TIME TRAVEL

MEGATRENDS AND SCENARIOS FOR QUEENSLAND TRANSPORT OUT TO 2048

Prepared by Claire Naughtin, Joanna Horton, Oswald Marinoni, Michael Mailloux, Alexandra Bratanova and Kelly Trinh

Queensland Government

CSIRO DATA 61

CITATION

Naughtin C, Horton J, Marinoni O, Mailloux M, Bratanova, A, Trinh K. 2018. Time travel: Megatrends and scenarios for Queensland transport out to 2048. Brisbane, Australia: CSIRO Data61.

ACKNOWLEDGEMENTS

We are grateful for the many individuals, including the Queensland Department of Transport and Main Roads staff and representatives, who kindly offered their time, expertise and resources in this project.

CONTENTS

FOREWORD

The future of transport is uncertain, with potentially massive changes on the horizon.

Some of these changes are widely discussed—automated and electric vehicles, drone deliveries, new ways of travelling such as through ride-sharing and car-sharing, growing and aging populations and changed work practices like work from home—to name just a few. The Department of Transport and Main Roads (TMR) is tasked with planning for the future of transport, and it is important that we take such changes into account as we develop our 30 year plan for the transport system—the Queensland Transport Strategy. Responding to the challenges of the future is critical if we are to achieve the department's vision of creating a single integrated transport network accessible to everyone.

I am pleased, therefore, to release this report—Time travel: Megatrends and scenarios for transport in Queensland out to 2048.

Transport and Main Roads has worked closely with CSIRO's Data61 to develop this report, which helps us to understand and plan for the challenges, risks and opportunities that the future may hold for transport in Queensland. The report identifies:

- emerging technological, social and business trends (such as the "sharing economy") that are likely to affect transport
- key uncertainties around how these trends could emerge and impact transport over time
- how Queensland communities, and those who use our transport system, could be affected by these changes in how people and goods move.

To help us understand how these upcoming changes might impact transport in Queensland, TMR and Data61 have developed four plausible scenarios that might play out, depending on:

- how quickly Queenslanders take up emerging technologies (like driverless and electric vehicles) and business models (such as ride-sharing and car-sharing)
- where and how they choose to live and work, which will determine length and number of trips Queenslanders need to make and whether (in urban centres) peak-hour weekday commutes continue to be the norm.

The four different worlds identified in this report show very different outcomes for transport fundamentals such as public transport usage, the cost of transport for households, and road safety. For instance, the number of road fatalities and injuries could be very different in a world where automated vehicles are widely adopted, or where people travel shorter distances, less often—compared to a world where automated vehicle technology is not taken up, or people continue to travel longer distances during peak hours.

In this report, these key transport fundamentals are modelled for each of the four scenarios, to show us what could be at stake and help us to prepare for the changes coming our way. This will assist TMR in ensuring that no group is unfairly disadvantaged by these changes and that the benefits are shared equitably across our communities, steering us towards the best future for transport in Queensland.

Neil Scales OBE

Director-General, Department of Transport and Main Roads
ONC (Eng), HNC (EEng), DMS, BSc (Eng), MSc (Control Engineering and Computer Systems), MBA, CEng (UK), FIET, FIMechE, FICE, FIEAust, FCILT, FLJMU, FRSA, FSOE, FIRTE, MAICD

INTRODUCTION

Transport is a key enabler that moves and connects people, places, goods and services. But the way Queensland's transport system achieves this is rapidly evolving. Understanding and adapting to these changes will help ensure safe, efficient and quality travel for all Queenslanders in years to come.

This report uses strategic foresight to explore how future trends and scenarios for Queensland's transport system could unfold out to 2048. This approach provides a structured and evidence-based analysis that can inform long-term strategic and policy decisions. This report does not aim to predict the future; instead it illustrates the future changes, risks, and opportunities for Queensland's transport system to help stakeholders understand and adapt to these in advance.

This is the second report from the *Q-Foresight* program — a joint strategic foresight research initiative between the Queensland Government and CSIRO's Data61. Q-Foresight is designed to help decision-makers in Queensland's government, industry and community make informed choices.

The report has three sections:

- Section one looks at five drivers of change, described as megatrends, that will impact how much, when and why people and goods travel in Queensland in the future.
- Section two looks at the key unknowns concerning Queensland's transport system which create uncertainty around future changes in technology, shared mobility models and travel patterns.
- Section three maps out four plausible future states for transport in Queensland, providing estimates for how this could impact key transport-related areas. These scenarios provide evidence-based narratives about plausible future changes.

This innovative report combines strategic foresight and quantitative modelling. In doing so, it draws on a wide selection of transport-related data from the Queensland Department of TMR, the Australian Bureau of Statistics and other sources.

The factors impacting the transport system will likely have different effects across the metropolitan, regional and rural areas of Queensland. This report therefore aims to provide a whole-of-state account of future changes, challenges, and opportunities in Queensland's transport system.

This report is a discussion starter for TMR to use with its stakeholders and the community. It is not a government policy proposal or plan. Rather, it is designed to inform the development of long-term transport strategies that leverage opportunities and mitigate risks for Queensland's transport system over the coming decades.

CHANGING GEARS

A megatrend is a powerful force of change that will affect government, industry and/or society. It occurs at the intersection of multiple trends and has a time frame of 10 years or longer.

This report identified five megatrends that will impact Queensland's transport system. These megatrends are the evidence base used to develop future scenarios for Queensland transport.

On the move

Demand for transport has risen consistently over the past few decades, with people and goods travelling more frequently. A key driver of this demand is population growth and Queensland's population is projected to increase from 4.5 million people in 2011 to 8.1 million by 2048.[1]

Demand for transport is further driven by the range of transport options, such as shared mobility models (e.g. app-based ride services, or bike-sharing programs), which reduce the need to own a private vehicle or bike. Alternatively, people can share rides and vehicles. Future developments such as fully connected and autonomous vehicles and high-speed travel could fuel further demand for mobility.

New mobility technologies, such as electric and autonomous vehicles, could also make it cheaper to travel in the future. For instance, fully connected and autonomous vehicles could reduce travel costs by $2,600–$5,200 per annum per vehicle by reducing the cost of crashes, travel time, fuel and parking.[2] In addition, the maintenance costs of electric vehicles are likely to be lower than that of internal combustion vehicles.[3,4]

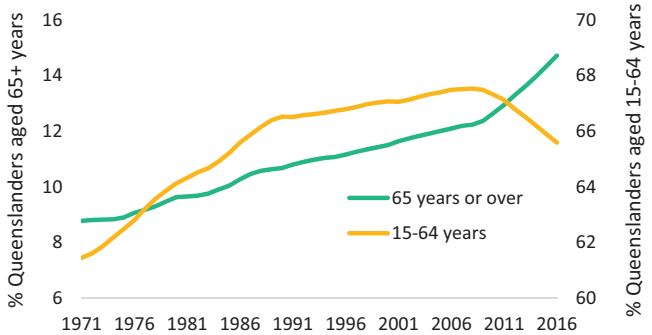


Figure 1. Percentage of Queensland population of working age (15–64 years) and aged 65 and over

Data source: Australian Bureau of Statistics[5]

The nature of transport demand is also changing. In 2011, 13.0% of Queensland's population was aged 65 or over and this is rising along with a decline in those of working age (see Figure 1). These demographic trends could change future demand for work-related travel and travel for other purposes (e.g. leisure, shopping or social activities).

Digital dividends

From autonomous vehicles to big data applications, Queensland's transport system is likely to experience significant changes as emerging technologies become more capable, affordable and widespread. These advances could improve the safety, reliability and quality of Queensland transport.

For example, building information modelling could reduce the cost of future transport infrastructure projects, with returns on investment anywhere from 16% to 1,654%.[6] Building information modelling digitally models construction projects in three or more dimensions quickly, precisely and accurately, and has been used extensively in the United Kingdom.[7]

Big data analytics could also be used to better understand, manage and shift peak traffic demand,[8,9] and design targeted transport solutions.[10] Moreover, cooperative intelligent transport systems could enable vehicles to communicate with each other and with connected infrastructure; one study estimates that this will more than triple highway capacity (see Figure 2). Even if these specific projections are not realised, fully connected and autonomous vehicles are still expected to provide major capacity benefits.

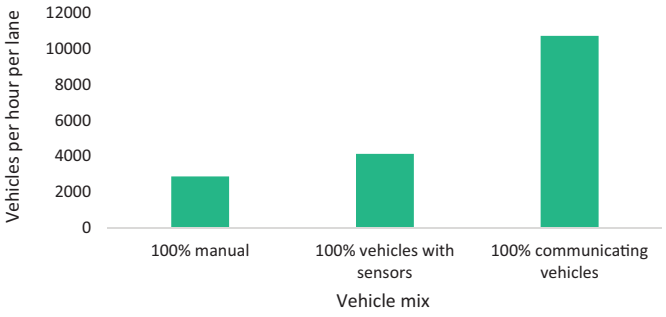


Figure 2. Highway capacity under full-adoption scenarios for manual, sensor-equipped and communicating vehicles

Data source: Tientrakool, Ho and Maxamchuk[11]

There is much interest in the impact of autonomous vehicles on the transport sector, as evident by rising investment in autonomous vehicles.[12] These investments are motivated by the potential for fully connected and autonomous vehicles to reduce transport costs and greenhouse gas emissions, and to improve road safety and transport accessibility.[13-15]

Virtually there

Advances in digital technologies open up new ways of accessing goods and services, thereby reducing the need to physically travel to places, particularly for those living in rural and regional areas. This is seen in the rise in online shopping in Queensland, up by 9.8% from 2016 to 2017[16], and the increase in transport-related transactions being completed online (see Figure 3).

