the best measure to get these vehicles into the marketplace':

There is no policy lever that would be more effective to increase the flow of these vehicles to Australia. Rather than overregulation around fuel supply, we think the vehicle emissions at this point should be the focus of the sector, and then that will stimulate demand much more naturally.⁷⁶

- 4.66 She also pointed to the luxury car tax (LCT) as an area where policy could better align with transport objectives, stating:

One thing that we've been advocating for is looking at all of the areas where we are collecting taxes on the transport sector. One area is luxury car tax. We know that the government very much enjoys that revenue. If there is no prospect of its removal, can the LCT that's attracted on zero-emission vehicles—because most of them do attract LCT because they're over the threshold—be diverted to things like infrastructure and to things like helping fleets get the vehicles into the marketplace? In excise tax as well, is there an

⁷⁴ Ms Claire Johnson, Chief Executive Officer, Hydrogen Mobility Australia, *Committee Hansard*, 19 February 2019, p. 7.

⁷⁵ Ms Claire Johnson, Chief Executive Officer, Hydrogen Mobility Australia, *Committee Hansard*, 19 February 2019, p. 7.

⁷⁶ Ms Claire Johnson, Chief Executive Officer, Hydrogen Mobility Australia, *Committee Hansard*, 19 February 2019, p. 8.

opportunity? So it is looking at the various taxes that are collected at the federal and state levels and creating funds to help us with that transition.⁷⁷

- 4.67 The NRMA also advocated specific incentives for the uptake of electric vehicles, stating that such incentives would ‘help to expedite the arrival of new mobility technology, bolster fuel security, and improve national health standards while achieving significant emissions reductions in Australia’s transport sector’.⁷⁸ NRMA identified three barriers to electric vehicle take-up: ‘purchase cost, range anxiety, and access to charging infrastructure’. It proposed ‘six priority reforms to help to address these concerns’:

1 Prioritise the rollout of charging infrastructure

Australian governments should work with industry to support the establishment of home, kerbside, destination and fast charging infrastructure, and offer consumers access to low interest loans and household rebates to encourage local energy capture and use.

2 Set a government fleet target of 25 per cent of all new light passenger vehicles by 2025/26

All governments should demonstrate leadership by setting purchasing policies that mandate 10 per cent of light passenger vehicles acquired or leased should be zero emissions by FY2020/21, and that 25 per cent should be zero emissions by FY2025/26.

3 Short-term measures to reduce the upfront cost of purchasing electric vehicles

To stimulate early demand and help negate the short-term electric vehicle price premium, the Australian Government should remove the LCT for electric vehicles as it was primarily put in place to protect domestic vehicle manufacturing which has now ceased.

4 Reduce Australia’s reliance on imported liquid fuels

Given Australia’s significant and increasing dependency on crude and fuel imports for transport, the Australian Government should make a clear policy statement of its preference for promoting domestic electricity generation as opposed to relying on imported liquid fuel.

⁷⁷ Ms Claire Johnson, Chief Executive Officer, Hydrogen Mobility Australia, *Committee Hansard*, 19 February 2019, p. 8.

⁷⁸ NRMA, *Submission 27*, p. 4.

5 Prioritise electric vehicles and establish an inter-governmental electric vehicle working group

Australian governments should establish a working group, with representation from industry and consumers, to seamlessly coordinate the transition to electric vehicles to ensure that Australia is ready for the future of mobility, including electrification and automation.

6 Promote industries associated with electric vehicles

Australian governments should encourage and support research and development in materials, components and technologies associated with electric vehicles, including whole-of-life considerations such as the reuse, recycling and responsible disposal of batteries.⁷⁹

- 4.68 Engineers Australia also urged incentives for the take-up of electric vehicles. It stated that ‘purchase incentives must be a key policy driver in promoting EV uptake across Australia’, citing the example of the ACT, ‘a market leader in the deployment of charging infrastructure and electric vehicle uptake rates’, which had introduced ‘stamp duty exemptions and discounted registration for zero emissions vehicles’. EA noted that ‘a number of Australian states and territories are already embracing automated electric vehicle technology and are conducting trials of electric driverless buses’. It encouraged ‘governments to continue supporting trials through fuel efficiency targets and a regulatory environment conducive to greater EV uptake for businesses and individuals’, noting that ‘as the domestic market grows, EV manufacturers will provide more options for Australian consumers’. EA argued that the Australian Government must ‘work to reduce commercial barriers for business in order to drive the uptake of electric vehicles’, and that ‘further investment needs to focus on application of renewable energy source to reduce emission levels’. It encouraged the government ‘to continue to implement policies which incentivise electric vehicle market growth and support the electrification of our transport networks’.⁸⁰

Communications technology, data and cyber security

Infrastructure

⁷⁹ NRMA, *Submission 27*, pp. 4–5.

⁸⁰ Engineers Australia, *Submission 37*, pp. 6–7.

- 4.69 The importance of communications infrastructure to vehicle automation was emphasised by Mr James Hurnall, Technical Director of the Federal Chamber of Automotive Industries. He stated that:

In terms of the connected vehicle infrastructure – which is perhaps also where things are moving very quickly – the chip set makers are developing chips for vehicles and the communication infrastructure that will be able to operate on multiple types of communications. There is DSRC – dedicated short-range communications – which is essentially a wi-fi technology, as well as 4G and 5G mobile networks. They’re building chips that’ll work on both types.⁸¹

- 4.70 Mr Hurnall noted the work being done by the Australian Communications and Media Authority (ACMA), which had referenced the European standard for vehicle-to-vehicle communications as part of its licensing and standards. Australia was harmonising its standards with other jurisdictions – and needed to keep doing so.⁸²

- 4.71 Dr Jonathan Spear (Infrastructure Victoria) noted that ‘high quality network connectivity will promote vehicle efficiency and safety’; and that ‘sharing of real-time transport data will promote the facilitation of on-demand mobility services and mobility as a service offerings, which help to facilitate the complementary relationship that automated vehicles can have with mass transit, be it automated mass transit or more traditional’.⁸³ He also emphasised the importance of ICT connectivity for network-wide management:

That is relevant to the work that the NTC were describing earlier around government access to automated and connected vehicle data, because there is the potential to optimise the network to avoid those sort of pinch points that you’ve described if that data is available and also the underlying infrastructure to enable that network management to actually occur.⁸⁴

- 4.72 The importance of increasing the connectivity was emphasised by Mr Terry Lee-Williams, Strategic Transport Advisor with Arup, who observed that:

⁸¹ Mr James Hurnall, Technical Director, Federal Chamber of Automotive Industries, *Committee Hansard*, 19 February 2019, p. 5.

