ENGINEERS
AUSTRALIA

Automated mass transit

Submission to the House of Representatives Standing Committee on Infrastructure, Transport and Cities

December 2018

Table of Contents

1. Introduction 3

1.1 About us 3

1.2 Introduction 3

1.3 Key messages 3

1.4 Contact 3

2. Automation in road and rail mass transit 4

3. Benefits of automation in mass transit 4

4. Obstacles to automation in mass transit 5

5. New energy sources in land based mass transit 6

5.1 Electric Vehicles 6

5.2 Hydrogen 7

5.3 Biofuel 8

6. Commonwealth roles and responsibilities 9

1. Introduction

1.1 About us

Engineers Australia is the peak body for the engineering profession in Australia. With about 100,000 individual members across Australia, we represent individuals from a wide range of disciplines and branches of engineering. Engineers Australia is constituted by Royal Charter to advance the science and practice of engineering for the benefit of the community. Engineers Australia's response is guided by our Charter and Code of Ethics which states that engineers act in the interest of the community, ahead of sectional or personal interests towards a sustainable future. Engineers are members of the community and share the community's aspirations for Australia's future prosperity.

1.2 Introduction

Engineers Australia welcomes the opportunity to provide this submission to the House of Representatives Standing Committee on Infrastructure, Transport and Cities (the Committee) inquiry into automated mass transit.

Transport systems around the world are undergoing a transformation. This change has been caused by a convergence of rapid economic growth in India and China, growing and changing inner city populations, consumer behaviours, new technologies and the emergence of innovative services.

Rising fuel prices, the availability of new sophisticated and innovative technologies and greater social and environmental consciousness are some factors that have contributed to the transformation of global transport systems.

Emerging trends towards convenience and walkability in modern urban planning represents an opportunity to rethink the way we deliver transport.

Automation has the potential to improve the safety, efficiency and productivity of Australia's transport networks. Automated transport technology may assist in addressing long term challenges in the transport sector such as accidents, efficiency issues and population growth.

The future of transport is electric, connected, automated and shared and Engineers Australia recommends working towards a regulatory environment that embraces this future.

1.3 Key messages

- Engineers Australia advocates for greater investment into innovative research and design in automated transport technology and alternative energy sources.
- Engineers Australia encourages governments to prioritise transport policies with a focus on sustainability, productivity and affordability and which support the global trend away from fossil fuel reliance.
- Engineers Australia recommends further investment in deployment of infrastructure supporting the electrification and automation of the transport network.
- Engineers Australia advocates for government prioritisation of a regulatory environment to support a healthy market for the development of Mobility as a Service (MaaS)
- Engineers Australia encourages government at all levels to appoint a Chief Engineer and advocates for the early and ongoing engagement of engineers in the planning and development of Australia's transport future.

1.4 Contact

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2. Automation in road and rail mass transit

Investment in advanced world class infrastructure is one of the key drivers of economic growth. As the transport market evolves, fresh and innovative solutions are required to adapt transport infrastructure to the changing demands of the future.

With Australia's population projected to grow by 1.1% annually,[1] continued economic growth and required maintenance of existing infrastructure assets, greater and optimum investment allocation is required if we want to stay ahead.

Transportation systems are being transformed by rapid advancements in technology. Vehicle automation, connectivity and demand for a greater focus on sustainability and the environment has seen significant investment in innovative research and design in transport technology.

Many vehicles already support simple automation systems such as parking assistance and vehicle manufacturers globally are locked in a race to provide safe and fully automated vehicles.

Over 30 cities including Copenhagen, Dubai, Seoul and Vancouver already operate fully autonomous trains and road vehicle trials are being conducted globally.

According to International Association of Public Transport (UITP) statistics published in 2016, there were 55 automated metro lines in 37 cities globally, representing a rate of growth doubling each decade since implementation of the first automated metro 30 years ago.[2]

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.

There is no doubt that there are risks associated with fully automated transport and whilst fully automated road and rail transport systems will not be standard in the immediate future, it is clear that it is set to become a reality and as such adequate research planning and preparation for an electric, connected future is a necessity.