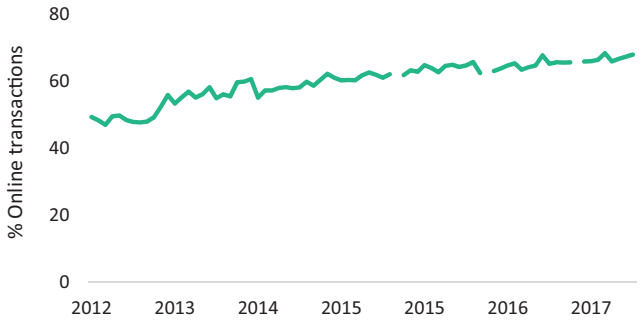


Figure 3. Percentage of Queensland Transport and Main Roads transactions performed online out of total available transactions that can be performed online

Data source: Queensland Department of Transport and Main Roads
Note: Gaps in trend line indicate missing data.

The number of people who regularly work remotely has increased across Australia, but Queensland lags behind the national average (14.7% vs. 18.0% in 2016–17).[17,18] The increasing use of artificial intelligence and robotics in the workforce will likely reduce time spent on physical tasks and increase time spent on intellectual tasks that can be done remotely.[19]

Employment in the services sector is already growing. Industries such as administrative services, professional services and health care and social assistance are among the fastest growing industries in Queensland (see Figure 4). Growth in Queensland's services sector mirrors national and global trends, and reflects the state's transition to a more knowledge-based economy.

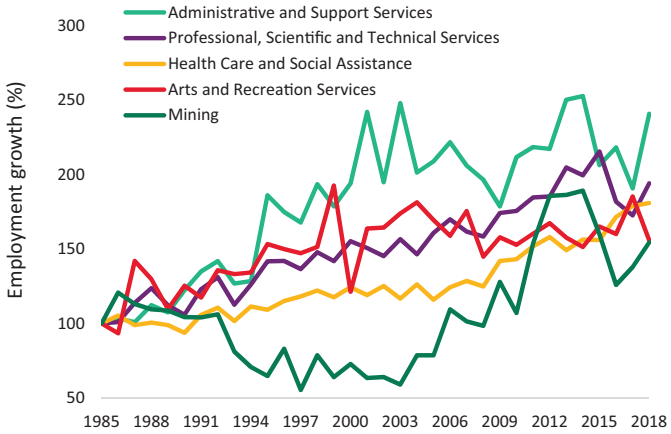


Figure 4. Employment growth across Queensland's five fastest growing industries (index 1985 = 100)

Data source: Australian Bureau of Statistics[20]

More time online has resulted in reduced physical activity, with the average Queensland adult spending 38.5 hours per week on sedentary activities.[21] A lack of physical activity is associated with obesity, diabetes, cardiovascular disease and premature mortality.[22] Through cycling and walking, there are opportunities to use travel as a means to counter these health trends.

A lighter footprint

The transport sector has a significant impact on the environment and accounted for 14.3% of Queensland's total greenhouse gas emissions in 2014.[23] A global geopolitical shift to reduce this sees many countries phasing out the sale of petrol and diesel vehicles over the coming decades,[24] or setting targets for electric car sales.[25]

Low-emission, electric vehicles have become more accessible by the 72.7% fall in the price of lithium-ion batteries between 2010 and 2016 [26]. While up to 33% of the global car fleet will be electric by 2040,[27] Queensland's, and indeed Australia's, uptake of electric vehicles has been low (see Figure 5), likely due to limits in vehicle capabilities and availability of electric vehicles.[28]

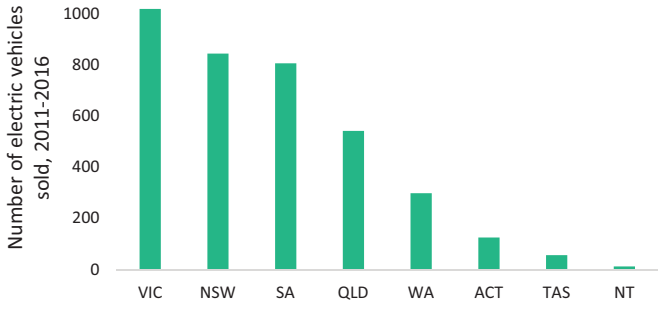


Figure 5. Number of electric vehicles (excluding hybrid vehicles) sold across each Australian state from 2011–2016

Data source: ClimateWorks Australia[28]

Vehicles have become more fuel efficient with average emissions dropping by 26.9% from 2002 to 2015.[29] These benefits of increased vehicle efficiencies could be greater if vehicle sharing became mainstream. There has also been a noticeable shift from 5-/6-cylinder to 4-cylinder vehicles (see Figure 6). The latter consume less fuel (11.7 vs. 10.0 L per 100 km) [30] and therefore produce fewer emissions.

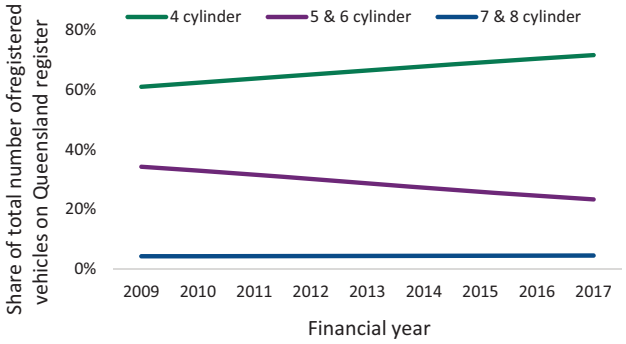


Figure 6. Share of total number of registered vehicles on Queensland register by cylinder type

Data source: Queensland Department of Transport and Main Roads

Road safety is another area of concern for the transport sector. Road crash fatalities have remained stable in recent years,[31] but incidents involving vulnerable road users (e.g. motorcyclists) have risen.[32] Fully connected and autonomous vehicles could lead to radical improvements in safety, with full vehicle automation potentially reducing traffic accidents by up to 90%.[33]

Empowered consumers

The past few decades have seen growing consumer demand for greater choice and personalisation of services.[34] In the transport sector, consumers increasingly expect individual, on-demand and streamlined transport services over traditional schedule-based models. Enabled by the proliferation of smartphones and access to data, new platforms have emerged which better connect passengers and freight to mobility services.

Sharing schemes for cars, bikes, freight and individual passenger trips have become increasingly popular. For instance, the number of available bikes in docked bike-sharing schemes rose from 139,300 in 2010 to 278,057 in 2018.[35,36] Novel 'mobility-as-a-service' schemes that integrate multiple mobility services into a single subscription fee are also emerging.[37]

But not all sharing is equal. Vehicle sharing can reduce CO_2 emissions, congestion and the need for parking spaces,[38] but ride sharing can have the opposite effect if rides are not shared with passengers on the same route. Indeed, a study of ride sharing in New York found a net increase of 31 million trips and 966 million vehicle kilometres travelled from 2013 to 2016.[39]

Younger consumers are particularly responsive to these new forms of transport—they own fewer cars (see Figure 7), drive less and have a more favourable view of public transport than older age groups.[40-42] Moreover, licensing growth rates in Queensland for people aged under 25 have dropped from 3.1% in 2006–2007 to 1.2% in 2016–2017.[43] This is consistent with a global decline in licensed youth.[44] Young people are more likely to use app-based ride services (33.6%) compared to all other age groups (25.1% or lower).[45]

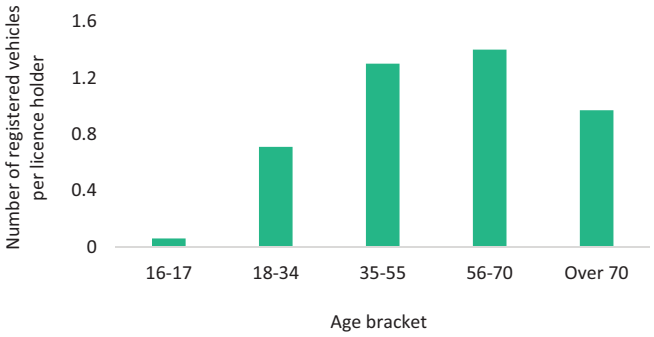


Figure 7. Rates of vehicles registered to Queensland licence holders by age bracket

Data source: Queensland Department of Transport and Main Roads


RAIL
CROSSING
WAY
GIVE
WAY

KEY BLIND SPOTS

The megatrends identified in this report raise key uncertainties for Queensland's transport system over the coming decades. Where will people work and live? How will travel patterns change? How willing and able will Queenslanders be to adopt new technologies and mobility service models?

The future is difficult to predict and Queensland's transport system could head in a range of plausible directions. This report identified four scenarios for Queensland transport out to 2048 based on two of the most significant and impactful uncertainties: variability in mobility patterns and level of technology transformation in the transport system.

Variability in mobility patterns: where and when will people travel?

It is unclear whether Queensland's mobility patterns will become more concentrated or more dispersed in the future. This has implications for managing peak demand and the viability of mass transit systems, particularly in regional and remote communities.