⁸² Mr James Hurnall, Technical Director, Federal Chamber of Automotive Industries, *Committee Hansard*, 19 February 2019, p. 6.

⁸³ Dr Jonathan Spear, Executive Director and General Counsel, Infrastructure Victoria, *Committee Hansard*, 27 February 2019, p. 9.

⁸⁴ Dr Jonathan Spear, Executive Director and General Counsel, Infrastructure Victoria, *Committee Hansard*, 27 February 2019, p. 15.

Connected will take a while because we actually need not only the 5G network but a far better fibre network for 5G to work because 5G's very short distance and it goes into fibre, transmits and comes out the other end. It's not just flipping through the air like 4G. So you need a lot more infrastructure and you use an enormous amount of data.⁸⁵

- 4.73 Dr Matt Wenham, Executive Director, Policy, with the Australian Academy of Technology and Engineering, described infrastructure readiness as 'a key barrier in terms of automated mass transit':

If we're thinking about automated trains and public transport, there's quite a large investment required in new rolling stock and platform and station infrastructure that allow these trains to be operated safely. That's been seen in the rollout of an automated train line in Sydney. If you look at the car space and connected autonomous vehicles, there are obviously a lot of infrastructure implications there, largely around the communications side of things and how cars communicate with each other and their environment, and the investment required in that area.⁸⁶

- 4.74 The precise infrastructure requirements of different vehicles and technologies were still in development and there was a lack of 'a consistent message from industry about what their infrastructure requirements are'. Mr Marcus Burke (NTC) stated:

Some companies seem to be taking the approach that they will take the infrastructure as they find it, rather than seeking for governments to provide a certain level of infrastructure. There's certainly been feedback from some of the companies in this space that infrastructure that is good for human drivers—clear signs, clear line markings—is also good for automated systems. But it does depend on those different applications as well. The infrastructure required for automated freight on freeways is different to that required for a low-speed shuttlebus going around a local area or a robotaxi-type application around an inner city.⁸⁷

- 4.75 In addition to the broader issue of communications infrastructure for automated transport, the Centre for Disaster Management and Public Safety (CDMPS), at the University of Melbourne, 'identified a number of key

⁸⁵ Mr Terry Lee-Williams, Strategic Transport Advisor, Arup, *Committee Hansard*, 27 February 2019, p. 44.

⁸⁶ Dr Matt Wenham, Executive Director, Policy, Australian Academy of Technology and Engineering, *Committee Hansard*, 27 February 2019, p. 52.

⁸⁷ Mr Marcus Burke, Director, Automated Vehicles, National Transport Commission, *Committee Hansard*, 27 February 2019, p. 5.

opportunities where the inclusion of data from C-ITS [Cooperative Intelligent Transport Systems] into decision support and incident management systems has the potential to provide significant benefits' It noted that 'from a disaster management and public safety perspective there are three key areas of interest for the CDMPS, namely emergency management, road safety and crime/intelligence applications'.

4.76 Emergency Management applications included:

- eCall and eReporting capabilities, which involves the autonomous reporting of incidents based on the vehicle's sensor network for example the detection of a major impact would autonomously report the vehicles location and details of the event to a PSAP/ECS [Public Safety Answering Point/ Emergency Call Services] (SCoTI 2012);
- evacuation management support, which can involve a range of activities including the optimisation of evacuation routes and the placement of traffic control points, monitoring the flow of traffic being evacuated from an area as well as dynamically rerouting traffic around an incident and damage within the road network;
- emergency messaging, which can involve displaying messages on smart signs and the interruption of other communications services;
- emergency response, which can involve the integration of a broad range of dynamic sensor data into an incident management or decision support application using the SWE [Sensor Web Enablement] standards.

4.77 Road Safety applications included:

- offence detection, which can involve the analysis of data captured by C-ITS sensors or the use of specific sensors on recidivist offenders or their vehicles;
- analysis and use of ITS Big Data and road safety informatics to support enforcement decisions, which can target responses using fixed and mobile RSUs [Road Side Units] devices;
- response activities, which can be initiated where an event is detected by C-ITS sensors. Developments like Mercedes-Benz's new augmented reality application Rescue Assist will help first responders rescue people trapped within a vehicle more quickly and in a safer manner (Edelstein 2016); and
- medical injury index from vehicle telemetry.

4.78 Crime and Intelligence applications included:

- real time monitoring, which can involve using C-ITS infrastructure to supplement monitoring a given area using other technologies and infrastructures, for example local government CCTV systems;
- investigation support, which could involve using data captured by the C-ITS infrastructure to support an investigation into an incident or person; and
- desktop surveillance, which could involve using C-ITS infrastructure to monitor a vehicle travelling on the road network.⁸⁸

4.79 The Australian Radio Communications Industry Association (ARCIA) indicated that emergence of autonomous capabilities may lead to long-term problems, 'due to the absence of a skilled technical support base to ensure resilient operation of the underpinning wireless technologies in a wide range of complex circumstances in both the built and natural environments'.⁸⁹ It recommended that governments focus on training for 'the skill sets necessary to ensure all Australian's are able to take full advantage of benefits from future technologies'.⁹⁰

Data

4.80 The data produced by connected vehicles and infrastructure was also seen as vital. Arup stated that 'the data produced by inter-vehicle connectivity, one of the preconditions of fully autonomous vehicles, provides a potential strong instrument to monitor and steer further development'.⁹¹ The importance of data access and use was highlighted by AECOM. Mr Roger Jeffries, Technical Director, Transport Advisory; and ANZ Technical Practice Leader, Transport Advisory with AECOM, told the Committee:

That's also around things such as fares, fare integration and ticketing integration; information provision, to operators, to government and to passengers; and the sharing of information and the sharing of data. There are three parties within that: the sharing of data between government to plan and optimise networks; to operators to deliver networks effectively, to optimise the operations and to deal with perturbations of service and incidents that occur;

⁸⁸ CDMPS, University of Melbourne, *Submission 28*, pp. 13–14.

⁸⁹ Australian Radio Communications Industry Association, *Submission 51*, p. 1.

⁹⁰ Australian Radio Communications Industry Association, *Submission 51*, p. 2.