3. Benefits of automation in mass transit

The safety benefits of increased automation in mass transit include:

- Elimination of adverse effects of driver inattention and distraction (human error)
- Automated failure analysis, detection and reporting
- Machine learning and cloud technology will ensure individual analysis can be transferred across the fleet
- More predictable running times for automated public transport options
- Greater capacity for data collection
- Accessibility
- Better recovery from delays
- Real time optimisation of energy consumption to take delays into account
- Increase lifespan of mechanical components, braking, wheels, due to smoother changes in acceleration and deceleration
- Reduced road congestion

[1] Australian Bureau of Statistics, *3222.0 Population Projections, Australia, 2017 (base) – 2066* http://www.abs.gov.au/ausstats/abs@.nsf/mf/3222.0

[2] Union International des Transport Public (UITP) Statistics Brief, *World report on metro automation*, July 2016, p1 and p2 https://www.uitp.org/sites/default/files/cck-focus-papers-files/UITP_Statistic%20Brief_World%20Metro%20Automation%202016_Final02.pdf

- Accessibility
- Energy optimisation
- Decreased operations and maintenance cost
- Reduced environmental impacts
- Economic efficiency (e.g. driverless long haul freight operations)
- Greater automation is conducive to an environment that supports Mobility as a Service (MaaS)[3]. MaaS has the potential to coordinate multimodal options, improve transport system effectiveness, strengthen public private relationships, personalise the service to align with user behaviours and promote sustainable transport.

4. Obstacles to automation in mass transit

The obstacles to increased automation in mass transit include:

- The technology is cost prohibitive on an individual basis and automated public vehicle transport remains largely under development. Furthermore, consideration of the implications for consumers must occur. For example, automated vehicles may or may not lead to significant changes in car ownership and insurance models. Consumers need to continue to be protected in regards to insurance and liability.
- Cybersecurity of automated vehicles will need to be strengthened for passenger and pedestrian safety as an attack on Australian transport networks would have vast economic repercussions.
- Research and testing to produce sufficient data demonstration safety and security will take time
- Changes to workforce compositions in the transport sector may displace staff. However, whilst there will be changes to the types of employment in this sector, there will still be a need for human staff.
- Social and cultural barriers
- Proprietary technology, locking users in with one manufacturer
- Mixed fleet integration will challenge network upgrades. There is significant research underway in driverless cars and the integration of a mixed fleet of driverless and non-driverless vehicles. Research out of the UK predicts that human-operated vehicles will remain part of our transport systems up to 2050.[4] The cost of network upgrades to support a mixed fleet is a major obstruction to automated driverless technology ubiquity.
- The length of time to transition to fully autonomous cars may present disruptions from emerging adjacent markets such as autonomous aerial passenger carrying vehicles. If it is too difficult and slow to mix driverless and non-driverless cars, then it may be simpler to make driverless vehicles airborne and physically separate them. In this scenario the land based networks may become less congested but will require significant advancements in airspace management through research in Unmanned Aerial Systems (UAS) Traffic Management (UTM).
- The current testing of automated vehicles is focusing on line marking and traffic signs which is showing up inadequacies with sensors (image recognition through cameras in particular). We also know that radar, LIDAR[5] and cameras have shortcomings in different environmental conditions as well as limitations on the distance to which they can detect an approaching object. Autonomous vehicles acting in isolation will struggle with many everyday driving situations. While they may react quickly enough for slow moving users such as pedestrians, faster moving users such as bicycle riders and trains will present major challenges (similar to the kangaroo challenge that gets popular coverage). Automated vehicles are unlikely to be able to respond quickly enough to avoid such collisions.
- The railway level crossing is particularly problematic given the speed of some trains and their absolute right of way over road traffic. Level crossings in regional areas are often protected by only a Give Way or a Stop sign and rely on the car driver to see the approaching train when it is several hundred metres away. Existing connected automated

[3] Mobility as a Service (MaaS) is a framework which aggregates infrastructure, services, technology and information to suit the travel and lifestyle needs of individuals. MaaS brings together transport operators and third parties, allowing a seamless provision of services, information, booking, payment and customer relationship management between transport modes. As an emerging concept, the definition of MaaS is not yet universal. The concept is also referred to as mobility management, future mobility, new mobility or smart mobility, with some jurisdictions considering it an independent framework and others an element of the aforementioned terms.

[4] Matthew Avery, Thatcham Research, *Automated Driving: The Technology and Implications for Insurance* http://www.pacts.org.uk/wp-content/uploads/sites/2/MatthewAvery.pdf

[5] A detection system which works on the principle of radar, but uses light from a laser

vehicle (CAV) sensors are not suitable to detect trains at a distance. Highly reliable low latency connectivity and dedicated short range communications will be vital. It is safety critical that the performance of AVs is independent of cell towers and telecommunications networks. Level crossings will require broadcast stations in order to communicate with approaching connected transport, both road based and rail based.

- Initially, these connected technologies will not be economically viable for comprehensive deployment. Therefore, the operating domain of the autonomous vehicle will be restricted by a geofence. Geofencing will be important in the deployment of most CAVs as they are unlikely to be able to deal with a range of operating scenarios due to sensor limitations or absence of connectivity in the early decades of deployment.