Queensland's population is becoming more concentrated, with South East Queensland showing the greatest internal net migration (see Figure 8). This is driven by the need and/or desire to travel for work and study. Concerns around productivity, cost, security, career progression, work–life balance and team coherence could discourage the large-scale adoption of teleworking.[46]

On the other hand, mobility could become more dispersed. Queensland is already the most dispersed state in Australia, with 51.7% of the population living outside the capital city.[47] Regional hubs outside of Brisbane are projected to be the fastest growing regions, including Ipswich (up 184.3% from 2016–36), Logan (72.0%) and the Scenic Rim (68.2%).[48]

Housing affordability is a key factor that could drive Queenslanders to live in more regional and remote areas. Out of the 12 regions in Queensland with the fastest growing housing prices, 11 of these are located in South East Queensland.[50] In addition, lengthy commutes could discourage people from living and working further from the city.[51]

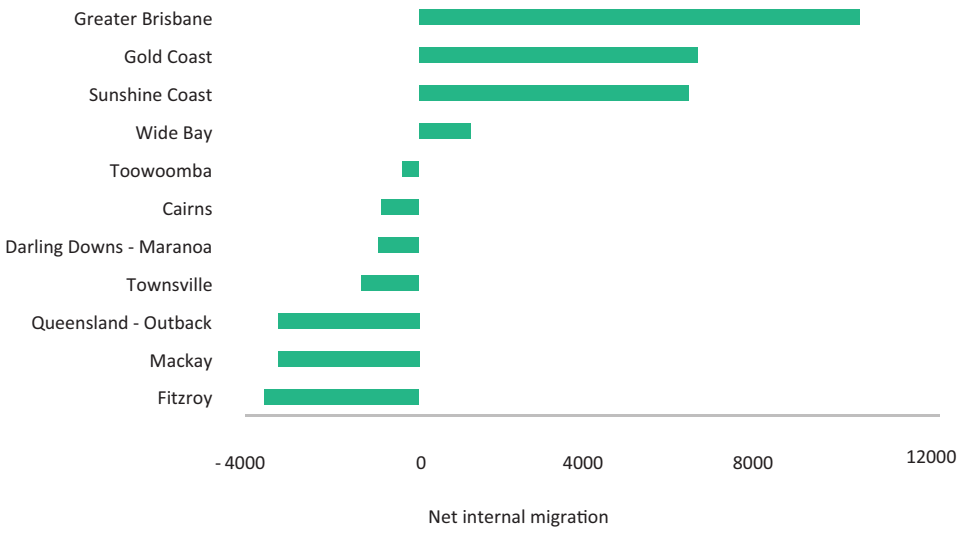


Figure 8. Net internal migration in Queensland from 2006 to 2016 by region

Data source: Australian Bureau of Statistics[49]

Level of transformation: will technologies and services be adopted?

The extent to which new digital and mobility technologies—and the business models they give rise to—penetrate and transform Queensland's transport system in the future is also unknown. This assumes that technology is a necessary prerequisite for, but not a determinant of, uptake of new mobility services.

We could see a high level of uptake of new digital and mobility technologies and services which significantly transform Queensland's transport system. This would include fully autonomous, electric and connected vehicles as well as intelligent digital transport infrastructure. It would enable efficient, safe and reliable transportation of people and goods across the state.

Signs of this are already evident, as Internet of Things applications (e.g. global positioning system trackers) are used in public transport systems and ride-sharing apps to provide real-time vehicle tracking.[52] The price of lithium-ion batteries is already on the decline too,[26] so electric vehicles could become increasingly affordable and capable in the future. The high level of investment in future transport technologies[12,53] further indicates the plausibility of these technologies being developed, introduced and transforming Queensland's transport system.

However, high uptake of new digital and mobility technologies and services is not a certainty, and could be disrupted by a number of future developments. Concerns around safety and cybersecurity could deter people from using new mobility services enabled by technology, such as fully connected and autonomous vehicles. This could be triggered by high-profile accidents involving autonomous vehicles, such as the 2018 incident where an autonomous car hit and killed a pedestrian.[54] The number of cyber-attacks in Australia are also on the rise (see Figure 9).

New digital and mobility technologies could also fail to meet consumer expectations and needs. Many present-day artificial intelligence experts raise these concerns around the development of fully autonomous vehicles.[55-58] Moreover, the need to drive long distances in Queensland could discourage many consumers from buying an electric car.[59]

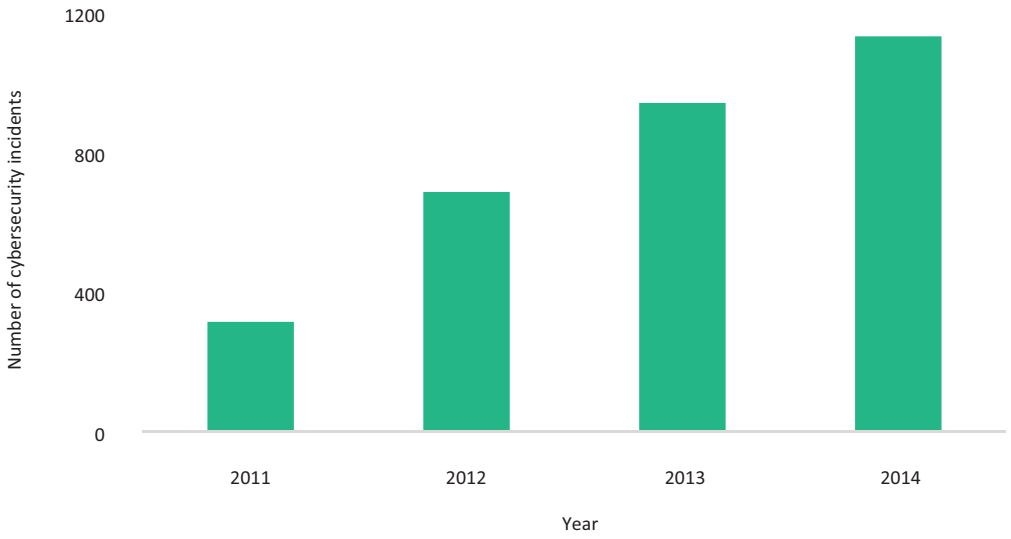


Figure 9. Number of cybersecurity incidents reported in Australia

Data source: Australian Cyber Security Centre[60]


Veefil
ELECTRIC VEHICLE FAST CHARGER
ISAAC REGION
ADVANCE QUEENSLAND
Queensland Government
TRITIUM
ELECTRIC VEHICLE
FAST CHARGER
Proudly supported by

ON THE HORIZON: FOUR SCENARIOS

This section presents four scenarios for Queensland's transport system over the next 30 years. These scenarios are not designed to predict the future, but to build awareness around key challenges, risks and opportunities for Queensland, and highlight the choices decision makers may face.

Off-peak, on-demand

The promises of autonomous, connected and intelligent transportation have been fully realised, and advances in digital technologies have reduced the need to physically access services. Queensland's population is more dispersed and people's travel is non-routine.

Movement of people and goods is done so via personalised, on-demand services and people take fewer and shorter trips. There is less need for Queenslanders to own a private vehicle, and transportation is more efficient, fair and reliable.

New digital infrastructure manages demand effectively. High upfront infrastructure costs mean the roll out of these developments are varied across the state, with some regions benefiting ahead of others. Parts of the network are underutilised and need to be re-purposed.

Dispersed mobility patterns

People's travel is non-routine and **dispersed**

Suburban streets

Uptake of digital and mobility technologies, such as autonomous and electric vehicles, is slow due to limitations in their capabilities and accessibility. This acts as a barrier to the creation of new mobility services. Private car ownership still prevails.

Many people now work and study remotely, driven by the desire to escape the rising costs of urban living and live in a more regional area. Teleworking does not substitute the office or classroom entirely though, so people still make the occasional trip into a central location.

Mass transit systems and the freight network operate inefficiently, and it is costly for government to service the mobility needs of a dispersed population. The divide between regional and metropolitan areas grows too, with those who can afford to live in the city benefiting from lower peak demand.

Cruise control

Mobility patterns concentrate around peak times and/or destinations, but new technologies and mobility models enable better traffic management. This significantly transforms Queensland's transport network.

Urban concentration of work, education and services continues to drive people's desire to live close to the city. Many people choose to forgo a car and use public transport and other point-to-point mobility services. While some have embraced shared mobility, others use autonomous vehicles like a private taxi.

The freight sector is highly efficient too, with mainstream use of autonomous trucks and drones for last-mile delivery. Freight deliveries are optimised for South East Queensland, as this increasingly becomes the centre of economic activity.

Bumper to bumper

Public safety and security concerns and a lack of investment in new infrastructure has halted uptake of new mobility technologies and services. Many futuristic predictions have not eventuated, and people still migrate to live, work and study in South East Queensland.

The concentration of travel patterns enables public transport systems in the Brisbane CBD to operate more efficiently, but the quality and reliability of public transport in regional areas declines. Many people still own a car as their preferred mode of transport, particularly for those outside of South East Queensland.

Uptake of shared mobility services and autonomous vehicles is minimal, which adds to inefficiencies in freight and passenger transportation. This drives up household expenditure on transport and transport-related emissions.

Scenario signals

Scenario signals are future events which may indicate that a certain aspect of a scenario has emerged. Understanding these signals can help decision makers better anticipate future risks, opportunities, and changes.