⁹¹ Arup, *Submission 32*, p. 10.

and to the passenger as well so they can plan journeys and deal with disruptions in services.⁹²

- 4.81 He provided the example of New York, where 'AECOM has been working with the metropolitan transit agency in New York City and IBM to bring artificial intelligence into the live operations centre for the rail network and the subway system in New York':

The reason for that is to deal with an already highly congested network that's running nearly at capacity, in terms of train services and in terms of passenger capacity, and to deal with issues that will regularly occur on a very busy urban rail service. When there are issues with the service, what they're actually trying to do is find ways to operationally redirect the train along the network to maybe different lines and direct passengers onto those lines to create resilience in the network such that, if there's a failure on one line, you may actually provide increased capacity on an alternative line and, in real-time, divert services to provide alternative capacity.⁹³

- 4.82 Mrs Natalie Malligan, Head of Cities, Australia and New Zealand with Uber, argued that 'in order to truly integrate public transport into the same technology platform, we need governments openly sharing data and sharing API [application programming interface] access'. She gave the example of Denver, in the United States, 'where it's now fully integrated and you can see the full public transport timetabling within the Uber app. Very soon to launch will be actually being able to book and pay for your public transport in that app as well.' She stated that it 'takes openness from governments to allow access to systems and to allow access to the payments and about some of the infrastructure challenges that go with that'.⁹⁴

- 4.83 The NTC noted that, regarding data, 'we have done some work over the last 12 months on government access to both connected and automated vehicle data, and we'll be making recommendations to transport ministers at their first meeting of 2019'. Mr Burke noted that the NTC, 'as part of our ongoing work on in-service safety ... will look at what a regulator might require from these vehicles to be able to appropriately monitor and enforce safety conditions'. He observed that 'there is some work going on at the

⁹² Mr Roger Jeffries, Technical Director, Transport Advisory; and ANZ Technical Practice Leader, Transport Advisory, AECOM, *Committee Hansard*, 28 February 2019, p. 44.

⁹³ Mr Roger Jeffries, Technical Director, Transport Advisory; and ANZ Technical Practice Leader, Transport Advisory, AECOM, *Committee Hansard*, 28 February 2019, p. 44.

⁹⁴ Mrs Natalie Malligan, Head of Cities, Australia and New Zealand, Uber, *Committee Hansard*, 28 February 2019, p. 19; Uber, *Submission 38.1*, p. 1.

international level around development of standards for what's referred to as event data recorders, which are effectively black boxes—you'll be familiar with them in planes—having similar technology in vehicles'.⁹⁵ Dr McKillop told the Committee that the NTC had recently 'completed extensive consultation on government access to data generated by automated vehicles and on motor injury accident and insurance as they relate to automated vehicles'. The NTC intended to make recommendations to the Transport and Infrastructure Council on these issues at its first meeting in 2019.⁹⁶

Cybersecurity

- 4.84 The importance of cybersecurity was also stressed in the evidence presented to the Committee. Professor Hussein Dia, of Swinburne University of Technology, observed that there are 'a number of privacy and security concerns about connected and autonomous vehicles' that pose challenges to automakers and regulators. These included 'concerns related to hacking into the connected vehicle's infotainment and computer systems to gain control of the vehicle and concerns about gathering too much information about drivers and travellers inside a connected and automated vehicle'. Professor Dia noted that 'the vulnerability of connected vehicles to "cyber attacks" was highlighted in two separate cases in the US and the UK which occurred in 2015':

In the first case, a leading UK-based software security system company demonstrated how car infotainment systems can be vulnerable to hacking and could put lives at risk by seizing control of a vehicle's brakes and other critical systems. This case coincided with a similar flaw discovered by two security researchers in the US where they demonstrated that they could take control of a Jeep Cherokee travelling along one of the Interstate highways, by sending data to its internet-connected entertainment and navigation system over a mobile phone network. The researchers managed to take full control of the vehicle while it was in a vacant parking lot, altering the engine speed, braking sharply and disabling the brakes completely.⁹⁷

- 4.85 Dr Allison Stewart (Infrastructure Victoria) stated that some stakeholders were seeking to address such problems by 'separation of driving systems from communications systems within vehicles and the ability to isolate

⁹⁵ Mr Marcus Burke, Director, Automated Vehicles, National Transport Commission, *Committee Hansard*, 27 February 2019, p. 7.

⁹⁶ Dr Kirsten McKillop, Acting Director, National Transport Commission, *Committee Hansard*, 27 February 2019, p. 2.

⁹⁷ Professor Hussein Dia, Swinburne University of Technology, *Submission 47*, p. 14.

certain parts of vehicles from being connected, such that they might be controlled in a different way'. She noted that 'there are many people and many companies who are looking at trying to address those kinds of challenges and potential technological solutions'.⁹⁸

4.86 The CDMPS argued that:

Any autonomous transit system should be considered for its potential to be classified as critical infrastructure and advice from the Department of Home Affairs Critical Infrastructure Centre should be engaged to ensure that cyber security and operational responses procedures/mechanisms are consistent with this classification and support entire ecosystem reliability and resilience.⁹⁹

4.87 It noted that 'interference between radio networks can occur and as a result the ACMA has developed a range of co-existence measures to manage anticipated interference'. CDMPS observed that 'ACMA will be a key partner in allocating the required spectrum to support the wireless operation of the system and ensure that that system is able to coexist with other radio operators'.¹⁰⁰

4.88 CDMPS highlighted the importance of data management and cybersecurity. Mr Geoff Spring, Senior Industry Adviser at CDMPS, explained:

The public safety mobile broadband network that's underway in most countries now, in the US, Europe and now here, is initially going to carry data, and it will carry an awful lot of data. It'll carry data from you as a person saying, 'I want help.' The data will increase when it goes through a control centre. There'll be data telling agencies where to go or what to do. There'll be confidential data. So the issues you raise are very important because, in the collection of that data and the storage of it, on your way through that process, you will be also accessing databases. So it's a matter of now starting to, in conjunction with other legislation, not forgetting that this is here—the realisation that, for example, police agencies may be running their response capability across a private sector network. You would normally say, 'Hang on a minute. What data? Is it my data? Is it your data? How are you protecting it?' It's the same with cybersecurity. I can't emphasise enough that we need to look at cybersecurity strategies but in a holistic sense, in terms of the ecosystem from one end to the other. It's a closed system. The final point is that, over the

⁹⁸ Dr Allison Stewart, Project Director, Infrastructure Victoria, *Committee Hansard*, 27 February 2019, p. 11.