5. New energy sources in land based mass transit

5.1 Electric Vehicles

Cars are responsible for approximately 8% of Australia's greenhouse emissions. About 6% of Australia's total emissions are attributed to urban car travel and approximately 75% of passenger car kilometres are travelled in urban areas.[6]

Data collected by the Australian Bureau of Statistics (ABS), for the 2018 Motor Vehicle Census shows that of 19.2 million motor vehicles registered in Australia, diesel powered vehicles constitute 23.4%. This represents growth of 1.3% since 2017, with a decline in the registered use of petrol powered vehicles. Diesel currently remains the fastest growing fuel type in Australia but the increase is only modest.[7]

As the cost of more modern transport technologies decreases, so too will the reliance on fossil fuels. The trend for many national governments around the world is to ban the sale of passenger vehicles powered by fossil fuels progressively over the next 20 years.[8] The future of transport appears to be electric.

Engineers Australia encourages governments to prioritise transport policies with a focus on sustainability, productivity and affordability and which support the global trend away from fossil fuel reliance.

In June 2017, there were 476 dedicated electric vehicle public charging stations in Australia.[9] 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.[10]

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.

Engineers Australia recommends further investment in deployment of infrastructure to support the electrification of the transport network.

[6] MRCagney, Zero Carbon Australia, *Electric Vehicles, beyond ZERO emissions*, 2016, p13 http://media.bze.org.au/ev/bze_ev_report.pdf
[7] Australian Bureau of Statistics 9309.0 – Motor Vehicle Census, Australia, 31 Jan 2018. Proportion of Vehicles - By Fuel Type Graph_data 2018 http://www.abs.gov.au/ausstats/abs@.nsf/mf/9309.0
[8] For example, see Michael Slezak, *As the UK plans to phase out petrol cars, is Australia being left behind?,* The Guardian, 30 July 2017. Available at: https://www.theguardian.com/environment/2017/jul/30/as-other-countries-give-petrol-cars-an-end-date-is-australian-being-left-behind
[9] *The State of Electric Car Charging Stations in Australia* https://ldcinfrastructure.com.au/the-state-of-electric-car-charging-stations-in-australia/
[10] Christopher Jones , The Australian Electric Vehicle Association, *Around Australia Electric Highway – now complete*, 2018 http://www.aeva.asn.au/Electric%20Highway

Australia is behind the global trend in electric vehicle (EV) uptake in developed nations but, whilst growth is slow, it is certain to increase. In 2017, 2,284 electric vehicles were purchased, an increase of 67% from 2016.[11]

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

The Australian Capital Territory (ACT) released the *Zero Emissions Vehicle Action Plan* earlier this year and is a market leader in the deployment of charging infrastructure and electric vehicle uptake rates. This increase in EV uptake is also due to stamp duty exemptions and discounted registration for zero emissions vehicles.[13] Purchase incentives must be a key policy driver in promoting EV uptake across Australia.

A number of Australian states and territories are already embracing automated electric vehicle technology and are conducting trials of electric driverless buses. Engineers Australia encourages governments to continue supporting trials through fuel efficiency targets and a regulatory environment conducive to greater EV uptake for businesses and individuals. As the domestic market grows, EV manufacturers will provide more options for Australian consumers.

Some progressive governments overseas have already taken steps to ban the manufacture and sale of internal combustion engines. Whilst unrealistic for the short term, the ultimate goal can be achieved if long term planning decisions are taken now.

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 Australian can sometimes be dirtier than many of the most popular petrol cars.[14] 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.

The government must work to reduce commercial barriers for business in order to drive the uptake of electric vehicles. Further investment needs to focus on application of renewable energy source to reduce emission levels.

Engineers Australia encourages governments to continue to implement policies which incentivise electric vehicle market growth and support the electrification of our transport networks.

5.2 Hydrogen

The overall economic benefits of hydrogen production in Australia have been widely documented.

Recently, the Hydrogen Strategy Group, chaired by Australia's Chief Scientist, produced a briefing paper for the Council of Australian Governments Energy Council extolling the broad social and economic benefits of hydrogen production for Australia.[15]

The group identified 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.*

[11] ClimateWorks Australia and the Electric Vehicle Council, *The State of Electric Vehicles in Australia. Second Report: Driving Momentum in Electric Mobility*, p3 https://climateworks.com.au/sites/default/files/documents/publications/climateworks_australia_state_of_electric_vehicles2_june_2018.pdf

[12] Department of Transport (DOT) *Victorian Integrated Survey of Travel and Activity (VISTA),* Victorian Government, 2018

