Pathways to a clean transport sector:

A Report on the Climate Transition Strategy for the Queensland Conservation Council

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Summary

The Queensland Climate Transition Strategy (2017) has a goal for Queensland to achieve zero net emissions by 2050 with an interim target for at least a 30% reduction in emissions on 2005 levels by 2030. The Queensland Conservation Council (QCC) is conducting a critical analysis of the strategy and its actions to determine how effective they could be and to identify any preferred pathways to a zero emissions society.

This report is concerned with transport sector emissions and begins its analysis with a review of the ClimateWorks Australia's (CWA) Technical Report on how "Queensland can achieve net zero emissions by 2050" (2016). A range of initiatives are then described and incorporated into a best case scenario for 2050, with emission reductions greater than those identified in the CWA report.

Our alternative best case scenario represents a 25 percent drop from business as usual (BAU) to 19 Mt CO_2-e in 2030 and 75 percent drop from BAU to 8 Mt CO_2-e in 2050. The much stronger impact in 2050 is due to the high inertia in vehicle fleets and urban form, with vehicles often lasting for 20 years and infrastructure much longer.

The 8 Mt CO2-e of annual emissions remaining in 2050 could be offset by a range of initiatives in the agriculture and land use sectors, resulting in net emissions of zero, along with biodiversity co-benefits.

A number of recommendations are made for new initiatives over and above those in existing transport plans and the Climate Transition Strategy.

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Introduction

The Queensland Climate Transition Strategy (2017) has a goal for Queensland to achieve zero net emissions by 2050 with an interim target for at least a 30% reduction in emissions on 2005 levels by 2030.

The Queensland Conservation Council (QCC) is conducting a critical analysis of the strategy to answer the question - what is the closest Queensland could get to achieving a zero emissions economy. This includes consideration of Queensland's current emissions trajectory, what zero-net emissions looks like in practice, and whether existing commitments and policy will get us there.

This report is an analysis and discussion of ClimateWorks Australia's (CWA) published emissions scenarios for Queensland from their Technical Report on how "Queensland can achieve net zero emissions by 2050" (2016). This report informs the QCC analysis, with a focus on the transport sector, that notes:

a) Potential changes to the transport sector to 2050, given technology and economic drivers including estimated uptake of electric vehicles, fuel-switching, and observed behaviour change;
b) potential infrastructure development and investment implications across the sector;
c) potential transport industry and manufacturing opportunities for Queensland; and
d) best case policy and planning scenario to achieve zero-net emissions across Qld's transport sector by 2050.

Potential changes to the transport sector to 2050 are examined, including technology and economic drivers such as estimated uptake of electric vehicles, fuel-switching, and observed behaviour change. These will build on the existing initiatives being progressed by the Queensland Government. Potential infrastructure development and investment implications as well as transport industry and manufacturing opportunities are examined. Best case policy and planning scenarios are developed to achieve zero-net emissions by 2050 with the best economic and social outcomes possible.

As an emissions-intensive resource-based economy, Queensland has a substantial task to decarbonise and will also be impacted by reductions in exports of emissions intensive energy sources as other countries take action. Our export revenue will take a hit as coal is an emissions intensive energy source and our biggest export earner. To prevent a drop in living standards, we need to find alternative export earners or we need to reduce the cost of some large imports such as oil and refined petroleum products. If the transport sector can successfully transition away from petrol and diesel, our standard of living could improve.

Over the coming decades, cities and towns will be engaged in a significant and rapid process of transformation as they decarbonise their economies and adapt to climatic changes that are already becoming evident. This transformation will involve both existing urban infrastructure and established patterns of urban living. The decarbonised and resilient future cities we seek could happen in many ways and will be shaped by the actions we take now.

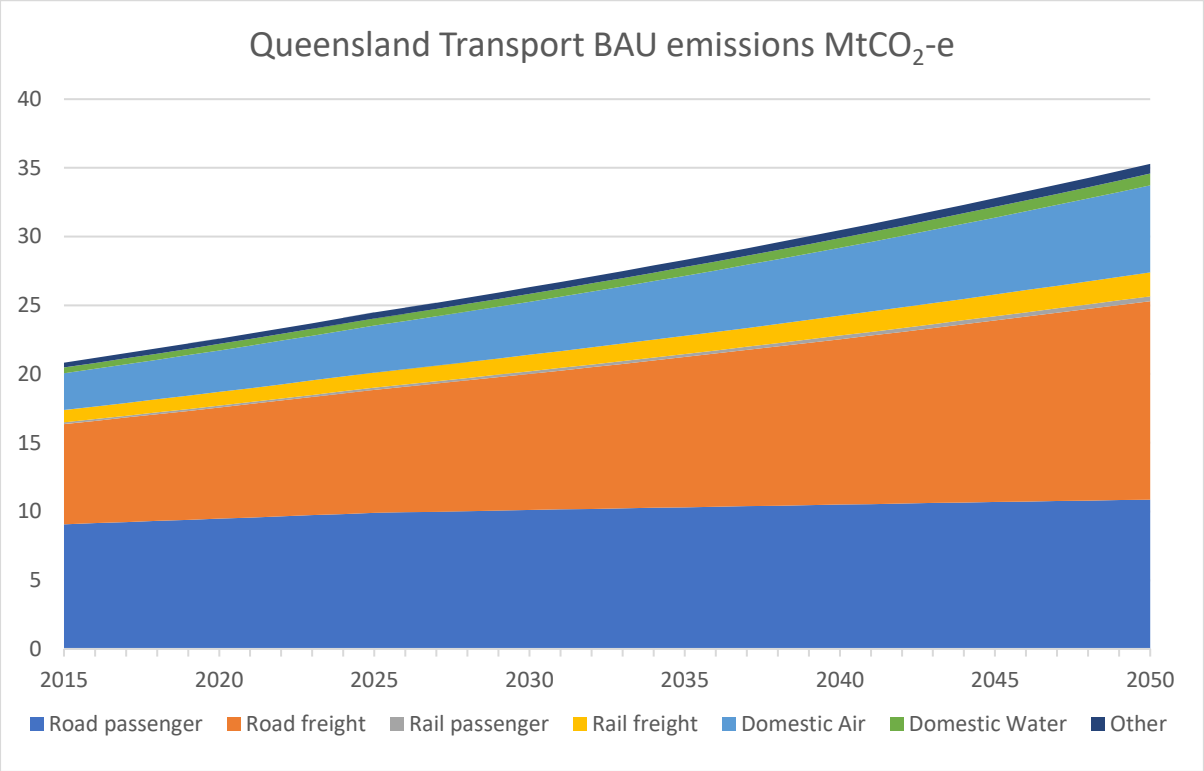
Any viable scenario needs to consider vulnerabilities that arise with changes in climate and extreme weather events and seek to increase resilience at the same time as reducing greenhouse emissions. Many climate change initiatives in the transport sector also have a range of co-benefits such as air quality, congestion, safety, physical activity and cost of living improvements.

Business as usual emissions

The transport sector accounts for 14% of Queensland's 31 tonnes CO_2-e emissions/capita, the third largest sector behind 'Electricity' and 'Agriculture and Forestry' (CWA, 2016). This is less than the 17% average for the transport sector across Australia, but that is because the total of 31 tonnes CO_2-e per capita in Queensland is well above the Australian average of 22 t CO_2-e per capita.

The ClimateWorks Australia (CWA) Technical Report on how "Queensland can achieve net zero emissions by 2050" (2016) projects a 76% increase in transport energy use and a 70% growth for Business As Usual (BAU) emissions in Queensland between 2015 and 2050, as shown in Figure 1 below. This scenario is based on BAU energy use projections and a slight decrease in fuel emissions intensity based on fuel mix changes. Further details for each component is provided following the figure.

Figure 1 BAU transport emissions 2015 to 2050



Road passenger BAU energy use

Road passenger travel is currently the largest component of transport energy use in Queensland as petrol and diesel motor vehicles dominate mode share across almost all trip types and locations. In the BAU scenario, motor vehicle travel is expected to grow at slightly less than population growth rates because of increasing congestion, and possibly fuel costs, leading to a slight reduction in per capita travel distance. The gradual trend improvement in fuel efficiency is also expected to continue, along with a slow uptake of electricity and biofuel, leading to average growth in energy use of 0.6 percent/annum or 26% between 2015 and 2050.