⁹⁹ CDMPS, University of Melbourne, *Submission 28*, p. 16.

¹⁰⁰ CDMPS, University of Melbourne, *Submission 28*, p. 16.

last couple of years, we've been talking about the citizen having to be seen as part of that system.¹⁰¹

4.89 Mr Ian Christensen (iMove Australia) highlighted work that iMove was doing 'in conjunction with Transport and Main Roads in Queensland to develop an appropriately cyber-secure mechanism for information sharing between automated vehicles and automated vehicles and infrastructure'. He agreed that 'ensuring appropriate cybersecurity arrangements over the transmitted information is going to be absolutely important'.¹⁰²

4.90 The NTC observed that the Australian Government was already active in this area through the Commonwealth's role in regulating the first supply of vehicles. Mr Burke explained:

The approach that was agreed was a self-certification approach with companies looking to bring the technology and needing to provide evidence against a set of safety criteria. That includes things like demonstrating that they can manage Australian conditions and comply with Australian road rules, that they can manage the on-road safety and interaction with other road users. One of the other criteria that was in there was cybersecurity. That means that a company looking to bring this technology in will need to demonstrate to the Commonwealth Department of Infrastructure and Regional Development and Cities, as the regulator, that they can manage the cybersecurity risks both upfront and then on an ongoing basis and that they have appropriate processes in place to do that. It's been left as quite a performance based approach. There's not prescription around how a company would do that, and the challenge may be different for an automated bus versus an application being used by a private owner of a vehicle, depending on the technologies that are being used for the specific application.¹⁰³

Managing change

4.91 Managing the transition to automation and alternative fuels was also a key consideration for policy makers. Dr Wenham (Australian Academy of Technology and Engineering) noted that 'there are a lot of different aspects to the transition, whether it be to connected autonomous vehicles or electric

¹⁰¹ Mr Geoff Spring, Senior Industry Adviser, Centre for Disaster Management and Public Safety, University of Melbourne, *Committee Hansard*, 27 February 2019, p. 32.

¹⁰² Mr Ian Christensen, Managing Director, iMove Australia, *Committee Hansard*, 28 February 2019, p. 13.

¹⁰³ Mr Marcus Burke, Director, Automated Vehicles, National Transport Commission, *Committee Hansard*, 27 February 2019, p. 3.

vehicles or automated mass transit'. He noted that 'one of the key issues that perhaps again isn't always factored in is the effect on workforces':

We've seen this in a number of other industries, be at the automotive manufacturing industry or the energy industry in certain regions around Australia. We can be fairly certain that this transition is going to happen over the next decade or so—we don't necessarily know how fast or to what extent. But, if the transition happens to, say, autonomous vehicles, that has huge implications for the public transport workforce and people who drive our trains and buses and, more broadly, anyone who relies on driving for a job. So government has an important role there to start thinking now, if this is going to impact on people's livelihoods in 10 or so years, what we might be doing in advance of that to ensure that the transition doesn't result in the sorts of things we've seen in the car industry, for example, where, virtually overnight, thousands of people lose their jobs. So that's an important consideration.¹⁰⁴

- 4.92 The issue of workforce transition was also highlighted by the Australian Rail, Bus and Tram Union (RTBU). Mr Dominic Ofner, Executive Officer of the RTBU, observed that that the loss of human capital with automation could have significant impacts on transport network efficiency, stating:

Governments and transport operators should be under no illusion that they will lose vital pieces of technical and social knowledge if change is not managed in partnership with workers and, if they lose this knowledge, the quality of our transport systems will ultimately suffer. Existing networks will be unable to cope with demand, and we will not realise the benefits of much-needed and long overdue expansions. If the objective of this inquiry is to review how we can make mass transit better, stronger and faster, then it must recognise this crucial fact.¹⁰⁵

- 4.93 He urged 'proper workforce planning as part of the long-term planning of Australia's transport needs', highlighting work being done in Singapore to manage the transition to automation:

Singapore is a very good example of that. Every industry, not just transport, has put together what they call industry transformation maps—a genuine tripartite model. It's not the rhetoric that we hear from a lot of people about stopping the combative nature of workers and unions versus governments and employers but actually about sitting around the table and coming up with

¹⁰⁴ Dr Matt Wenham, Executive Director, Policy, Australian Academy of Technology and Engineering, *Committee Hansard*, 27 February 2019, p. 52.

¹⁰⁵ Mr Dominic Ofner, Executive Officer, Australian Rail, Tram and Bus Union, *Committee Hansard*, 28 February 2019, p. 31.

a shared vision of what, in this case, public transport would look like and what our cities would look like, because obviously you can't split the two.¹⁰⁶

4.94 The RTBU recommended that the Australian Government:

- develop and fund a Future of Transport Work strategy to position workers for the transport jobs of the future, and to develop a contemporary workforce development strategy for the industry;
- introduce a new approach to urban planning and transport planning, including Federal funding for urban transport projects within a funding model that determines priorities based on long-term growth strategies that better analyse how a project integrates and connects with an entire transport network, rather than in isolation;
- mandate that projects receiving federal funding are appropriately staffed and resourced to keep the travelling public safe; and
- ensure that point-to-point/MaaS style transport models (whether autonomous or not) is only ever implemented following genuine consultations with transport workers and upholds the highest forms of safety standards, including a human driver always being present.¹⁰⁷

4.95 Mr Ofner urged the Australian Government to tie infrastructure funding to workforce planning:

Obviously, the nature of fiscal policy is that a lot of projects require federal funding. Rather than there just being this form of a blank cheque — 'Here you go; here's \$3 billion' — for this particular metro or Cross River Rail or something like that, look at a whole range of things that we would like to see, or that the federal government would like to see. That could include things like value capture. But, in addition to the innovative funding models that they'd like to see from the state government, it should, and could, also include: where is the workforce planning, where is the workforce development? If you are going to say, 'The New South Wales government says, "Thank you, Canberra, for this money. We're going to build a driverless train system, which includes converting existing heavy rail,"' well, New South Wales government, we'd like to see, before we hand over this money, what your plan is for people who might be displaced from their current jobs as part of the

¹⁰⁶ Mr Dominic Ofner, Executive Officer, Australian Rail, Tram and Bus Union, *Committee Hansard*, 28 February 2019, p. 34.