Signals for the evolution of Off-Peak, On-Demand include:

- Geopolitical events leading to a decline in global oil supply, which strengthens a push towards renewable sources of energy.
- Increased vehicle sharing and reduced vehicle ownership as current youth pass on similar values around mobility options to the next generation.
- A cultural shift from living in larger cities in favour of a more regional lifestyle. The feasibility of this for many Queenslanders is enhanced by the ability to work remotely.
- Population growth in regional and rural areas in Queensland increasing, along with declines in South East Queensland population growth and reduced net internal migration to South East Queensland.
- Capabilities of automation and digital technologies improving at an accelerated rate, and businesses increasingly implementing these technologies to replace workers for manual, routine tasks.

Signals for the evolution of Suburban Streets include:

- A social shift towards lifestyles that have a lower impact on the environment, with more people (both in Queensland and abroad) choosing to go 'off-grid' to various extents.
- Housing price pressures in Brisbane similar to those in Sydney and Melbourne.
- A major crash in the oil price further incentivising people away from electric vehicles in favour of petrol and diesel vehicles.
- Expanding tiers of government to better manage land use across a dispersed population. The role and influence of regional local governments increase as a result.
- Significantly delayed uptake of autonomous vehicles and other new mobility technologies, due to public concerns around safety and security, or technical barriers in their development.

Signals for the evolution of Cruise Control include:

- An increased focus on integrated land use and planning, and the centralisation of decision-making about future transport operations. Future investments in infrastructure corridors are therefore concentrated around urban centres.
- Updating of pricing models to reflect network use and end users are incentivised to use particular options (e.g. public transport, vehicle sharing or alternative travel times etc.) to better manage rising peak demand.
- An accelerated shift towards renewables for power generation improving cost and accessibility of power for electric vehicles.
- An increase in the number of electric vehicles manufacturers in Australia, opening up a wider selection of electric vehicles and promoting competition.

Signals for the evolution of Bumper to Bumper include:

- Slowing or plateauing improvements in autonomous and electric vehicles, along with investment in necessary infrastructure (e.g. charging stations).
- A significant event, or series of events, damaging the public's trust in autonomous vehicles, drones and other emerging technologies.
- Accelerating urban congestion and government expenditure on transport infrastructure in South East Queensland versus the rest of Queensland.
- Changes to immigration policies that encourage greater net overseas migration to Queensland, further adding to South East Queensland's rising population.

Transport fundamentals

The estimated impact of these alternative scenarios were modelled across the transport fundamentals:

- Vehicle kilometres travelled
- Public transport patronage
- Household expenditure on transport
- Greenhouse gas (CO_2) emissions
- Road traffic crash fatalities and hospitalisations

VEHICLE KILOMETRES TRAVELLED

Under Off-Peak, On-Demand, people access more services remotely and travel less. The freight fleet has to service a more dispersed population, but can do so more efficiently aided by new technologies.

Under Suburban Streets, limits in teleworking capabilities cap the extent to which passenger kilometres decline. The freight sector travels longer distances, and there is less demand for bus services.

Under Cruise Control, the breadth of new mobility services fuels demand for passenger transport, increasing the number of trips made by foot, bike, public transport and car.

Under Bumper to Bumper, there are few new mobility options, so growth in kilometres travelled is largely seen for cars and buses.

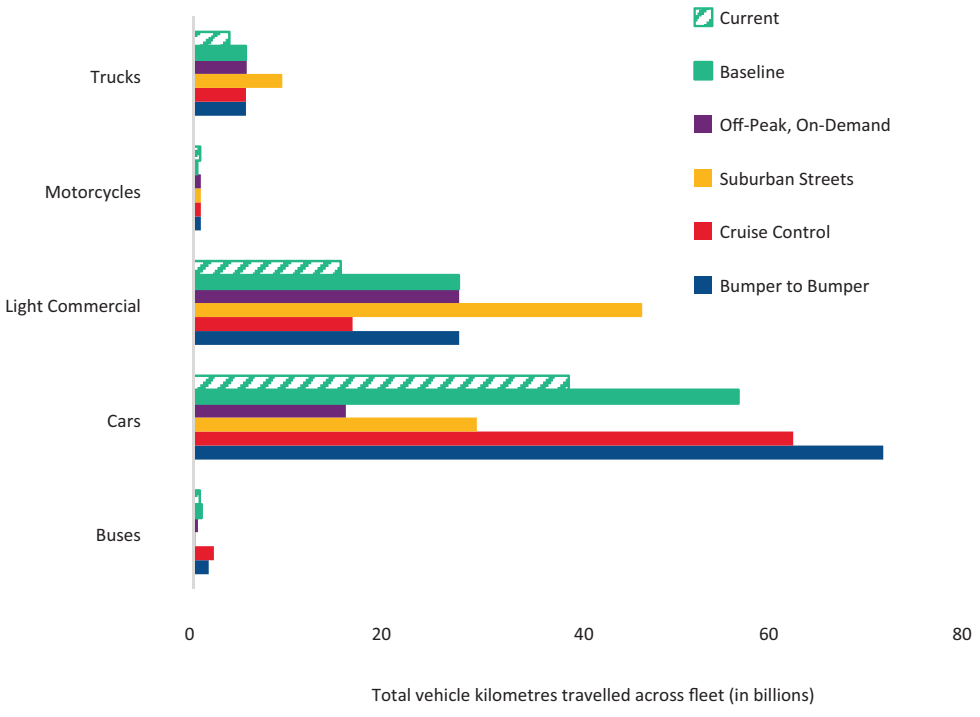


Figure 10. Projected vehicle kilometres travelled across the fleet (in billions)

Data source: Queensland Department of Transport and Main Roads and Data61 estimates

PUBLIC TRANSPORT PATRONAGE

Under Off-Peak, On-Demand, public transport patronage reduces for all modes in favour of more personalised, on-demand services.

Under Suburban Streets, demand for public transport declines, as an efficient and reliable mass transit system cannot be provided to meet the needs of a dispersed, more regional population.

Under Cruise Control, there is significant growth in public transport patronage, particularly for bus and rail, as it becomes the key mode of transport for people travelling in and out of the CBD at peak times.

Under Bumper to Bumper, public transport patronage is similar to a baseline scenario, with improvements in bus prioritisation and the suitability of rail for long-distance commuters boosting these modes.

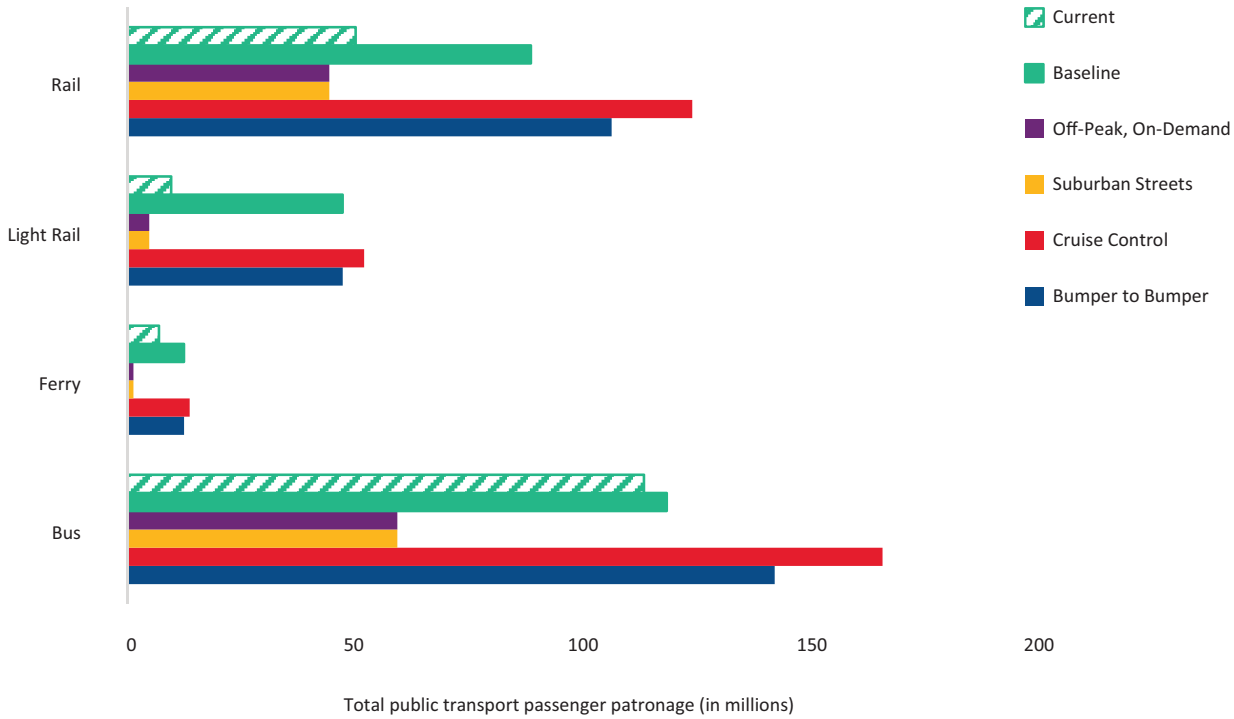


Figure 11. Projected public transport patronage across modes (in millions)

Data source: Queensland Department of Transport and Main Roads and Data61 estimates

HOUSEHOLD EXPENDITURE ON TRANSPORT

Under Off-Peak, On-Demand, the average cost of transport per household drops as fewer people own, and have to bear the cost of maintaining and operating, a private vehicle.

Under Suburban Streets, average household expenditure on transport grows at an accelerated rate due to higher levels of private car ownership and a lack of more affordable alternative transport options.