Road freight BAU energy use

Road freight travel is currently the second largest component of transport energy use in Queensland as diesel-fuelled heavy vehicles cater for much of the total freight movements in our large state with a dispersed population. Road freight growth trends have been high in recent decades, reflecting our growing population, wealth and a declining real cost of road freight. In the BAU scenario, these growth trends are projected forward, combined with a small fuel shift to gas and biofuel, leading to average growth in energy use of 2.2 percent/annum or 222% between 2015 and 2050.

Rail passenger BAU energy use

Rail passenger travel is a minor component of transport energy use in Queensland. In the BAU scenario, population growth and increasing urbanisation lead to high growth in energy use of 3.2 percent/annum but the total figure is only 5 PJ in 2050.

Rail freight BAU energy use

Rail freight travel is a minor component of transport energy use in Queensland as it consists of mainly long-haul bulk freight such as coal, which can be hauled by locomotives very efficiently. In the BAU scenario, rail freight growth trends are just below those for road freight at 1.9 percent/annum with total energy use doubling between 2015 and 2050.

Air transport BAU energy use (domestic)

Air transport is currently the third largest component of transport energy use in Queensland. In the BAU scenario, air travel is expected to grow at 2.5 percent/annum from 38 PJ in 2015 to 90 PJ in 2050.

Water transport BAU energy use (domestic)

Water transport is a minor component of transport energy use in Queensland. In the BAU scenario, water travel is expected to grow at 2 percent/annum to 12 PJ in 2050.

Other transport BAU energy use

Other transport is a minor component of transport energy use in Queensland. In the BAU scenario, other travel is expected to grow at 2 percent/annum to 10 PJ in 2050.

CWA Emission reduction potential to 2050

The CWA report analyses the costs and benefits of a range of identified emission reduction opportunities, including for the transport sector. It is a high level assessment of Queensland's technical or theoretical potential to reduce emissions based on predicted emission reduction potential from the ambitious uptake of known technologies.

In the road passenger fleet, a 23 percent fuel efficiency improvement is modelled, over and above the BAU fuel efficiency improvement, resulting in energy use remaining essentially flat between

2015 and 2050. All limitations on electric vehicles are removed, resulting in 100 percent penetration across the light vehicle fleet by 2050. Emissions from road passenger transport are thus reduced to close to zero, assuming almost full decarbonisation of the electricity supply.

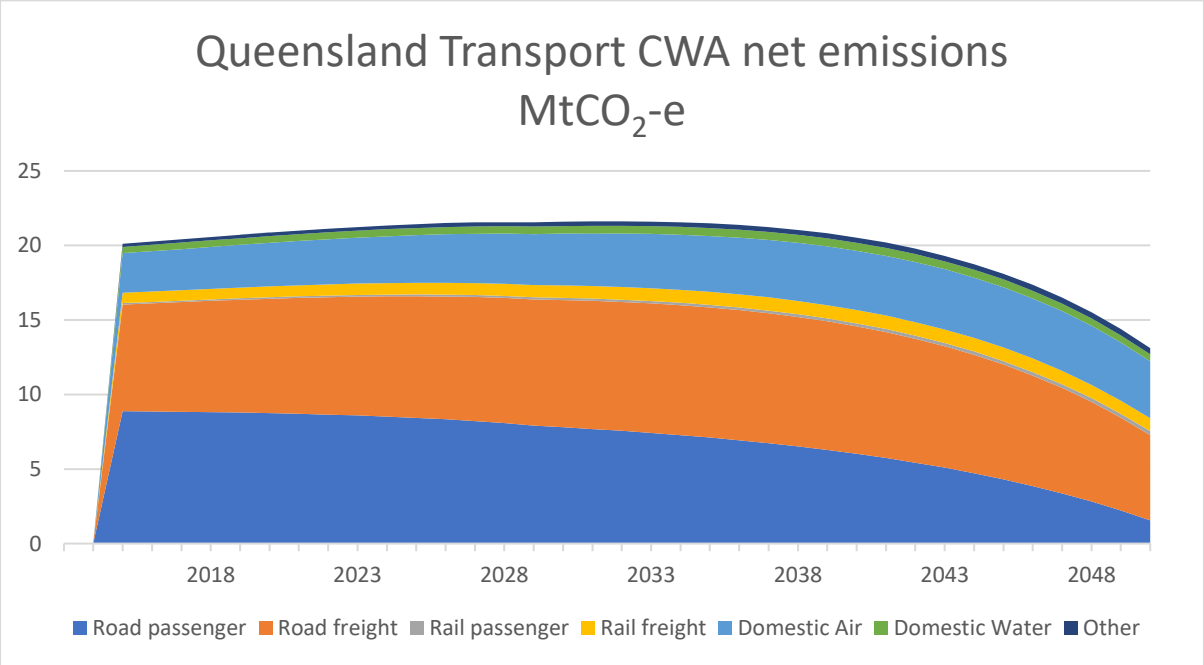
For road freight, fuel efficiency improvements are modelled, reducing energy growth by 0.4 percent per annum. Part of the rigid truck and bus fleet, amounting to 20 percent of the energy mix, is assumed to convert to electricity. Most of the remaining energy is provided by biofuels and natural gas.

For air transport, an additional 0.5 percent per annum energy efficiency improvement is modelled as well as a 50 percent share of bio-derived jet fuel.

For rail and water transport, energy efficiency improvements of 13% and 18% respectively are modelled as well as a modest market share for biofuel and natural gas.

The carbon content of electricity generation is also modelled to reduce to close to zero by 2050. The resulting net emissions are shown in Figure 2 below.

Figure 2 Transport net emissions after full policy implementation (CWA Report)



When compared with BAU, the net emissions represent a cumulative reduction of 305 Mt CO_2-e to 2050, about 16 percent of the total abatement identified for Queensland. The 2050 emissions of 13 Mt CO_2-e are a 63 percent reduction from the BAU figure of 32 Mt CO_2-e and about 38 percent lower than the emissions in 2015.

For the 2030 time horizon, emissions are estimated as 21 Mt CO_2-e, almost identical to the BAU emissions of 21 Mt CO_2-e. The range of initiatives serve essentially to reduce average fuel emission intensities by a similar amount to the expected growth in the transport task.

Although figure 3 requires full implementation of all the efficiency and fuel shift initiatives, it is a conservative assessment of potential abatement as it does not include predicted future technologies or behaviour change.

Transport sector emission reduction initiatives

This chapter explains a broad range of transport sector policies and projects with the potential to deliver substantial emission reductions in the 2030 and 2050 timeframes. Where relevant, the initiatives will be compared with the CWA Report and details of how they are being incorporated into a best case scenario will be explained.

Road passenger initiatives

The ITF Transport Outlook (2017) categorises decarbonisation initiatives for the transport sector as: avoid (unnecessary travel); improve (efficiency of vehicles); and shift (to low-carbon modes). For this analysis, the avoid and shift categories will be combined as a focus on reducing the motorised transport task, whereas the efficiency category will be split into fuel switching to electricity and fuel switching to biofuels.

Reducing the motorised transport task

For the 2030 and 2050 timeframes, there are many case studies and evidence-based analyses demonstrating that large mode shifts from motorised light vehicles to walking, cycling and public transport are feasible. In the best case scenario, it is proposed that substantial implementation of these initiatives could reduce motorised light vehicle mode share from about 80 percent currently to below 50 percent, with consequent increases in walking, cycling and public transport. Based on this mode shift, a further reduction from CWA's BAU of 25 percent in transport energy use is modelled, on top of the 23 percent reduction in the CWA emission reduction potential scenario. Despite the large increase in population, total energy use for road passenger travel drops to 85 PJ in 2050, about 65% of current levels.