¹⁰⁷ RTBU, *Submission 14*, p. 4.

conversion of heavy rail. I think from an early phase, perhaps, projects could be planned with that in mind.¹⁰⁸

- 4.96 Mr Mathieu Voisin, Technical Director with AECOM, highlighted successful workforce planning in the automation of Line 1 on the Paris Metro, noting that ‘when RATP [Régie Autonome des Transports Parisiens] in 2012 converted existing line 1 into a fully automated one, it was a very big and complex infrastructure challenge, but it was also a very complex social challenge, and it was handled quite well’. He continued:

It was complex because this line was used during the day as a classic line, and it was worked out and changed during the night with a brand-new system, so there was system redundancy. It was a lot of investment. It was a lot of technical complexity, but it was addressed. In the same interval, there was a social program which permitted the workforce to be enhanced and to be transformed, and new skills were created towards system supervision and towards passenger-centric services. The important thing in that program is that, by its nature, it was not a project but a program, and it had five different projects, one project for rolling stock, one project for systems, one project for communications, one project for civil engineering and one project itself for the social evolution of skills.¹⁰⁹

- 4.97 On the other hand, Mr Lee-Williams (Arup) emphasised that there was always jobs transfers with technological change, ‘so we must always be careful that we don't talk about everybody losing their job’:

With freight, robots that can unpack and redistribute are not great, and they certainly can't take things upstairs because, like the Daleks, they can't quite manage that yet. But drivers are very expensive, particularly in public transport. Train drivers are very expensive. This may be apocryphal, but I'm told it takes less time to train an astronaut than a Sydney train driver. They're very expensive and there are thousands of them. With automatic train operation and automatic train protection, with existing, decades-old technology you could remove all of those drivers over the course of a seven-year investment program, but you wouldn't remove the guard. You wouldn't have the guard standing inside a locked cabin with reflective glass and pretending they're not there, either. You would actually have people moving through the train. We already have revenue protection officers, trained police, all sorts of people moving through. It's very rare that the train's actually

¹⁰⁸ Mr Dominic Ofner, Executive Officer, Australian Rail, Tram and Bus Union, *Committee Hansard*, 28 February 2019, p. 35.

¹⁰⁹ Mr Mathieu Voisin, Technical Director, AECOM, *Committee Hansard*, 28 February 2019, p. 43.

unattended by somebody. The driver is almost invisible—in fact is invisible, as they're not allowed to leave the cabin, even in an emergency.¹¹⁰

Road funding

- 4.98 Currently, fuel excise represents the main mechanism for pricing the use of road infrastructure. Arup noted that 'transport autonomy is likely to reduce income through eliminating traffic and parking fines and electrification will in time eliminate fossil fuel excise', and suggested that 'income from new sources that also evolves to manage travel demand can help fill this income gap'. Arup argued that this would be 'required to secure funding for our roads and infrastructure, which will continue to be required for the foreseeable future'.¹¹¹ Arup suggested that 'because external costs of road use relate more closely to distance travelled than to fuel use (especially as motive technologies change), a distance-based charging mechanism should be introduced'. This would include 'mass and location components to better reflect, for example, road damage and congestion impacts'. Arup noted that 'the trend towards more fuel-efficient vehicles, albeit slow, accentuates pressure for such a shift in the way road use is priced, because of the revenue impact on the federal government budget'. In addition, Arup argued, 'reformed road pricing would increase the cost of road use in areas where external costs are high, providing incentives for shared mobility solutions and reducing incentives for further urban sprawl, coming through increased ownership/use of AEVs'. Arup note that the use of shared mobility would increase under a marginal social cost (MSC) pricing regime, 'which is what an efficient pricing system should achieve'.¹¹²
- 4.99 The BIC also urged the development of 'a road pricing regime that prices the full social costs of vehicle movement, full or empty, creates the opportunity to exercise more effective and efficient transport network management control over potentially serious adverse unintended outcomes, from greatly increased demand for limited road space and pressure for accelerated urban sprawl'.¹¹³ The BIC argued for 'road transport pricing reform that charges users for the marginal social costs of their travel choices and, when this pricing is in place, for public transport pricing (fare setting) to better reflect

¹¹⁰ Mr Terry Lee-Williams, Strategic Transport Advisor, Arup, *Committee Hansard*, 27 February 2019, p. 46.

¹¹¹ Arup, *Submission 32*, p. 5.

¹¹² Bus Industry Confederation, *Submission 25*, p. 26.

¹¹³ Bus Industry Confederation, *Submission 25*, p. 5.

marginal social costs of service provision'. It indicated that 'some continued subsidies to public transport will remain defensible, because of the presence of wider economic benefits (e.g., agglomeration economies) and social inclusion benefits from PT services'.¹¹⁴

- 4.100 Transurban agreed, stating that 'with the rapid advance in transport technology, governments should prepare to transition to an alternative funding model/s to support road infrastructure'.¹¹⁵ It noted that electric vehicles also have significant implications for how roads are funded, with significant declines in fuel excise revenue forecast. Transurban stated:

Every year there are more fuel efficient and electric vehicles on the road ... the result is that fuel excise, which currently contributes 52 per cent of total road-related revenue from all levels of government, is declining at 16 per cent each year, and, in short, coming to an end.¹¹⁶

- 4.101 It argued for a road funding model that provided 'a fair and sustainable system that is built on a principle of those who benefit, pay', indicating that this would 'allow us to invest and use the infrastructure more efficiently and provide a revenue stream that is aligned with actual road use'.¹¹⁷
- 4.102 Transurban noted that 'a significant first step is under way with the Federal Government's Heavy Vehicle Road Reform', which would establish 'a transparent, fair and efficient charging system that invests revenue into road infrastructure to meet user need'. According to Transurban, the Heavy Vehicle Road Reform 'is only the first step in reform'. It recommended that government progress 'planning toward a light vehicle road-user charging scheme in line with the forecast growth in electric vehicle uptake'; and that 'road-user charging frameworks are also designed to meet other transport objectives such as improving travel times and road utilisation'.¹¹⁸

Chief Engineer

- 4.103 In its submission, Engineers Australia encouraged governments at all levels 'to appoint a Chief Engineer', and advocated 'for the early and ongoing engagement of engineers in the planning and development of Australia's

¹¹⁴ Bus Industry Confederation, *Submission 25*, p. 25.

¹¹⁵ Transurban, *Submission 17*, 'Inquiry into Transport Technology', p. 4.

¹¹⁶ Transurban, *Submission 17*, 'Inquiry into Transport Technology', p. 6.