Under Cruise Control, people benefit from reduced costs of owning a private vehicle and the availability of cheaper shared and point-to-point mobility services.

Under Bumper to Bumper, transport costs rise due to increased demand during peak hours, high levels of car ownership and low uptake of electric vehicles.

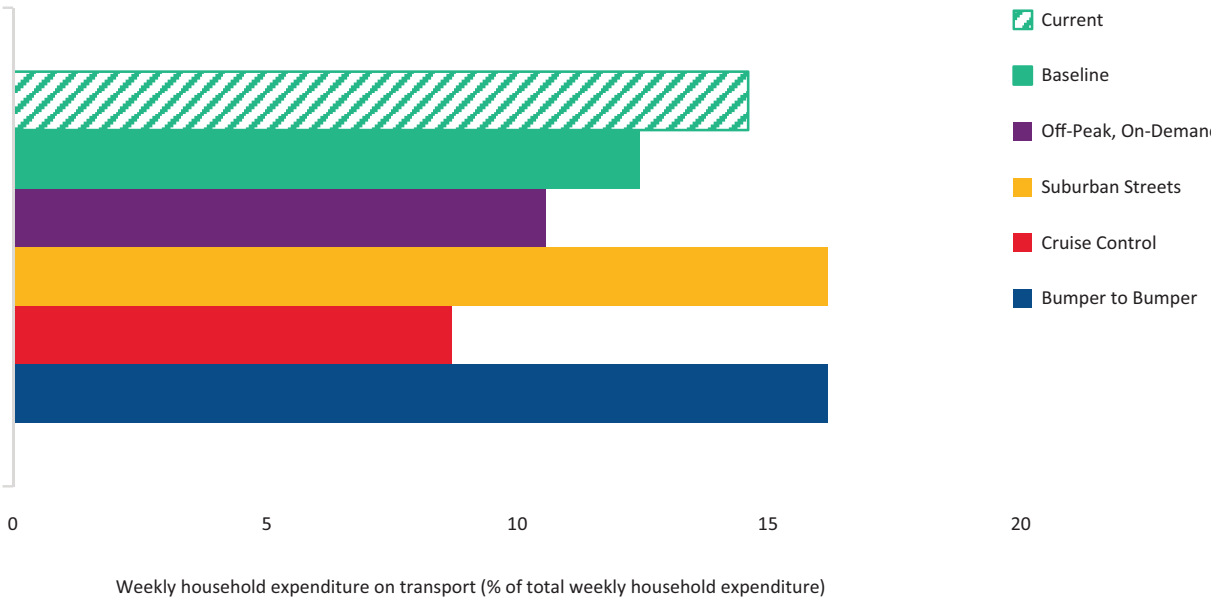


Figure 12. Projected weekly household expenditure on transport

Data source: ABS Household Expenditure Survey[61] and Data61 estimates

GREENHOUSE GAS EMISSIONS

Under Off-Peak, On-Demand, a smaller fleet and shorter distances travelled by the passenger and freight fleet drives down emissions.

Under Suburban Streets, a large share of the fleet is still powered by petrol or diesel, resulting in a significant increase in the rate of transport-related greenhouse gas emissions.

Under Cruise Control, the proliferation of shared mobility and electric vehicles helps significantly lighten the transport load on emissions.

Under Bumper to Bumper, greenhouse gas emissions produced by the transport sector continue to grow along the current trajectory in the face of minimal uptake of electric vehicles or shared mobility models.

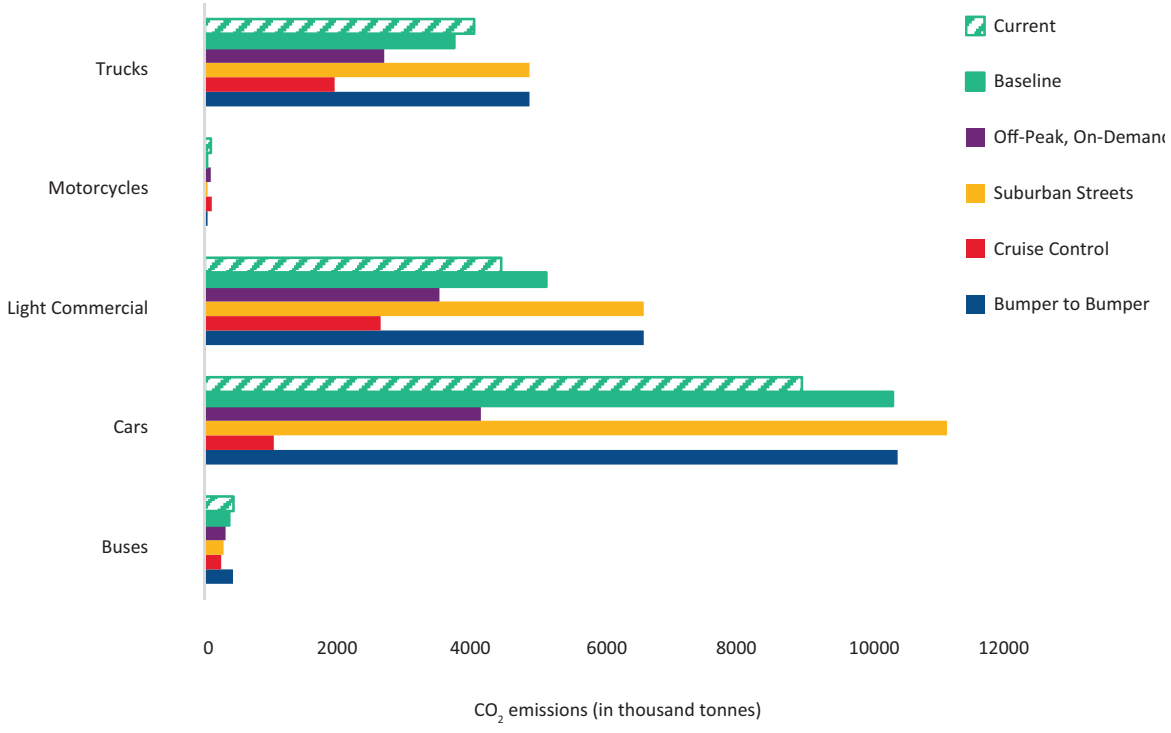


Figure 13. Projected CO_2 emissions of road transport by vehicle type (in thousand tonnes)

Data source: Queensland Department of Transport and Main Roads; Australian Bureau of Statistics;[62] Reedman & Graham;[63] Department of Environment and Energy;[64] and Data61 estimates

ROAD TRAFFIC FATALITIES AND HOSPITALISATIONS

Under Off-Peak, On-Demand, rates of road crash incidents drop off significantly due to autonomous vehicles being safer and reduced peak travel demand.

Under Suburban Streets, the number of road crash incidents reduces slightly as people take fewer and shorter trips, but accidents still occur due to human error.

Under Cruise Control, the road toll reduces due to the increased number of trips via autonomous vehicles and public transport, lowering the frequency of road traffic accidents during peak hour.

Under Bumper to Bumper, road crash incidents are slightly above the baseline scenario, as concentrated mobility patterns combined with minor vehicle safety improvements heighten the risk for accidents.

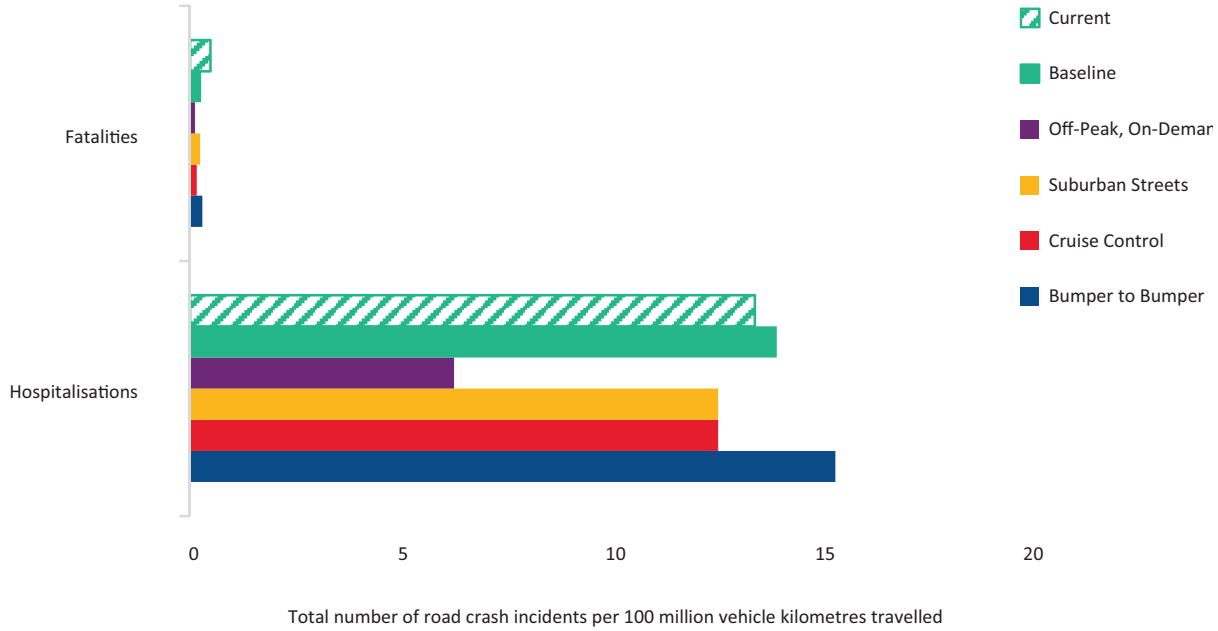


Figure 14. Projected number of road crash incidents per 100 million vehicle kilometres travelled

Data source: Queensland Department of Transport and Main Roads and Data61 estimates

NEXT STEPS

The megatrends and scenarios raise a number of risks, challenges and opportunities for Queensland's transport system and TMR's operating environment in the future. Outlined here are a number of key policy considerations for TMR over the next 30 years.