The discussion below examines travel patterns in other wealthy cities, analyses the potential for voluntary travel behaviour change programs and highlights trends in best practice urban design, infrastructure upgrades and new micromobility services. Together, this information shows that a focus on improving walking, cycling and public transport over several decades can deliver a large reduction in motorised vehicle travel.

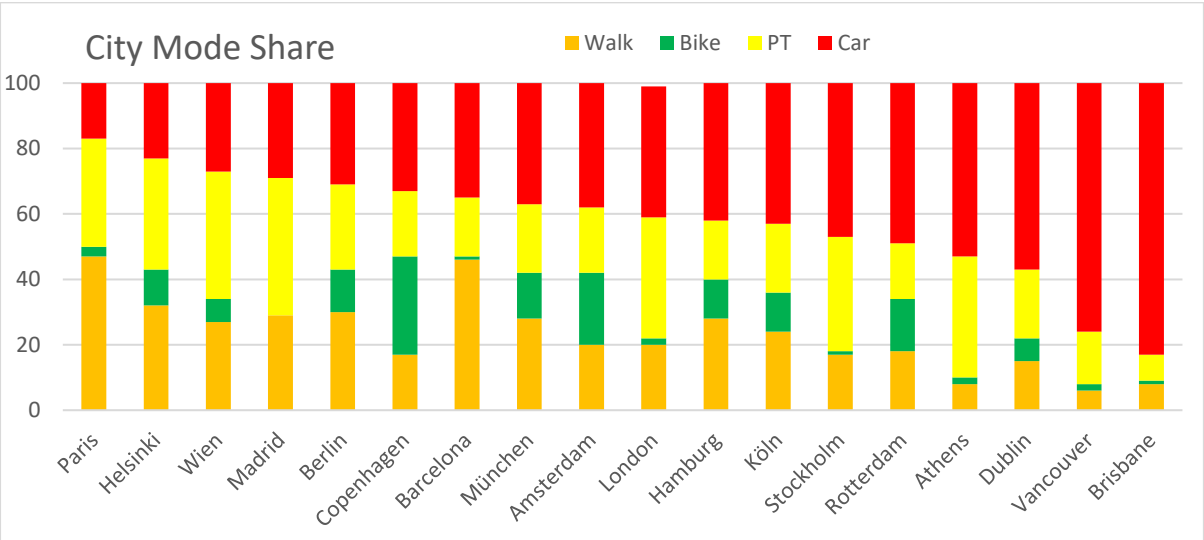
Existing mode shares in high income countries

Mode share data from other cities across the world shows a large variation in how urban travel occurs. Figure 3 below shows walk, bike, public transport and car mode share for a range of selected cities. All the cities have a high standard of living so mobility isn't constrained by any lack of affordability of cars.

Some of the cities have a large high density and pedestrian-friendly urban core with a traffic-calmed culture, leading to high levels of walking such as in Paris and Barcelona. Many of the larger capital cities, such as London, Madrid, Vienna, Athens and Stockholm, have extensive public transport networks that provide high levels of service and access to most destinations. Other cities such as Copenhagen, Amsterdam and many German cities have invested in high quality bike path networks that have transformed city travel over the last few decades.

Although Queensland does not currently have urban form to compare to these cities, this figure shows that there are many ways that walking, cycling and public transport can be improved to become preferred modes over cars for many trip types. Large changes require sustained efforts over decades, but they are clearly achievable.

Figure 3 Mode shares for selected cities



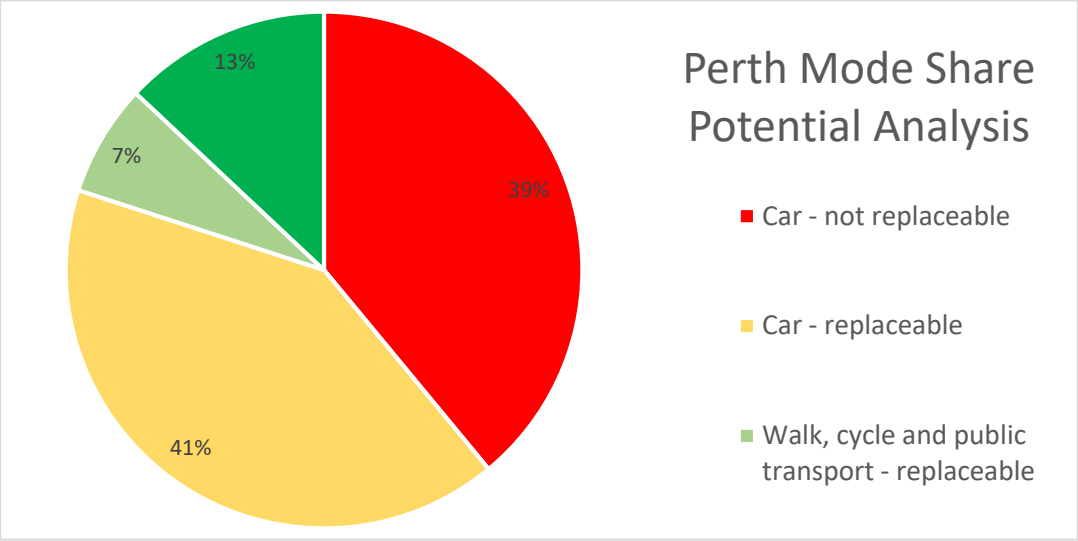
Source: www.epomm.eu/tems/compare_cities.phtml

Travel behaviour change programs

In 1997, Perth implemented a pilot travel behaviour change project that resulted in a 14 percent reduction in vehicle kilometres travelled, with a large mode shift from 'car as driver' to walk, cycle and public transport. This large change, supported by similar results in Europe, spurred research in the field and helped encourage governments across Australia to implement a range of behaviour change methodologies. The most comprehensive analysis of the potential for behaviour change is in a Western Australia report from 2000. It used surveys and in-depth phone discussions to examine all trips and categorise them into whether they are constrained to a particular mode or whether there is an objective choice or lack of awareness that could be overcome to change mode choice. Constraints are items such as luggage, health concerns, weather or no bus available. Objective choices are items such as the bus taking too much longer than a car. A lack of awareness includes a lack of knowledge of available bus services or an unrealistic understanding of travel time differences. The research showed that almost half of car trips were replaceable: one fifth by public transport; one quarter by bicycle; and one fifth by walking.

Figure 4 shows that about half of car trips in Perth, an urban area similar to Brisbane, could be replaced by walking, cycling and public transport. Behaviour change programs have so far not been able to convert more than one third of this potential, but they demonstrate that there is substantial potential for change in the short term and without major infrastructure upgrade costs.

Figure 4 Potential behaviour change (Socialdata Australia, 2000)



Best practice urban design and infrastructure upgrades

Queensland currently has a population of around five million, with projections for a population of eight million by 2050, a 60% increase. This large increase in population over several decades provides a big opportunity to change how and where we house and employ people and provide services to them.

Our planning system thus far has provided only weak incentives to locate new employment, services and residences at public transport nodes and does not adequately discourage outer-urban subdivisions that lock in both long travel distances and high mode shares for cars. We can continue the old trends and get similar results or we can change our incentives and disincentives to build a different future.

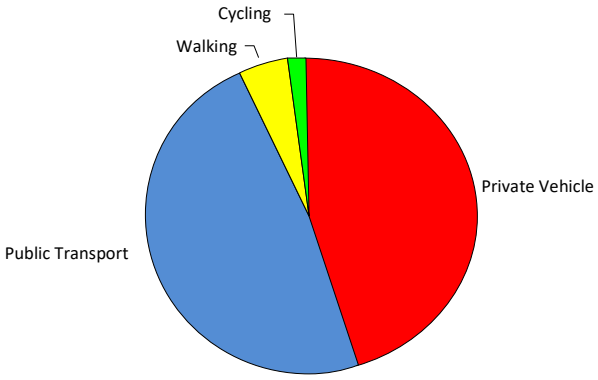
The recent high density development in Brisbane's inner city shows that industry and the market can deliver much improved outcomes. If our planning system were to constrain most job and services growth to within the pedestrian catchment of our train and busway stations, public transport could provide a high level of service to a growing share of trip purposes. If those nodes were developed with a place-making focus and high urban design quality, then local walking trips and cycle access would be safe and convenient, leading to growth in these modes.