¹¹⁷ Transurban, *Submission 17*, 'Inquiry into Transport Technology', p. 6.

¹¹⁸ Transurban, *Submission 17*, 'Inquiry into Transport Technology', p. 7.

transport future'.¹¹⁹ EA sought a 'chief engineer who sits across all portfolios and provides the engineer's perspective on whatever the policy dilemma is', much as the Chief Scientist provided advice across a diverse range of issues.¹²⁰ EA observed that:

Engineers' specialised skills and engagement in almost every sector of the economy gives them a special insight to the innovative potential of public infrastructure like roads and hospitals, our defence capability, energy prospects and preparedness for a connected, shared and automated future. It is this life cycle experience and knowledge that provides engineers with a unique perspective of government projects and policies that can provide good governance, public surety and the reduction of risk from research, to procurement, design, delivery and beyond.

- 4.104 Engineers Australia believed that 'the commonwealth has a responsibility to ensure early and ongoing engagement of engineers to ensure innovative and resilient planning for an automated, shared and connected Australia'.¹²¹

Office of Future Transport Technologies

- 4.105 As discussed above, the Australian Government has established the Office of Future Transport Technology within DIRDC to provided policy direction on autonomous and connected vehicles. Drawing on the 'interconnected nature of autonomy and electric drivetrains', Hydrogen Mobility Australia has recommended that 'both vehicle technologies be given equal consideration in government decision making and policy development', either by the creation of a similar dedicated group or alternatively an expansion of the Office of Future Transport Technology to take carriage of both.¹²² Addressing these concerns before the Committee, Ms Claire Johnson, Chief Executive Officer of Hydrogen Mobility Australia, emphasised the need for a coordinated policy response within the Australian Government focused on a single office:

What is holding this technology back from introduction to Australia is government coordination of infrastructure, vehicles and customers. Alignment is needed between these three aspects to realise a zero-emission vehicle sector

¹¹⁹ Engineers Australia, *Submission 37*, p. 3.

¹²⁰ Mr Jonathan Russell, National Manager, Public Affairs, Engineers Australia, *Committee Hansard*, 15 February 2019, p. 24.

¹²¹ Engineers Australia, *Submission 37*, p. 9.

¹²² Hydrogen Mobility Australia, *Submission 24*, p. 5; Ms Claire Johnson, Chief Executive Officer, Hydrogen Mobility Australia, *Committee Hansard*, 19 February 2019, p. 4.

in Australia as well as the technology these drive trains can utilise. To address this, our submission calls for a number of things, some of which include federal government coordination of procurement across public and private mass transit operators to enable cost savings through mass purchase and flow on demand for refuelling infrastructure; introduction of zero-emission vehicle targets for public operated or contracted mass transit fleets to stimulate vehicle uptake and development of an initial customer base; introduction of a national light and heavy vehicle CO2 emission standard to encourage zero-emission technology purchase and accelerate the supply of vehicles to Australia; and the development of a zero-emission vehicle infrastructure strategy and development of suitable funding models, including approaches for deployment of hydrogen refuelling stations to support back-to-base mass transit operators. We recommend the above be coordinated by a dedicated office for zero emission vehicles providing a centralised point for all mobility related policy and regulatory matters due to the complexity of this space.¹²³

Committee conclusions

- 4.106 The evidence presented to the Committee indicates that the Australian Government, along with State and Territory Governments, has a significant role to play in the development of automated mass transit and new energy sources in Australia. The evidence also suggests that governments at all levels are already engaged with the issues, looking at automation and electrification from the point of view of policy, planning, regulation and implementation.
- 4.107 The Australian Government has a central role in providing policy leadership and coordination nationally, especially through COAG and the work of agencies such as the National Transport Commission and Austroads. The Australian Government is already coordinating the development of policy in this sphere through the Office of Future Transport Technology, which has demonstrated in its evidence to the Committee a high level of understanding of the requirements of automation.
- 4.108 The Committee is aware of the ongoing work being done by the National Transport Commission and other agencies to identify and resolve regulatory barriers to the introduction of automated and electric vehicles, and supports the Australian Government continuing to pursue regulatory reform through this process. The Committee is also aware of the work being done by

¹²³ Ms Claire Johnson, Chief Executive Officer, Hydrogen Mobility Australia, *Committee Hansard*, 19 February 2019, p. 2.

Austroads and other agencies to identify the road infrastructure requirements of automated vehicles.

- 4.109 The work that has been done by Infrastructure Victoria to scope the challenges, benefits, requirements and potential costs of automation and alternative energy sources, while focussed on Victoria, has national (and even international) implications. The Australian Government should undertake a study to establish the national implications of Infrastructure Victoria's work and the requirements its findings have for infrastructure policy and investment.

Recommendation 8

- 4.110 **The Committee recommends that the Australian Government undertake a study to establish the national implications of Infrastructure Victoria's work on automated and zero emissions vehicles infrastructure, and the requirements its findings have for infrastructure policy and investment.**
- 4.111 Within this context, the Committee is best placed not so much to offer detailed advice on how automation and new energy sources can be developed, but to set out some guiding principles and offer some more detailed suggestions. It is vital that we identify and overcome regulatory barriers to automated vehicles, particularly trains, trams and buses. The Committee believes that preparing road and rail networks for automation is essential to the smooth transition to the new technology and that governments need to commit to the automation and alternative fuels by designing and building infrastructure around those requirements.
- 4.112 Perhaps the most important thing the Australian Government can provide to the future development of automated transport and new energy sources is vision. A clearly articulated vision of cities and regions, and the connectivity within and between them, is vital to ensuring that automation meets the needs of the people rather than the other way around. This national vision should encompass:
- A vision for and planning of the urban and regional environment (see the Committee's previous report on the development of cities, *Building Up & Moving Out*) incorporating automated mass transit and new energy sources.
 - A clear articulation of the optimum design of the urban environment, including mass transit and active transport.
 - A vision for shared mobility incorporating Mobility as a Service (MaaS).

- The goal of fuel security.

4.113 Within this vision, the Australian Government can provide leadership and coordination of policy with a focus on consistency and interoperability between jurisdictions. The main responsibility of the Australian Government in this area is to ensure that there is coordination in the development of automation with a view to achieving a high level of compatibility and interoperability across jurisdictions. In this regard, the Committee is sympathetic to the idea of an intergovernmental agreement to look at how we move people in our cities and regions and what that means in the context of long-term integrated land use and transport and infrastructure plans.