Alternative charging models for vehicle and road users

The lower rates of vehicle ownership among young road users, as well as the market shift from 5-/6-cylinder to 4-cylinder vehicles, have significant implications for TMR's future revenue streams from vehicle registration fees. With these trends in the vehicle fleet, there is an increasing need to explore alternative models for charging vehicles and road users.

For example, the Productivity Commission has suggested that most government road fees and charges could be replaced with a single fee based on how much and when drivers use roads.[67] Present-day technologies already enable tracking of vehicle movements within the network and make this charging model feasible under all future scenarios.[67] These and other models warrant ongoing consideration and discussion.

Shared mobility solutions for transport

Shared mobility offers a number of benefits: decreasing the passenger fleet size by reducing the need to own a private vehicle; reducing CO_2 emissions, congestion and the land use dedicated to public parking;[38] and thereby reducing transport costs incurred by consumers and government.[68] Conversely, low uptake of shared mobility can hinder efforts to reduce the environmental and economic impact of the transport sector.

Not all app-based mobility services are equal though. For example, services that allow users to source rides probably have different impacts to those that allow users to pool their trips with other passengers. Ride-sourcing services that lack quality, reliability and integration with other mass transit and active modes can exacerbate congestion challenges.[39] To meaningfully reduce congestion, emissions and transport costs, app-based ride services need to be integrated in a way that complements, rather than competes with, mass transit and active travel modes.

Ensuring equal and fair access to transport

New transport technologies must be considered in terms of their impact on mobility disadvantage. For instance, new mobility options, like autonomous vehicles and app-based ride services, could improve mobility access for people with disabilities. However, new transport services could also introduce new challenges to mobility disadvantage. For instance, US research has found evidence of racial discrimination on app-based ride services.[69]

There is also a geographic factor to mobility disadvantage. Under the low technology transformation scenarios, the mobility divide between Queensland regions could widen due to relative differences in the accessiblity and quality of transport options. Emerging app-based ride services operate most effectively in more densely populated areas. Thus, if the technology and the market for these services exist (e.g. as in Off-Peak, On-Demand), more regional communities could see an expansion in the breadth of mobility options.

A shift from government as a service provider to service broker

While the shift towards more digital and personalised services will likely continue under all future scenarios, high technology uptake scenarios may drive a stronger push towards more individualised options. These scenarios could see greater emphasis on mobility-as-a-service schemes that provide an end-to-end journey suited to individual needs. This rise in these schemes could see TMR's role shift from service provider to a service broker.

Under a mobility-as-a-service scheme, as transactions become increasingly digital, the focus of TMR service centres could shift from routine transactions (e.g. licensing and registration) to more complex customer service needs. For example, TMR could play the role of a collaborator between businesses, providing bespoke services, such as insurance and registration bundles that are based on the customers' need (e.g. a one-off month subscription). The nature of these services will depend on other changes (e.g. changes in the registration funding model), but this future would see TMR focus more on business-to-business than business-to-customer services.

Setting the direction for climate transition strategies

The four scenarios illustrate potential challenges and opportunities for the Queensland Government in meeting the objectives of its climate transition strategy. They also demonstrate how climate transition strategies necessitate consideration of factors beyond vehicle efficiency, technology and fuel shifts. For instance, shared mobility can enable more efficient movement of people and goods, and in turn, reduce emissions produced by the transport sector.

Queensland's climate transition strategies need to consider economic and social impacts, as well as the environmental factors. Transport is a derived demand, in which the value the transport system provides is in its ability to move people and goods, rather than the services themselves. For this reason, there are complementary policy settings outside of transport that will influence TMR's capacity to meet its objectives around transport-related emissions. As illustrated in the scenarios, changes in employment models, land-use patterns and public safety concerns could impact transport patterns and decisions around future climate transition policies.

Security and safety considerations for physical and virtual assets

The megatrends demonstrated significant benefits of new mobility technologies and service models: improved road safety[70] and fleet efficiency[71], reduced congestion[8,9] and (potentially) environmental impacts.[72-74] These benefits, however, depend on these technologies being widely adopted across Queensland. As vehicles become increasingly sophisticated and connected, cybersecurity risks will similarly rise, and require appropriate protection systems.

The responsiveness of legislative change could slow uptake of new digital and mobility technologies if it lags behind the pace of these developments. For instance, a key area for future legislation could be the commercial use of drones for delivering small parcels following on from the release of the 2017 Queensland Drone Strategy.[75]

Maintaining existing and to-be-developed infrastructure and assets

As new mobility technologies come online, so will demand for new types of transport infrastructure, such as electric charging stations for electric vehicles. The level and type of infrastructure investment will differ across each scenario, and this can encourage new mobility behaviours.[76] Population dispersion is a major factor. A more dispersed population (as in Off-Peak, On-Demand and Suburban Streets) means that the initial infrastructure investment and ongoing operational costs needed to support new mobility technologies may be more expensive.

Changes in technology could also have implications for how infrastructure is managed. For example, parts of the network could be limited to fully connected and autonomous vehicles. Moreover, the data produced by digital infrastructure will be subject to standards of security and management. These data will be valuable in managing and shifting peak demand,[77] as well as designing targeted transport solutions.[10] Under-utilisation of existing infrastructure is another risk emerging from the scenarios, particularly in those where mobility patterns become more dispersed. Strategies for asset use will need to be considered under each scenario.

CONCLUSION

This report highlights possible trends and scenarios for Queensland transport over the next 30 years. The goal here is not to predict the future, but rather to improve capacity to understand and adapt to these changes, and to start a discussion about the future of Queensland's transport system.

The report illustrates the risks and opportunities for Queensland's future transport system. One potential future opportunity is that high technology uptake and concentrated mobility give rise to a more efficient transport network in urban areas, but there is the risk that such benefits may not be realised in regional Queensland. Likewise, advances in teleworking could reduce the need to physically travel to work, study and access services, reducing the tyranny of distance across the state. But a more dispersed population could mean that transport of goods becomes more costly, or infrastructure in urban areas is under-utilised.

The insights provided in this work are intended to inform future policy and strategy decisions around Queensland's transport system. This report also aims to provide a common starting point for TMR with its external stakeholders and the community. By understanding the future patterns and drivers impacting Queensland's transport system, and the range of plausible ways these trends could unfold in the future, stakeholders in government, industry, and the community will be in a better position to anticipate and respond to these changes.

REFERENCES

1 QGSO. 2015. Projected population, by series, by statistical area level 4, Queensland, 2011 to 2036 Queensland Government Statistician's Office: Brisbane, Australia.

2 Fagnant D J, Kockelman K. 2015. Preparing a nation for autonomous vehicles: opportunities, barriers and policy recommendations. Transportation Research Part A: Policy and Practice, 77, 167-181.

3 Palmer K, Tate J E, Wadud Z et al. 2018. Total cost of ownership and market share for hybrid and electric vehicles in the UK, US and Japan. Applied Energy, 209, 108-119.

4 Delucchi M A, Lipman T E. 2001. An analysis of the retail and lifecycle cost of battery-powered electric vehicles. Transportation Research Part D: Transport and Environment, 6(6): 371-404.

5 ABS. 2016. Australian Demographic Statistics (Catalogue No. 3101) Australian Bureau of Statistics: Canberra, Australia.

6 Giel B, Issa R. 2013. Return on Investment Analysis of Using Building Information Modeling in Construction. Journal of Computing in Civil Engineering, 27(5): 511-521.

7 Department for Business, Innovation and Skills. 2012. Building information modelling. UK Government: London, United Kingdom.

8 Cárdenas-Benítez N, Aquino-Santos R, Magaña-Espinoza P et al. 2016. Traffic Congestion Detection System through Connected Vehicles and Big Data. Sensors, 16(5): 599.

9 Hu X, Chiu Y-C, Zhu L. 2015. Behavior Insights for an Incentive-Based Active Demand Management Platform. International Journal of Transportation Science and Technology, 4(2): 119-133.

10 International Transport Forum. 2015. Big data and transport: Understanding and assessing options (International Transport Forum policy papers, No. 8). International Transport Forum. Paris, France.

11 Tientrakool P, Ho Y, Maxemchuk N F. Highway Capacity Benefits from Using Vehicle-to-Vehicle Communication and Sensors for Collision Avoidance. 2011 IEEE Vehicular Technology Conference (VTC Fall); Columbia University.

12 Kerry C F, Karsten J. Gauging investment in self-driving cars. [Internet]. 2017 Available from: https://www.brookings.edu/research/gauging-investment-in-self-driving-cars/.

13 Bagloee S A, Tavana M, Asadi M et al. 2016. Autonomous vehicles: challenges, opportunities, and future implications for transportation policies. Journal of Modern Transportation, 24(4): 284-303.