The SEQ Household Travel Survey 2003-2008 revealed that around 9% of the regions private person trips were to Brisbane's inner city (CBD, Spring Hill, Fortitude Valley, Milton, South Brisbane, Kangaroo Point, Herston, West End and Woolloongabba). **Figure 5** below shows that these trips have much higher mode shares for walking, cycling and public transport than the rest of the region. In particular, the 43.6% mode share for public transport to the inner city stands in stark contrast to the average 8% public transport mode share across Greater Brisbane. Over the period to 2050 we have

the opportunity to build much more of our region to achieve high mode shares for walking, cycling and public transport.

Figure 5 Weekday private journeys to the inner city by mode
(Source: Marinelli et al. 2010)

Mode	Share
Private Vehicle	47.0%
Public Transport	43.6%
Walking	7.7%
Cycling	1.7%
Total	**100%**



Power-assisted and low-powered vehicles are rapidly emerging overseas (haveago.city/) now that electric motor and battery technology is cost-effective and convenient, with several new brands shown in Figure 6. The combination of the new vehicles, "sharing economy" ethic and platform technologies used for ridesharing services such as Uber, points to a likely micromobility revolution in the years ahead (www.curbed.com/word-on-the-street/2018/5/3/17312390/transportation-scooters-bird-spin-lime-san-francisco#473964449). Docked shared bicycle schemes such as CityCycle emerged a decade ago but are now being overtaken by dockless systems in communities across Europe, Asia and America. In addition to standard bicycles, the new dockless systems are offering power-assisted bicycles (pedalecs), electric scooters and electric mopeds. The future is likely to bring other innovative vehicles yet to emerge. Several dockless bike share services have recently established in Australia, including Mobike on the Gold Coast and Ofo, ReddyGo and O bike in Sydney, Melbourne and Adelaide.

Figure 6 Image of Jump dockless pedalec and Bird dockless e-scooter

Improvements to walking, cycling and public transport facilities are likely to be supercharged as these new sustainable modes offer a more compelling alternative for the many short trips that were previously made in cars, despite the congestion and parking hassles. Unfortunately the existing

Australian Design Rules for motor vehicles and road rules are very restrictive and act to eliminate or severely curtail the import or use of many of these new safe and sustainable modes. Some relaxations of power limits or addition of new vehicle classifications would be beneficial. For example, there is a very large gap between a <200 Watt electric motorised scooter, speed limited to 10 km/h and intended primarily for footpath use and a moped, speed limited to 50 km/h and intended for road use. A useful additional category could fit in-between, with a power limit of 300 - 500 Watt, speed limited to about 25 km/h and intended as bicycle substitutes.

Fuel switching to electricity

Electric Vehicles (EVs) are entering the global market place in large numbers where incentives have been provided for early adopters. It is becoming increasingly clear, however, that a comprehensive portfolio of national, state, and local actions is critical for the increased deployment and use of electric vehicles in the short term (ICCT, 2015). As Australia lacks these policies and incentives, EV sales have been low and adoption will be slower than some other countries. Once EVs become economically viable, however, there is no real upper limit to their adoption except the rate of turnover of the vehicle stock (Climate Works Australia, 2017). A strong case could be made for a high penetration of EVs by 2050 in CWA's BAU scenario based on recent projections (ENERGEIA, 2018).

A shift to 100 percent electric vehicles for passenger travel in Australia is both feasible and affordable. Urban car travel is well suited to a transition to electric vehicles. Typical urban Australians have a daily driving distance of only 35km, with almost half of trips taken being less than 5km, and more than 99 per cent of trips being less than 120km, which is within the range of a relatively modest electric vehicle (Zero Carbon Australia, 2016). It is expected that most drivers will take advantage of the convenience and low cost of charging their vehicle at home. The Queensland Electric Super Highway shown in Figure 7 is a good first step to address "range anxiety" concerns and remove one of the barriers to growth of EVs in Queensland.

The introduction of EVs are not expected to have any substantial negative impact on the electricity grid as an extra one million electric cars is the equivalent of 5.2 terawatt hours of power demand. This is about a 2 per cent increase in overall grid demand, according to the Commonwealth Minister for the Environment and Energy, Josh Frydenberg MP (Stand by, Australia, for the electric car revolution, Sydney Morning Herald, 12 January 2018). The energy storage potential of car batteries and their ability to be charged overnight in home garages could also deliver benefits in grid stabilisation and energy storage.

The shift to EVs also applies to buses in Australia. Most buses operate in congested urban driving conditions in proximity to charging infrastructure. In China there are already cities with a 100 percent electric bus fleet, delivering cheaper no-emissions public transport. Despite an average life of over 20 years, by 2050 all urban buses could be electric.

There is sufficient experience of EV technology and reliability to be confident that EVs are safe and robust and could cater for effectively all road passenger transport in the long term. Electricity has an existing reliable distribution network and the equivalent energy cost is well below the price of petrol and diesel. The remaining barrier is the cost of batteries. Cost curves for battery production have been decreasing rapidly so they are expected to be competitive with conventional vehicles within the next decade. By this stage the electricity charging network will have evolved so 'range anxiety'

should not impact many. Although growth in penetration rates will take many years as the community becomes familiar with EVs, the adoption in the new vehicle fleet is likely to be rapid once the financial case has been made.

By 2030 almost all new light vehicles could be EVs. By 2050 almost all the light vehicle fleet could be EVs, with a few Internal Combustion Engine vehicles remaining for enthusiasts and to be displayed as vintage and collector items at festivals. If the electricity grid has been effectively decarbonised, the road passenger sector in Queensland could be essentially emissions free.

Figure 7 Queensland Electric Super Highway

Source: https://www.qld.gov.au/transport/projects/electricvehicles/map

Fuel switching to biofuels

The Queensland Government has developed the Queensland Biofutures 10-Year Roadmap and Action Plan (2016) to support development of the biofuel industry. Alongside this is the ethanol and biodiesel mandate to support inclusion of ethanol and biodiesel into the fuel mix. The mandate will help establish some ethanol and biodiesel production but the existing vehicle fleet will not support

more than about 5 percent ethanol of the total petrol volumes. As most of the passenger vehicle fleet is expected to become EVs by 2050, ethanol is not likely to be a large contributor to greenhouse emission reductions so it is not included in the best case modelling. Biodiesel will be discussed in the road freight section.

Road freight initiatives

Road freight travel is currently the second largest component of transport energy use in Queensland as diesel-fuelled heavy vehicles cater for much of the total freight movements in our large state with a dispersed population. Road freight growth trends have been high in recent decades, reflecting our growing population, wealth and a declining real cost of road freight. In the BAU scenario, these growth trends are projected forward, combined with a small fuel shift to gas and biofuel, leading to growth in energy use of 222% between 2015 and 2050.

For the 2030 and 2050 timeframes, there are many case studies demonstrating that large efficiency improvements and reductions in travel through improved load factors are feasible. There are currently no fuel efficiency standards for trucks in Australia, yet standards are implemented in United States, Japan, China and Canada (ITF, 2017). Vehicle maintenance, driver training and vehicle loading, routing and scheduling are additional behaviours that the freight industry can introduce to reduce emissions intensity. Higher capacity or Freight Efficient Vehicles (FEVs) also have the capacity to reduce emissions intensity.

Long term projections of recent freight growth rates are fraught with uncertainty as freight flows are correlated with economic growth. Australia has had a record period of economic growth which is unlikely to be maintained for another 30 plus years. There is also evidence that the world has reached the limits of the global outsourcing model as the proliferation of global value chains has halted and manufacturing has become more regionalised (ITF, 2017). A brief discussion below of consumption patterns, production patterns and energy production, demonstrate that even with high population and economic growth rates, there is potential for substantial reductions in freight.