Recommendation 9

4.114 **The Committee recommends that the Australian Government articulate a clear vision for cities and regions and the connectivity within and between them, including:**

- **A vision for and planning of the urban and regional environment incorporating automated mass transit and new energy sources.**
- **A clear articulation of the optimum design of the urban environment, including mass transit and active transport.**
- **A vision for shared mobility incorporating Mobility as a Service (MaaS).**
- **The goal of fuel security.**

This vision should be articulated in an intergovernmental agreement focussed on consistency and interoperability between jurisdictions.

4.115 The Committee also agrees with the proposition that the development of national standards should be facilitated by the Australian Government. Emphasis should be placed, wherever possible, on adopting relevant international standards to ensure that Australia has easy access to the best technology and is not spending money on reinventing the wheel. The Committee endorses the concept of an integrated standards development roadmap.

Recommendation 10

- 4.116 The Committee recommends that the Australian Government pursue an effective standards based approach to the development of transport automation and electrification, including effective use of international standards and engagement with international standards bodies, and the development of an integrated standards development roadmap to identify gaps in standards and evolving standards requirements.**
- 4.117 The importance of energy and communications infrastructure cannot be overstated. With regard to energy, Infrastructure Victoria's work highlights the increased demand for electricity likely to come from the widespread adoption of electric vehicles; while the work of the Chief Scientist and CSIRO highlights the infrastructure demands of a hydrogen economy. The development of both will entail a commitment to low or zero greenhouse gas emission power generation technologies.

Recommendation 11

- 4.118 The Committee recommends that the Australian Government undertake research to estimate the national requirement for electricity generation under an electric and automated transport future, with a view to ensuring that electricity generation will meet anticipated demand while adhering to national greenhouse gas abatement targets.**
- 4.119 Automation will ultimately require the capacity for vehicles to communicate with each other and the surrounding infrastructure. This will necessitate the development of a new generation of communications infrastructure. In this regard, the Committee highlights the importance of the recommendations made in its *Smart ICT* report. Automation will also require and generate large amounts of data. Access to this data will facilitate operation and innovation, and governments should encourage access to data between the public and private sectors with due regard to individual privacy. Cybersecurity will also be an essential element of automation. Governments and industry are already active in this regard. The Committee recommends the ongoing development of cybersecurity protocols to ensure the safe operation of automated transport systems at all times.

Recommendation 12

- 4.120 The Committee recommends that the Department of Infrastructure, Regional Development and Cities conduct an audit of Australia's existing**

transport communications infrastructure and requirements for automation at various stages, with a view to developing a national strategy for transport communications infrastructure for full automation of land transport; this audit and strategy to be development in conjunction with the transport and infrastructure industries; and cover:

- **ICT infrastructure requirements**
- **Data management and sharing**
- **Privacy**
- **Cybersecurity.**

4.121 The Australian Government can also seek to facilitate the development of these new technologies through incentives, whether tax breaks for the importation of electric or automated vehicles; support for research and development, such as pilot projects for automated shuttle buses; or fleet purchasing. The key incentive for adoption of electric vehicles is vehicle emissions standards. The adoption of stringent emission standards combined with a movement towards zero-emission requirements will undoubtedly facilitate the adoption of electric vehicles. Activities the Australian Government can facilitate include:

- Subsidising zero-emission vehicles
- Promoting zero-emission vehicles through vehicle emission standards
- Implementing low- or zero-emission zones
- Providing public charging infrastructure
- Strengthening renewable energy targets
- Phasing out petrol and diesel vehicles

Recommendation 13

4.122 **The Committee recommends that the Australian Government consider facilitating the transition to automated and electric vehicles by giving consideration to options such as:**

- **Subsidising zero-emission vehicles**
- **Promoting zero-emission vehicles through vehicle emission standards**
- **Implementing low- or zero-emission zones**

- **Providing public charging infrastructure**
- **Strengthening renewable energy targets**
- **Phasing out petrol and diesel vehicles over the long term.**

4.123 Managing change is an essential aspect of automation. There is the need to build up public confidence and trust in the new technology and emphasise the benefits that come from it. There is also a need to manage the transition of the transport workforce, to ensure the transport jobs of the future are not at the expense of current employees, and to ensure the retention of corporate memory. There are examples of successful workforce transitions that Australian governments can draw upon as a template for the future here.

Recommendation 14

4.124 The Committee recommends that the Australian Government assist in managing change in the transition to automation by making workforce training and development a condition of Commonwealth funding for relevant transport projects.

4.125 An important side effect of new energy sources and automation (assuming a transition to shared mobility) will be the decline in fuel excise for road funding. This has potentially very serious implications for transport infrastructure investment. A number of agencies have done work on new forms of road pricing. The Australian Government needs to consider a transition to road user pricing to properly price and adequately fund road infrastructure.

Recommendation 15

4.126 The Committee recommends that the Australian Government give early consideration to road pricing models, recognising the inevitable decline of fuel excise revenue due to the increase in alternative energy vehicles.

4.127 The Committee notes that in its report on the development of cities, *Building Up & Moving Out*, the Committee recommended the creation of the Office of Chief Planner. The Committee for the same reason sees the logic in creating an Office of Chief Engineer to advocate for the early and ongoing engagement of engineers in the planning and development of Australia's

infrastructure and to ensure that sound engineering solutions are incorporated into the development of Australia's transport networks.

Recommendation 16

4.128 The Committee recommends that the Australian Government establish the statutory Office of a National Chief Engineer, to provide independent expert advice on the planning and development of Australia's infrastructure.

4.129 The Committee is also of the view that given the synergies and convergence between automation and electrification of transport that the Office of Future Transport Technology be expanded to cover alternative energy sources such as battery electric power and hydrogen fuel cell power.

Recommendation 17

4.130 The Committee recommends that the Office of Future Transport Technology within the Department of Infrastructure, Regional Development and Cities be expanded to cover alternative energy sources such as battery electric power and hydrogen fuel cell power.