14 Janssen R, Zwijnenberg H, Blankers I et al. 2015. Truck Platooning: Driving the future of transportation. TNO: The Hague, Netherlands

15 Keeney T. Autonomous electric trucks could disrupt rail and transform logistics. ARK Invest: [Internet]. 2017 Available from: https://ark-invest.com/research/autonomous-trucks.

16 Australia Post, Startrack. 2017. Inside Australian online shopping: 2017 e-commerce industry paper. Australia Post: Melbourne, Australia.

17 ABS. 2016. Household Use of Information Technology, Australia, 2014-15 (Catalogue No. 8146.0) Australian Bureau of Statistics: Canberra, Australia.

18 ABS. 2018. Household Use of Information Technology, Australia, 2016-17 (Catalogue No. 8146.0) Australian Bureau of Statistics: Canberra, Australia.

19 AlphaBeta. 2017. The automation advantage: How Australia can seize a $2 trillion opportunity from automation and create millions of safer, more meaningful and more valuable jobs. AlphaBeta: Sydney, Australia.

20 ABS. 2018. Labour Force, Australia, Detailed, Quarterly, Feb 2018 (Catalogue No. 6291.0.55.003) Australian Bureau of Statistics: Canberra, Australia.

21 ABS. 2012. 4364.0.55.004 - Australian Health Survey: Physical Activity Australian Bureau of Statistics: Canberra: Australia.

22 Medibank Private. 2009. Stand Up Australia: Sedentary behaviour in workers. Medibank Private: Melbourne, Australia.

23 Department of Environment and Heritage Protection. Transport sector greenhouse gas emissions. [Internet]. 2017 Available from: https://www.ehp.qld.gov.au/state-of-the-environment/finding/?id=3.4.0.3.

24 Petroff A. These countries want to ban gas and diesel cacrs. CNN Money [Internet]. 2017 Available from: http://money.cnn.com/2017/09/11/autos/countries-banning-diesel-gas-cars/index.html.

25 International Energy Agency. 2017. Global EV Outlook 2017. OECD/IEA: Paris, France.

26 Curry C. Lithium-Ion Battery Costs: Squeezed Margins and New Business Models. Bloomberg New Energy Finance [Internet]. 2017 Available from: https://about.bnef.com/blog/lithium-ion-battery-costs-squeezed-margins-new-business-models/.

27 Bloomberg New Energy Finance. Electric Vehicle Outlook 2017. 2017. Bloomberg New Energy Finance: London, United Kingdom.

28 ClimateWorks Australia. 2017. The state of electric vehicles in Australia. Electric Vehicle Council: Melbourne, Australia.

29 NTC. 2016. Carbon Dioxide Emissions Intensity for New Australian Light Vehicles 2015. National Transport Commission: Melbourne, Australia.

30 BITRE. 2017. Fuel economy of Australian passenger vehicles - a regional perspective. Australian Government Department of Infrastructure and Regional Development: Canberra, Australia.

31 BITRE. 2017. Australian Infrastructure Statistics: Yearbook 2017. Australian Government Department of Infrastructure Regional Development and Cities: Canberra, Australia.

32 TMR. 2018. Road casualties. Queensland Government: Brisbane, Australia.

33 Bertoncello M, Wee D. 2015. Ten ways autonomous driving could redefine the automotive world. McKinsey and Company: New York.

34 Hajkowicz S, Cook H, Littleboy A. 2012. Our Future World: Global Megatrends That Will Change the Way We Live. CSIRO: Brisbane, Australia.

35 Shaheen S A, Guzman S, Zhang H. 2010. Bikesharing in Europe, the Americas, and Asia. Transportation Research Record: Journal of the Transportation Research Board, 2143, 159-167.

36 O'Brien O. Bike Share Map. [Internet]. 2018 Available from: http://bikes.oobrien.com/#zoom=3&lon=60&lat=40.

37 Intelligent Transport Systems Review. MaaS provider launches Midlands trial. [Internet]. 2017 Available from: http://www.its-ukreview.org/maas-provider-launches-midlands-trial/.

38 International Transport Forum. 2016. Shared Mobility: Innovation for Liveable Cities. OECD: Paris, France.

39 Schaller B. 2017. Unsustainable? The Growth of App-Based Ride Services and Traffic, Travel and the Future of New York City. Schaller Consulting: New York, USA.

40 Klein N J, Smart M J. 2017. Millennials and car ownership: Less money, fewer cars. Transport Policy, 53, 20-29.

41 TransitCenter. 2014. Who's on Board? 2014 Mobility Attitudes Survey. TransitCenter: New York, USA.

42 Jaffe E. The Clearest Explanation Yet For Why Millennials Are Driving Less. CityLab [Internet]. 2015 Available from: https://www.citylab.com/transportation/2015/07/the-clearest-explanation-yet-for-why-millennials-are-driving-less/398366/.

43 Department of Transport and Main Roads. 2017. Current Queensland driver licences. Queensland Government: Brisbane, Australia.

44 Delbosc A, Currie G. 2013. Causes of Youth Licensing Decline: A Synthesis of Evidence. Transport Reviews, 33(3): 271-290.

45 Roy Morgan Research. 2017. Uber soars and well-placed to tackle rising competition. Roy Morgan Research: Melbourne, Victoria.

46 Deloitte. 2011. Next Generation Telework: A Literature Review. Australian Government Department of Broadband Communications and the Digital Economy: Canberra, Australia.

47 ABS. 2017. 2016 Census QuickStats. Australian Bureau of Statistics: Canberra, Australia.

48 Queensland Government Statistician's Office. 2015. Projected population, by local government area, Queensland, 2011 to 2036. Queensland Government: Brisbane, Australia.

49 ABS. 2017. Migration, Australia, 2015-16 (Catalogue No. 3412.0) Australian Bureau of Statistics: Canberra, Australia.

50 Geck M, Mackay S. 2018. Housing in Queensland: Affordability and Preferences. Queensland Productivity Commission: Brisbane, Australia.

51 BITRE. 2016. Lengthy commutes in Australia. Australian Government Department of Infrastructure and Regional Development: Canberra, Australia.

52 Moon P. Melbourne buses finally show how handy GPS tracking data is for customers. Australian Financial Review [Internet]. 2016 Available from: https://www.afr.com/technology/apps/melbourne-buses-finally-show-how-handy-gps-tracking-data-is-for-customers-20160715-gq6rlj.

53 Lienert P. Global carmakers to invest at least $90 billion in electric vehicles. Reuters [Internet]. 2018 Available from: https://www.reuters.com/article/us-autoshow-detroit-electric/global-carmakers-to-invest-at-least-90-billion-in-electric-vehicles-idUSKBN1F42NW.

54 Overly S. Uber suspends testing of self-driving cars after crash. Sydney Morning Herald [Internet]. 2017 Available from: https://www.smh.com.au/world/uber-suspends-testing-of-selfdriving-cars-after-crash-20170326-gv6kn9.html.

55 Ackerman E. Toyota's Gill Pratt on Self-Driving Cars and the Reality of Full Automation. International Institute of Electronic Engineers - IEEE Spectrum [Internet]. 2017 Available from: https://spectrum.ieee.org/cars-that-think/transportation/self-driving/toyota-gill-pratt-on-the-reality-of-full-autonomy.

56 Marowits R. Self-driving Ubers could still be many years away, says research head. Financial Post [Internet]. 2017 Available from: http://business.financialpost.com/pmn/transportation-business-pmn/autos-transportation-business-pmn/self-driving-ubers-could-still-be-many-years-away-says-research-head.

57 Mervis J. Are we going too fast on driverless cars? Science Magazine [Internet]. 2017 Available from: http://www.sciencemag.org/news/2017/12/are-we-going-too-fast-driverless-cars.

58 Truett R. Don't Worry: Autonomous Cars Aren't Coming Tomorrow (Or Next Year). Automotive News [Internet]. 2016 Available from: http://autoweek.com/article/technology/fully-autonomous-vehicles-are-more-decade-down-road.

59 Jacks T. Why electric cars have hit a dead end in Australia. Sydney Morning Herald [Internet]. 2017 Available from: https://www.smh.com.au/business/companies/why-electric-cars-have-hit-a-dead-end-in-australia-20171012-gyzs5j.html.

60 Australian Cyber Security Centre. 2015. The Australian Cyber Security Centre 2015 Threat Report. Australian Government: Canberra, Australia.

61 ABS. 2016. Household Expenditure Survey, Australia: Summary of Results, 2015-16 (Catalogue no. 6530.0) Australian Bureau of Statistics: Canberra, Australia.

62 ABS. 2016. Survey of Motor Vehicle Use, Australia, 12 months ended 30 June 2016 (Catalogue no. 9208.0) Australian Bureau of Statistics: Canberra, Australia.

63 Reedman L J, Graham P W. 2013. Transport Greenhouse Gas Emissions Projections 2013-2050. CSIRO: Canberra, Australia.

64 Department of Environment and Energy. 2016. National greenhouse accounts factors: Australian national greenhouse accounts. Australian Government: Canberra, Australia.

65 Santos G, Shaffer B. 2004. Preliminary Results of the London Congestion Charging Scheme. Public Works Management & Policy, 9(2): 164-181.

66 Lehe L. A History of Downtown Road Pricing. Medium [Internet]. 2017 Available from: https://medium.com/@lewislehe/a-history-of-downtown-road-pricing-c7fca0ce0c03.