Consumption patterns

Behaviour of consumers is changing with the emergence of more local, virtual and shared consumption. Local food markets and the notion of food-miles as a sustainability indicator are an example of localisation that would reduce freight flows. Digital or virtual objects such as e-books, on-line music and newspapers have replaced the need to freight physical objects. The emergence of car sharing and sharing of other items has the potential to reduce freight.

Production patterns

Technologies such as 3D printing and automation allow production closer to major consumption centres and reduce the benefit of cheaper labour. The movement toward a circular economy could dramatically reduce travel distances and the amount of raw materials required. These production changes could lead to substantial reductions in freight flows of raw materials and manufactured items.

Appendix C

Energy production

Oil and coal represent a large share of global trade flows. As countries decarbonise and grow renewable energy, the export and import of oil and coal will reduce dramatically. Australia will import less oil and refined petroleum products and Queensland will export less coal. Bulk coal currently accounts for a large share of our rail freight so capacity will become available for other freight such as grain or livestock, some of which may convert from road.

Best case scenario

In the best case scenario, it is proposed that intensive implementation of improvement initiatives could reduce the growth in the road freight task by one percent/annum compared with the CWA emissions reduction potential scenario. Road freight energy use will still grow at 0.75 percent per annum, compared with the BAU rate of 2.15% and CWA rate of 1.75%. This results in 137 PJ of road freight energy use in 2050, about 30 percent more than the 106 PJ used in 2015.

A range of specific initiatives are discussed below to demonstrate how the energy growth rates can be reduced.

Optimising load factors

Road freight transport operators can optimise their load factors in many ways. With a mature road network and freight industry, operators can turn their attention to optimisation of their task by moving more freight with fewer vehicle kilometres. This is done through route optimisation, asset sharing between companies (warehouses, trucks, IT systems), higher capacity vehicles and a relaxation of delivery windows (as this has a large impact through increasing scheduling flexibility). The result will be fewer, but perhaps larger and more fuel efficient, heavy vehicles travelling on the roads. While travelling, the heavy vehicles are expected to be fully utilised for a higher portion of the trip with a minimisation of empty trips. Optimising the supply chain and increasing vehicle utilisation will deliver substantial benefits.

Heavy Vehicle Monitoring and Charging

There are a range of regulatory initiatives, pricing policies and mechanisms for government to incentivise a shift to a more efficient road freight industry. Economic measures and regulations need to be aligned with industry actions to improve vehicle design and utilisation. Enforcement practices also need to be effective in preventing illegal behaviour.

The existing large truck fleets have technology fitted that records all aspects of the travel such as speed, time, weight, route, etc. Driving hours and speed are regulated and some routes are prohibited for certain heavy vehicles with dangerous goods or higher weights. Enforcement, however, relies mainly on weigh stations that rarely operate and an archaic system of driver log books that can easily be manipulated. Regulations and enforcement need to be updated to utilise the existing technology as good operators cannot compete against the many cowboys who cut corners. This would be the first step toward best practice by eliminating most of the illegal behaviour and gathering electronic data that can be utilised to optimise road planning and vehicle operations.

At present, heavy vehicles are charged for the damage they do to roads through a simple system of fuel excise calculated annually to match historical road upgrade costs that are apportioned to heavy

vehicles. This places trucks at a competitive advantage over trains where charges are based on the expected full costs of operating the infrastructure including a profit return to the asset owner. Technology now exists that allows trucks to be charged specifically for the location, distance, mass and any other relevant aspects of their travel. Through the Intelligent Access Program , processes have begun that will eventually replace fuel charges with a customised fee that covers the real costs for travel for every truck and results in optimised route and vehicle choices. This process will improve efficiency through more freight-efficient vehicle choices, shorter trips and avoiding congestion. While the charging regime is under development, a government initiative to charge the full fuel excise on heavy vehicles so they pay the same as private motorists, would provide incentives to improve efficiency and generate revenue that could be invested into better infrastructure.

Best practice infrastructure upgrades, including intermodal exchanges and industrial parks

Infrastructure and land use policies need to be aligned with industry actions to improve vehicle design and utilisation. With an expected 60% increase in population, Queensland will have many more workers and higher freight flows by 2050. In addition to rail and road investment, this will require new and expanded intermodal exchanges and industrial parks, providing opportunities to co-locate industries that require the same inputs or for which one business' output is a neighbouring business' input. When combined with a charging regime that incentivises better location decisions, this should lead to some mode shift from road to rail for longer trips such as Melbourne or Longreach to Brisbane and an average reduction in road travel length as more enterprises co-locate in new industrial parks.

Fuel switching to electricity

The urban freight task is diversified, utilising many types of vehicles from rubbish removal to concrete trucks to delivery vans, many sizes of rigid trucks and semitrailers. The common element of urban freight trips is they are relatively short and generally seen as a nuisance by residents even though we all know we are reliant on them.

Air and noise pollution from the trucks is a common complaint, as is their impact on congestion. The growing health concerns of diesel exhaust gases is leading more cities and countries to ban diesel use in some urban centres and sensitive airsheds. This will grow the electric truck sector and lead to expansion for other cities including in Australia.

The first models of electric rigid trucks are now available in Australia. A more comprehensive electrification of the urban freight task is expected as it addresses the noise and air pollution problems and electric trucks are likely to be cost competitive with diesel in the years ahead.

The best case scenario includes 20 percent electrification so that by 2050 most intraurban freight deliveries are by EV.

Fuel switching to biofuels

The Queensland Government Biofutures Roadmap (2016) supports growth of biofuel production. At present biodiesel appears unable to compete with mineralised diesel prices but several technology options are able to provide consistent quality products at commercial scale. For example, the existing Ecotech Biodiesel facility in Narangba, north of Brisbane, has the capacity to produce 30 million litres of biodiesel annually from used cooking oil and tallow. This provides confidence that with further research and technology development, biodiesel production will increase and take substantial market share off mineralised diesel when pricing or regulations, or both, facilitate this.

The Biofuels Association of Australia claims Australian biodiesel has the potential to reduce emissions by over 85% in comparison to diesel (http://biofuelsassociation.com.au/biofuels/). To be commercially viable and achieve the emission benefits, the production process will need to be efficient and the feedstock will need to be a low value input stream such as used cooking oil, tallow, algae, sawmill and agricultural wastes.

Biodiesel is chemically similar to mineral diesels and up to 5 percent can be included without labelling in the current diesel supply. A 20 percent (B20) biodiesel mix with 80 percent mineral diesel is available at some service stations and is utilised in some heavy vehicles. Proportions up to B100 are in use across Australia and would be suitable for all heavy vehicles and equipment in the future.

Global production of conventional biofuels reached 136.5 billion litres (79 million tonnes of oil equivalent) in 2016, accounting for around 4% by energy of world road transport fuel (OECD/IEA, 2017).

The IEA defines advanced biofuels as sustainable fuels produced from non-food crop feedstocks, which are capable of delivering significant life-cycle GHG emissions savings compared with fossil fuel alternatives, and which do not directly compete with food and feed crops for agricultural land or cause adverse sustainability impacts. In Queensland, the Liquid Fuel Supply Regulation 2016 prescribes biofuel sustainability criteria, including a greenhouse gas benefit and project specific environmental performance standards. Biofuel projects need to demonstrate compliance to be eligible for support under Queensland's Biofutures program.

Biofuels, primarily biodiesel and bio-based jet fuels, play a key role in the decarbonisation of long-haul transport modes, complementing measures aimed at constraining the sector's energy needs and the enhanced role of electrification and other measures in urban and other shorter-haul transport applications. The International Energy Agency (IEA) estimates biofuels will provide some 40% of air transport fuel in 2060, and 30% of bunker fuel for shipping, with a goal for biofuels to meet more than a quarter of world demand for transportation fuels by 2050 to reduce dependence on petroleum.

The best case scenario, similar to the CWA emissions reduction potential scenario, includes a biodiesel share of 60 percent of road freight fuels, with the remaining 20 percent converted from diesel to natural gas. Methane, either as Compressed Natural Gas (CNG) or Liquified Natural Gas (LNG) has been trialled in heavy vehicle fleets in Australia and has proven successful. It has slightly lower emissions intensity than diesel and can be used in the same engines so is an ideal domestic fuel to replace diesel where electricity or biofuel is not viable.