[13] Electric Vehicle Council, *Electric Vehicle industry welcomes ACT's policy leadership,* 16 April 2018, http://electricvehiclecouncil.com.au/electric-vehicle-industry-welcomes-acts-policy-leadership/

[14] City of Melbourne, Transport Strategy Refresh, April 2018, p2 https://s3.ap-southeast-2.amazonaws.com/hdp.au.prod.app.com-participate.files/6615/2948/1938/Transport_Strategy_Refresh__Zero_Net_Emissions_Strategy_-_Greenhouse_Gas_Emissions_and_Air_Quality.pdf

[15] Hydrogen Strategy Group, *Hydrogen for Australia's future,* August 2018 https://www.chiefscientist.gov.au/wp-content/uploads/HydrogenCOAGWhitePaper_WEB.pdf

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.*[16]

Whilst the combustion characteristics of hydrogen differ from other fuels, overall the associated risks are similar.[17]

With an increased demand for zero emissions transport options, hydrogen fuel cells can provide a reasonably priced, rapid refuel and long range alternative. Furthermore, as hydrogen has the capacity to store energy and flexible load, grid resilience is increased.

In tandem with the incentives and deployment of infrastructure policies required for the electrification of our transport networks, Engineers Australia encourages the government to recognise the value of fostering our hydrogen energy power.

With air quality becoming an increasing concern in cities, hydrogen offers a cleaner, quieter alternative. Whilst the initial expense for purchase of a hydrogen train

Germany has recently embraced hydrogen rail power, with the first hydrogen train entering into commercial service earlier this year. Another fourteen hydrogen trains will be delivered in Germany by 2021 with other countries following suit.

Despite the benefits outlined above, hydrogen is still expensive to produce and unless it is produced using renewable sources, cannot be considered renewable.[18]

5.3 Biofuel

Biofuels are derived from organic matter and currently account for approximately 2% of Australia's fuel consumption.[19]

Concerns have been raised about the effect on food security, water security and the environment of first generation biofuels which are derived from food sources such as sugar, corn, maize, wheat, oats and sorghum.[20] Producing biofuel from these sources has consequences for the environment, as it requires land clearing, water use and could increase food costs.

Technological advances have seen an emphasis on production of sustainable second generation biofuels, which are produced using a wider range of sources such as wood waste and agricultural residues and therefore mitigate food/water and environmental security issues. As an example, the University of Melbourne has developed a process for converting inedible algal biomass to biofuel.[21]

Second generation biofuels are capable of producing a wider range of fuels and *may provide a direct path to hydrogen production…and…have the potential to replace a significant proportion of our transport fuel requirements.*[22]

Converting algal biomass and other inedible plant material into fuel could reduce Australia's reliance on fuel imports and reduce transport emissions. With agricultural expertise and potential to harness solar power, Australia is in an excellent position to develop a sustainable and competitive biofuel industry.[23]

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[16] Ibid.
[17] Energy Pipelines Cooperative Research Centre, *Research Report: Identifying the commercial, technical and regulatory issues for injecting renewable gas in Australian distribution gas networks*, July 2017, https://www.energynetworks.com.au/sites/default/files/epcrc_report_for_ena_-_research_report_-_july_2017_-_final_with_appendix.pdf
[18] US Department of Energy Alternative Fuels Data Center *Hydrogen Production and Distribution,* https://afdc.energy.gov/fuels/hydrogen_production.html
[19] Australian Renewable Energy Agency, https://arena.gov.au/about/what-is-renewable-energy/bioenergy/
[20] Parliament of Australia, *Alternative Fuels,* https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/Browse_by_Topic/ClimateChangeold/responses/mitigation/emissions/alternative#BIOF
[21] Australian Renewable Energy Agency, https://arena.gov.au/about/what-is-renewable-energy/bioenergy/
[22] Parliament of Australia, *Alternative Fuels,* https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/Browse_by_Topic/ClimateChangeold/responses/mitigation/emissions/alternative#BIOF
[23] Australian Renewable Energy Agency, https://arena.gov.au/about/what-is-renewable-energy/bioenergy/

6. Commonwealth roles and responsibilities

The commonwealth has a responsibility to the states and territories to support sophisticated research and development of automated transport technology and alternative fuel sources.

The commonwealth 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 has 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.

The commonwealth has a responsibility in supporting 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.

Engineers Australia advocates for government prioritisation of a regulatory environment to support a healthy market for MaaS to emerge.

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.

Engineers Australia believes that all governments at the federal, state and territory level, need a Chief Engineer to provide a link between them and the engineering profession to benefit from this insight.

It is widely understood that engineers are critical in risk management, but engineering expertise is often neglected until an event has unfolded. Engineers Australia believes 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.

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