John Alexander OAM MP

Chair

25 March 2019

A. List of submissions

- 1 Council of Mayors (SEQ)
- 2 Mr Eric Jensen
- 3 Australasian Centre for Rail Innovation (ACRI)
- 4 Northern Territory Government
- 5 iMOVE Australia
- 6 National Transport Commission
- 7 Standards Australia
 - 7.1 Supplementary submission
- 8 La Trobe University
- 9 Siemens Mobility SAS
- 10 Monash University
- 11 Monash University Accident Research Centre
- 12 ANCAP Safety
 - 12.1 Supplementary submission
- 13 Dr John Stone
- 14 Rail, Tram and Bus Union
 - 14.1 Supplementary submission
- 15 Australian Gas Infrastructure Group (AGIG)
- 16 Infrastructure Victoria
- 17 Transurban

- 18 ITS Australia
- 19 Roads Australia
- 20 Cubic Transportation Systems
- 21 Queensland University of Technology (QUT)
- 22 AECOM
 - 22.1 Supplementary submission
- 23 Mott MacDonald
- 24 Hydrogen Mobility Australia
- 25 Bus Industry Confederation
- 26 Australian Renewable Energy Agency (ARENA)
- 27 NRMA
- 28 Centre for Disaster Management and Public Safety at University of Melbourne
 - 28.1 Supplementary submission
- 29 Transdev Australasia Pty Ltd
 - 29.1 Supplementary submission
- 30 Project 412
- 31 Royal Automobile Club of WA (Inc.) (RAC)
- 32 ARUP
- 33 Infrastructure Partnerships Australia
- 34 Federal Chamber of Automotive Industries
- 35 Business Council of Co-operatives and Mutuals
- 36 Australasian Railway Association
 - 36.1 Supplementary submission
- 37 Engineers Australia
- 38 Uber
 - 38.1 Supplementary submission
- 39 The Planning Institute of Australia (PIA)
- 40 The Committee for Sydney

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- 41 Council of Capital City Lord Mayors
 - 42 CSIRO
 - 43 Transport for NSW
 - 44 Hyperloop Transportation Technologies
 - 44.1 Supplementary submission
 - 45 City of Melbourne
 - 46 Department of Infrastructure, Regional Development and Cities
 - 47 Professor Hussein Dia
 - 48 Consult Australia
 - 49 Office of the Hon Rita Saffioti MLA
 - 50 Australian Academy of Technology and Engineering
 - 51 Australian Radio Communications Industry Association (ARCIA) Inc.
 - 52 Australasian Critical Communications Forum Ltd

B. List of public hearings and witnesses

Tuesday, 12 February 2019

Parliament House, Canberra

Department of Infrastructure, Regional Development and Cities

- Ms Gayle Milnes, Executive Director, Portfolio Coordination & Research
- Mr Alex Foulds, Executive Director, Surface Transport Policy
- Mr Richard Wood, Executive Director, Cities Division
- Mr Roland Pittar, General Manager, Office of Future Transport Technology
- Mr Daniel Caruso, General Manager, Infrastructure Investment Policy
- Ms Cathryn Geiger, General Manager, Land Transport Market Reform Branch
- Mr Andrew Hyles, General Manager, Rail Policy and Planning

Friday, 15 February 2019

Parliament House, Canberra

ANCAP Safety

- Mr James Goodwin, Chief Executive Officer

Siemens Mobility Limited

- Mr Charles Page, Head, Business Development and Strategy

CSIRO

- Dr Chen Cai, Research Group Leader

- Dr David Harris, Research Director: Low Emissions Technology

Engineers Australia

- Mr Johnathan Russell, National Manager, Public Affairs
- Mr Shalendra Ram, Chair, Transport Australia Society
- Ms Sybilla Grady, Policy Advisor

Bus Industry Confederation

- Mr Michael Apps, Executive Director

Tuesday, 19 February 2019

Parliament House, Canberra

Federal Chamber of Automotive Industries

- Mr James Hurnall, Technical Director
- Mr Leigh Obradovic, Policy Director

Hydrogen Mobility Australia

- Ms Claire Johnson, Chief Executive Officer

Australasian Railway Association

- Mr Duncan Sheppard, General Manager - Freight and Contractors
- Mrs Emma Woods, General Manager – Passenger and Corporate Services

Wednesday, 27 February 2019

Parliamentary Annex, Melbourne

National Transport Commission

- Mr Marcus Burke, Director - Automated Vehicles
- Dr Kirsten McKillop, Acting Director

Infrastructure Victoria

- Dr Johnathan Spear, Executive Director and General Counsel
- Dr Allison Stewart, Project Director

Transurban

- Mr Stephen McDonald, GM Strategic Initiatives

Monash University

- Professor Graham Currie, Chair of Public Transport and Director, Public Transport Research Group, Institute of Transport Studies

Centre for Disaster Management and Public Safety at University of Melbourne

- Mr Geoff Spring, Senior Industry Adviser

La Trobe University

- Professor Aniruddha (Ani) Desai, Director and Research Professor, Centre for Technology Infusion
- Mr Simon Barnes, Director, Master Planning, Sustainability & Systems, Infrastructure and Operations Division

ARUP

- Hon Justin Madden, Principal – Cities Leader Vic/SA
- Mr Mark Rowland, Associate – Transport and Cities Planning
- Terry Lee-Williams, Strategic Transport Advisor

Australian Academy of Technology and Engineering

- Dr Matt Wenham, Executive Director, Policy

Transdev Australasia Pty Ltd

- Mr David Le Breton, Business Development Manager, New Mobility
- Mr Ben Hayes, Group Manager, Business Performance & Innovation

Thursday, 28 February 2019

Commonwealth Parliamentary Offices, Sydney

Hyperloop Transportation Technologies

- Mr Bibop Gresta, Chairman / Co-Founder
- Mr Wesley Heron, Lead, Business Development Australia

Standards Australia

- Mr Daniel Chidgey, Head of Stakeholder Engagement
- Mr Scott McGrath, Public Affairs Officer

iMOVE Australia

- Mr Ian Christiansen, Managing Director

Uber

- Mrs Natalie Malligan, Head of Cities, Australia & New Zealand

- Mr Richard Willder, Public Policy & Government Affairs, Australia & New Zealand

The Planning Institute of Australia (PIA)

- Mr John Brockhoff, Principal Policy Officer NSW and National
- Mr Colin Henson, Convenor, Transport Network

Rail, Tram and Bus Union

- Mr Dominic Ofner, Executive Officer

The Committee for Sydney

- Mr Gabriel Metcalf, CEO
- Mr Sam Stewart, Policy and Advocacy Officer

AECOM

- Mr Mathieu Voisin, Technical Director
- Mr Roger Jeffries, Technical Director – Transport Advisory; and ANZ Technical Practice Leader – Transport Advisory