Rail passenger initiatives

Rail passenger travel is a minor component of transport energy use in Queensland. In CWA's BAU scenario, population growth and increasing urbanisation lead to high growth in energy use of 3.2 percent/annum but the total figure is only 5 PJ in 2050. In the CWA potential emission reduction scenario, no major change has been modelled.

There is scope for further electrification of passenger services on rail. However, as rail is energy efficient, fuel costs are a small component of total costs and the relative benefits of switching from diesel to electricity are low. Passenger rail in South East Queensland has already been electrified for air quality and noise reasons. It has been assumed that the proportion of electricity use remains at current levels.

Regional passenger rail services are operated with the same locomotives that are also used for freight services. For the best case scenario, it has been assumed that natural gas and biofuel use increase linearly to 25 percent each by 2050, similar to rail freight.

Rail freight initiatives

Rail freight travel is a minor component of transport energy use in Queensland as it consists of mainly long-haul bulk freight such as coal, which can be hauled by locomotives very efficiently. In the CWA BAU scenario, rail freight growth trends are just below those for road freight at 1.9 percent/annum with total energy use doubling between 2015 and 2050. In the CWA emission reduction potential scenario, energy efficiency improvements of 13% are modelled as well as a modest market share for biofuel and natural gas.

There is scope for further electrification of freight services on rail. However, as rail is energy efficient, fuel costs are a small component of total costs and the relative benefits of switching from diesel to electricity are low. Several major bulk coal haulage routes have already been electrified as it is the cheapest energy source and the economic benefits exceeded the capital costs. It has been assumed that the proportion of electricity use remains at current levels as any long term reduction in bulk coal haulage is likely to weigh against any attempt to increase electrification of additional traffic.

For the best case scenario, an energy efficiency improvement of 13% is modelled and it has been assumed that natural gas and biofuel use increase linearly to 25 percent each by 2050, similar to the CWA emissions reduction potential scenario.

Air transport initiatives

The majority of air transport emissions are related to international travel. The United Nations Framework Convention on Climate Change does not include these in specific countries inventories, rather they are dealt with in the context of the International Civil Aviation Organisation (ICAO). The ICAO has defined a range of operational efficiency improvements and a global market-based measure aimed to limit international aviation emissions to their 2020 levels. These improvements are broadly equivalent to a two percent annual efficiency improvement and a conversion to 50 percent biofuels by 2050.

Domestic air transport is currently the third largest component of transport energy use in Queensland. In CWA's BAU scenario, air travel is expected to grow at 2.5 percent/annum from 38 PJ in 2015 to 90 PJ in 2050. In the CWA emissions reduction potential scenario, a 0.5 percent per annum energy efficiency improvement over and above BAU is modelled as well as a 50 percent share of bio-derived jet fuel.

The International Air Transport Association and other industry groups all forecast revenue passenger kilometres of flight to increase by about five percent annually for the decades ahead, a little below recent growth rates. The Transport Outlook (ITF, 2017) points out that in 2050 over 20 percent of all non-urban domestic passenger transport is expected to be by aviation compared with 10 percent in 2015. This rapid rise demonstrates that aviation is a critical component of long term decarbonisation of transport.

A Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) will set a benchmark at 2019-20 emission levels. Countries can enter voluntarily from 2021 but it will become mandatory from 2027. Emissions above the baseline levels will have to be offset. ICAO have introduced CO_2 efficiency standards for new aircraft, designed to ensure efficiency improvements even if fuel costs do not rise. An Airport Carbon Accreditation Program is already in existence with many airports focusing on reducing direct and indirect emissions and then offsetting any unavoidable residual emissions.

The global average efficiency improvement between 2004 and 2013 was 2.5 percent for tonne kilometres (passengers and freight) and 3.7 percent for passenger kilometres. It is not expected that this improvement rate can be sustained, so the Transport Outlook (ITF, 2017) adopts an annual improvement of 2 percent in their low carbon scenario, corresponding to the resolution of ICAO members in 2013.

The Transport Outlook low carbon scenario includes an assumed penetration of 50 percent for biofuels across the sector, growing from 2030. Biofuels need to become cheaper and their production more efficient before they will be able to displace fossil fuels in large quantities. If carbon savings compared to conventional jet fuels are 70 percent (a typical figure for current aviation biofuels) an industry target of a 50 percent reduction in emissions by 2050 would require all flights to be powered by biofuels. There are very large uncertainties around the potential for the development of commercially viable biofuels in these quantities, so a maximum share of 80 percent is assumed. This would require advanced second-generation aviation biofuels produced from algae or non-food parts of crops, so it does not compete with food production or necessitate the destruction of carbon sinks such as forests (ITF, 2017). In Queensland, the Liquid Fuel Supply Regulation 2016 prescribes sustainability criteria that are a good starting point.

The best case scenario for air travel in Queensland assumes that domestic air travel emissions will be relatively consistent with the ICAO goal for global aviation emissions to stabilise at around current levels. An additional annual efficiency improvement of 0.5 percent over and above the CWA emissions reduction potential scenario and a biofuel share rising to 60 percent by 2050 are modelled, maintaining emissions comparable to current rates.

High Speed Rail

High Speed Rail (HSR) is a potential competitor to both air and road travel between Australia's three largest cities and intermediate towns and cities including Canberra. Various forms of HSR have been proposed in Australia for decades, since the Europeans and Japanese established that trains could safely travel at over 300 kilometres per hour.

If train travel could link Brisbane and Sydney (and Sydney and Melbourne) with a travel time of close to three hours, many people would choose this in preference to air travel. Air travel involves not just the flight time but the landside travel to each airport and the inconvenience of security checks and baggage limits, so a three hour trip is competitive.

The Zero Carbon Australia (2014) report into HSR points out that these corridors could position a HSR station within 50 km of 60 percent of Australia's population. Approximately 45 percent of regional travel in Australia is contained within the corridor from Brisbane to Melbourne via Sydney and Canberra. A HSR project could replace half of this demand and has been modelled in the best case scenario as a one off reduction of domestic air emissions of 20 percent from 2040.

The impediment to HSR is the high capital cost, estimated at $84 billion (ZCA, 2014). Other estimates have been higher. This would be a large commitment from the Australian Government and the three states and ACT, but could be feasible due to high expected revenue when the system is operational. The recent commitment to establish a second airport for western Sydney is likely to delay consideration of HSR but may facilitate cost reductions through a direct HSR link with Parramatta and the new airport rather than eastern Sydney. New technologies may emerge to reduce construction and operating costs while providing very fast, safe and efficient travel. One such proposal is Elon Musk's Hyperloop which uses sealed tubes with very low air pressure to provide almost frictionless very high speed travel.

Water transport initiatives

Water transport is a minor component of transport energy use in Queensland. In CWA's BAU scenario, water travel is expected to grow at 2 percent/annum to 12 PJ in 2050. In the CWA emissions reduction potential scenario, energy efficiency improvements of 18% are modelled as well as a modest market share for biofuel and natural gas.

The vast majority of maritime emissions are related to international travel. The United Nations Framework Convention on Climate Change does not include these in specific countries inventories, rather they are dealt with in the context of the International Maritime Organisation (IMO).

As Australia has a relatively mature rail and road network along coastal stretches between the main population centres, the domestic maritime task is relatively small. The difficulty and expense of the modal interchange required at both ends of ship trips, generally means that domestic freight remains on the truck or rail line from where it originates to its final domestic destination. Most Australian ports are dominated by large international shipments so they are not well suited to smaller domestic shipments and the land access to them is already congested.

Ship design and efficiency standards will improve through IMO initiatives known as the Energy Efficiency Design Index and Ship Energy Efficiency Management Plan. The IMO will seek a 70% efficiency improvement by 2050, primarily through conversion to biofuels, to deliver on their 50 percent emissions reduction by 2050 target, based on 2008 levels (www.iea.org/newsroom/news/2018/april/commentary-imo-agrees-to-first-long-term-plan-to-curb-shipping-emissions.html).