67 Productivity Commission. 2017. Funding and Investment for Better Roads. Australian Government: Canberra, Australia.

68 UBS. 2017. Q-Series: How disruptive will a mass adoption of robotaxis be? UBS Evidence Lab.

69 Ge Y, Knittel C R, MacKenzie D et al. 2016. Racial and Gender Discrimination in Transportation Network Companies. NBER Working Paper No. 22776. The National Bureau of Economic Research, Cambridge, MA, USA.

70 US Department of Transportation. 2015. Critical Reasons for Crashes Investigated in the National Motor Vehicle Crash Causation Survey. Traffic Safety Facts. US Department of Transportation: Washington, D.C., USA.

71 International Transport Forum. 2015. Urban Mobility System Upgrade. OECD: Paris, France.

72 Mersky A C, Samaras C. 2016. Fuel economy testing of autonomous vehicles. Transportation Research Part C: Emerging Technologies, 65, 31-48.

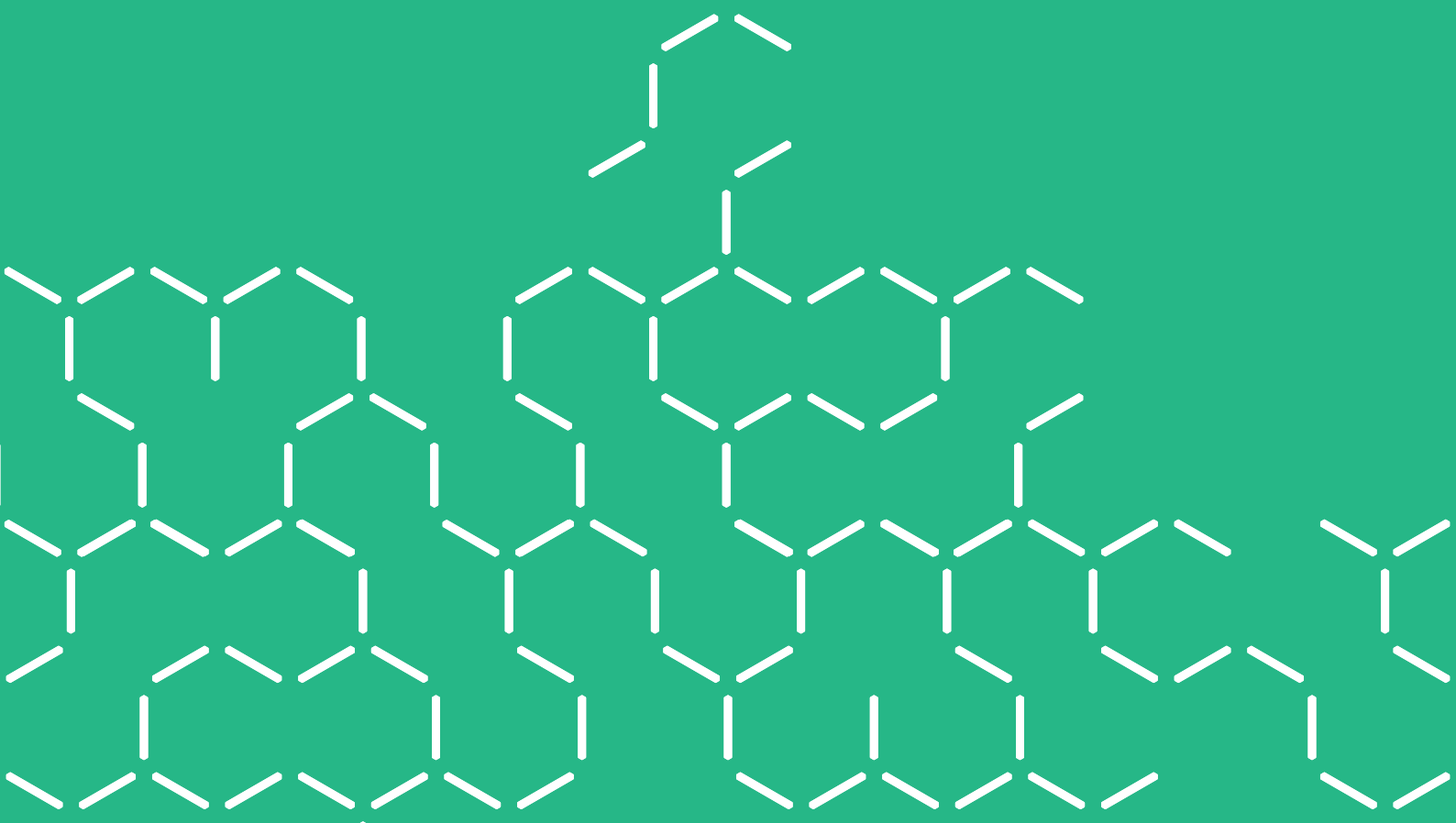
73 E. Stern R, Cui S, Delle Monache M L et al. 2017. Dissipation of stop-and-go waves via control of autonomous vehicles: Field experiments. Transportation Research Part C: Emerging Technologies, 89, 205-221.

74 Chen Y, Gonder J, Young S et al. in press. Quantifying autonomous vehicles national fuel consumption impacts: A data-rich approach. Transportation Research Part A: Policy and Practice.

75 Queensland Government. 2017. Queensland drone strategy: Consultation paper. Queensland Government: Brisbane, Australia.

76 BCC. 2012. Brisbane Active Transport Strategy 2012-2026. Brisbane City Council: Brisbane, Australia.

77 UN Global Pulse. 2017. Using Big Data Analytics for Improved Public Transport, Project Series, no. 25.



CONTACT US

t 1300 363 400
+61 3 9545 2176
e csiroenquiries@csiro.au
w www.data61.csiro.au

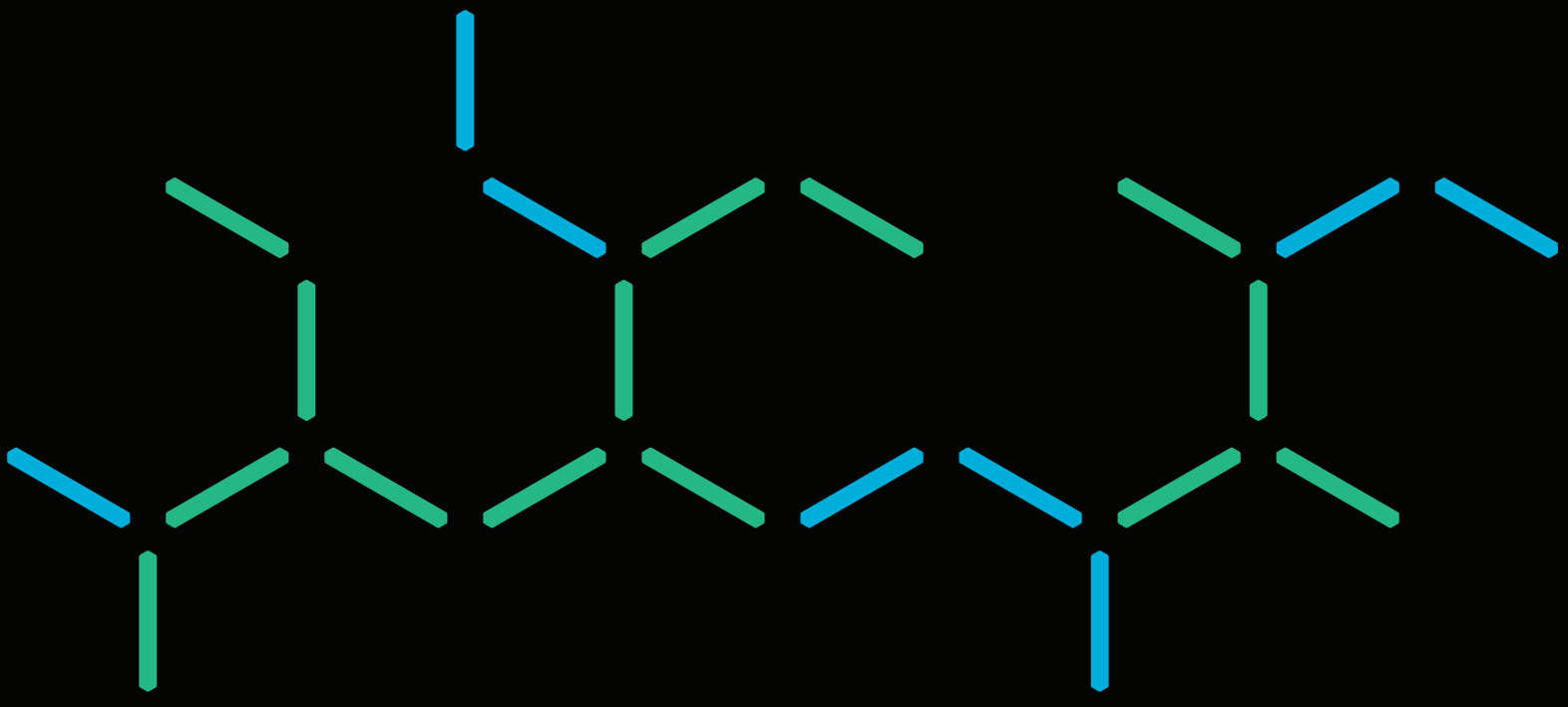
WE DO THE EXTRAORDINARY EVERY DAY

We innovate for tomorrow and help improve today – for our customers, all Australians and the world.

WE IMAGINE
WE COLLABORATE
WE INNOVATE

FOR FURTHER INFORMATION

Data61 Insight team
e insight.data61@csiro.au
w www.data61.csiro.au



B&M | 18-00382