The Transport Outlook (ITF, 2017) stringent technology scenario results in an efficiency improvement of 27 percent by 2030 compared to BAU and a 50 percent improvement by 2050. The best case scenario for this analysis will retain the CWA efficiency improvement of 18 percent and combine this with a biofuel share of 60 percent. This will deliver benefits broadly in line with those sought for international maritime emissions.

Other transport initiatives

Other transport is a minor component of transport energy use in Queensland. In CWA's BAU scenario, other travel is expected to grow at 2 percent/annum to 10 PJ in 2050. No changes have been modelled for the CWA emissions reduction potential or best case scenarios.

Best case emission reduction potential to 2050

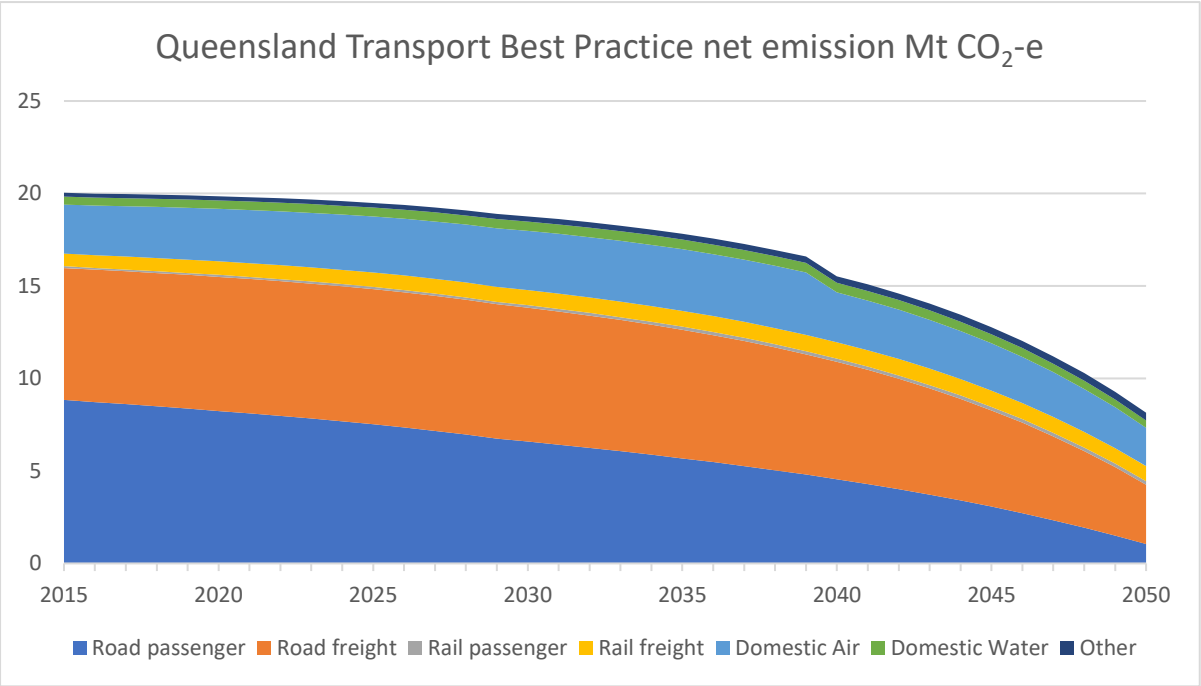
This chapter incorporates the broad range of transport sector policies and projects detailed in the previous chapter into the modelling used for the CWA's BAU and CWA emissions reduction potential scenarios.

Substantial emission reductions are achievable in the 2030 and 2050 timeframes if the policies are fully implemented. Figure 8 below shows the outcomes of the modelling. The results include a 10 percent drop from current levels of 21 Mt CO_2-e to 19 Mt CO_2-e by 2030 and a 60 percent drop to 8 Mt CO_2-e by 2050. This is considerably more emission reductions than the CWA emissions reduction potential scenario which resulted in net emissions of 21 Mt CO_2-e in 2030 and 13 Mt CO_2-e in 2050.

The best case scenario represents a 25 percent drop from CWA's BAU in 2030 and 75 percent drop from their BAU in 2050. The much stronger impact in 2050 is due to the high inertia in vehicle fleets and urban form, with vehicles often lasting for 20 years and infrastructure much longer.

The 8 Mt CO_2-e of annual emissions remaining in 2050 could be offset by a range of initiatives in the agriculture and land use sectors, resulting in net emissions of zero.

Figure 8 Transport net emissions of best case scenario

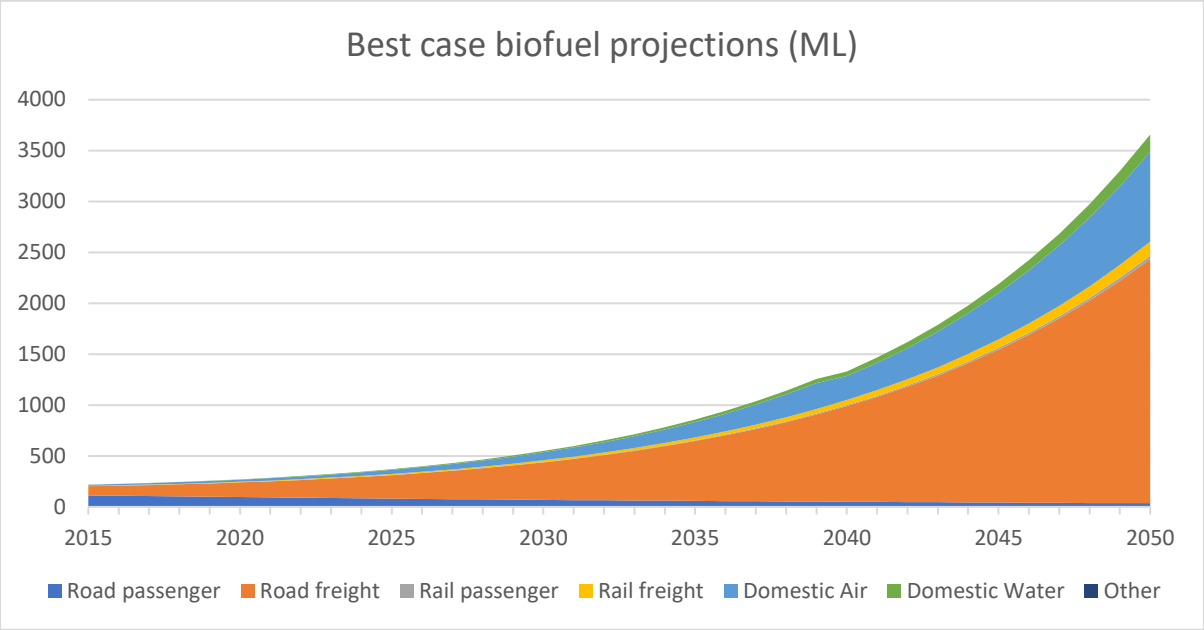


The emissions reductions associated with the best case scenario rely on additional electricity and biofuel to replace fossil fuels.

The electricity requirement is substantial, primarily for passenger vehicles but the growth is gradual, dispersed and is likely to follow growth in rooftop solar installation. Much of the EV charging will be at domestic residences and potentially overnight, thus not contributing to peak loads and offering potential benefits in grid stabilisation and energy storage if associated with supportive public policies and incentives in the energy and transport sectors.

Biofuel production volumes, however, will need to rise to replace a lot of fossil fuel imports, particularly for the road freight and domestic air travel sectors, as shown in Figure 9 below. From relatively minor volumes currently, biodiesel and bio-based jet fuel production of over 3.6 billion litres is projected annually by 2050 (based on energy content of 35 MJ/litre). This does not include biofuels for international aviation and shipping which are also intended to be large users by 2050. This scale of production requires both large volumes of raw materials and new production technologies to ensure that sustainability criteria are met.

Figure 9 Best case scenario biofuel volumes (million litres)



Co-benefits and broader implications

Local pollution

Electric vehicles for passengers and freight will remove much of the air pollution in urban areas.

Air pollution is associated with stroke, heart disease, lung cancer and respiratory diseases, including asthma. Globally, outdoor air pollution causes an estimated 3.5 million premature deaths each year. In OECD countries, an estimated 50% of the economic costs of air pollution-related death and ill-health is due to air pollution from motor vehicles (OECD, 2014).

The scientific evidence "no longer supports the notion that there is a safe level for pollutant concentrations". It has been estimated that 3,000 deaths (or 28,000 years of lost life) across Australia are attributable to the impact of urban air pollution each year. The health costs of air pollution-related mortality in Australia are estimated to be between $11–24 billion per year (Keywood, Hibberd and Emmerson, 2017).

Accessibility

Policy packages that are well coordinated and address the externalities of high motorised vehicle mode shares in cities make a significant difference for sustainable urban futures. Policies that promote more walking, cycling and public transport and land use changes that reduce average trip lengths will improve accessibility to jobs, education and other urban functions. This provides social inclusion benefits as it reduces the transport disadvantage suffered by people with no or low access to independent mobility through cars. This makes up about one third of the population in

Queensland, including those under 17 years of age, the frail aged, disabled and medically unable to drive (temporarily or permanently) and those unable to afford a car.

Physical activity

Regular physical activity is proven to help prevent and treat noncommunicable diseases such as heart disease, stroke, diabetes and breast and colon cancer. It also helps prevent hypertension, overweight and obesity and can improve mental health, quality of life and well-being (WHO, 2018).

Walking and cycling are good forms of physical activity and can provide health benefits if undertaken regularly and of sufficient duration and intensity. In some countries, levels of inactivity can be as high as 70%, due to changing patterns of transportation, increased use of technology and urbanization.

The WHO Global Action Plan on Physical Activity (2018) has 20 evidence-based actions, many of which involve the transport sector. The four WHO actions below show that mode shifts from car to walking, cycling or public transport deliver physical activity benefits as well as emission reductions.

Action 1.2: Conduct national and community-based campaigns to enhance awareness and understanding of, and appreciation for, the social, economic, and environmental co-benefits of physical activity, and particularly more walking, cycling and other forms of mobility involving the use of wheels (including wheelchairs, scooters and skates) and thereby make a significant contribution to achievement of the 2030 Agenda for Sustainable Development (SDG2; SDG3; SDG4; SDG5; SDG8; SDG9; SDG10; SDG11; SDG13; SDG15; SDG16; SDG 17).

Action 2.1: Strengthen the integration of urban and transport planning policies to prioritize the principles of compact, mixed-land use, at all levels of government as appropriate, to deliver highly connected neighbourhoods to enable and promote walking, cycling, other forms of mobility involving the use of wheels (including wheelchairs, scooters and skates) and the use of public transport, in urban, peri-urban and rural communities.

Action 2.2: Improve the level of service1 provided by walking and cycling network infrastructure, to enable and promote walking, cycling, other forms of mobility involving the use of wheels (including wheelchairs, scooters and skates) and the use of public transport, in urban, peri-urban and rural communities, with due regard for the principles of safe, universal and equitable access by people of all ages and abilities, and in alignment with other commitments.

Action 2.3: Accelerate implementation of policy actions to improve road safety and the personal safety of pedestrians, cyclists, people engaged in other forms of mobility involving the use of wheels (including wheelchairs, scooters and skates) and public transport passengers, with priority given to actions that reduce risk for the most vulnerable road users in accordance with the safe systems approach to road safety, and in alignment with other commitments.

Congestion and Infrastructure costs

Congestion threatens our local economy, environment and quality of life. Time wasted sitting in congested traffic reduces both leisure time and productivity; and longer travel times significantly increase transport costs for business. The Bureau of Infrastructure, Transport and Regional Economics (BITRE) predicts that the avoidable costs of traffic congestion in Australian cities will be around $30 billion by 2030 (BITRE 2015). These costs reflect the extra travel time, fuel usage, travel

time unreliability, and pollution arising from congestion, compared to a situation of optimal traffic flows, and it is a measure of what could be achieved by tackling traffic congestion.

The current level of congestion in Brisbane is estimated to cost the Queensland economy $2.3 billion annually. This is expected to increase to around $5 billion by 2030 (BITRE 2015).

Congestion delays the movement of workers and freight, raises stress levels and reduces productivity. Fuel costs and vehicle emissions are 30% higher in congested conditions and it is estimated that nearly 40% of the fuel used by road vehicles in Australian cities is the result of interruptions to the traffic flow. Because overcrowded roads increase pollution emissions, everyone is negatively impacted by traffic congestion and would benefit from its reduction (RACQ 2008).

Cars are not just the most emissions-intensive travel mode, they are also the most space-intensive. Mode shifts to walking, cycling and public transport can reduce congestion and avoid the need for expensive road widening or tunnel projects. Any avoided infrastructure costs could then be used to improve our urban amenity or to adapt our existing infrastructure for extreme weather events.

Climate change adaptation and resilience

The increase in severity and frequency of extreme weather events, particularly rainfall and flooding, as well as rises in sea level and extreme temperatures, will place more stress on our transport infrastructure. With a dispersed and largely coastal population, high temperatures in western and northern areas and tropical storms to contend with, infrastructure repair costs will increase. A greater share of transport resources will need to be devoted to increasing the resilience of our roads, rail, ports and airports and repairing the damage that occurs from extreme weather. This will place more pressure on urban areas to mitigate emissions without a major spend on new infrastructure.

Energy Security

Energy security is about Australia's ability to meet the energy needs of the Australian community in the short and long term. Improving Australia's energy security is important to minimise shortages of liquid fuels (petrol, diesel and jet fuel) which cause significant disruption (www.energy.gov.au/government-priorities/energy-security).

Mode shift away from Internal Combustion Engine vehicles to walking, cycling and public transport, and fuel substitution to domestic electricity, both reduce demand for imported liquid fuels and improve energy security.

Balance of payments

As an emissions-intensive resource-based economy, Queensland has a substantial task to decarbonise and will be impacted by reductions in exports of emissions intensive energy sources as other countries take action. Our export revenue will take a hit as coal is an emissions intensive energy source and our biggest export earner.

With less export revenue, we need to find alternative export earners or reduce import costs. Oil and refined petroleum products are amongst Queensland's largest imports so a transition away from petrol and diesel will improve our balance of payments and standard of living.

A 'fast follower' approach to reduce mitigation costs and risks

Much of the analysis on climate change mitigation or social change in general, emphasises a need for leadership to develop cutting-edge ideas. In the transport sector, however, Australia is well behind the adoption curve of many OECD countries so an approach of 'fast follower' may be more beneficial. As Australia no longer has a stake in the volume manufacture of motor vehicles and our cities do not suffer negative impacts like air pollution and congestion more than others, there are fewer benefits for us from investment in pure research. As a 'fast follower', our community would pay less to adopt changes and these changes would be lower risk as other societies have done the piloting for us. By lowering adoption risk, we avoid some failures and expenses that would create resistance and slow future changes. Our challenge becomes one of rapidly identifying, assessing and adopting the initiatives that will optimise benefits in our society. Decarbonisation in the Australian transport sector should adopt a 'fast follower' approach.

Job implications

Large infrastructure projects such as road widening and tunnel construction have a low labour component compared with material and equipment costs, so deliver relatively few jobs for the investment. A focus on small scale infrastructure improvements would deliver more jobs for Queenslanders for the same investment. The smaller scale projects could focus on improving resilience through better drainage, etc and improving urban amenity and provision for walking and cycling.

There are relatively few manufacturing jobs related to the transport sector in Queensland but there are some businesses working on buses and trucks. There may be some opportunities for these businesses to pilot more electric bus and truck services in South East Queensland to help them establish a market across Australia.

Most transport sector jobs are in freight logistics, involving driving, transferring loads at ports and interchanges and the back office staff that coordinate movements. Efforts to optimise freight movements may result in fewer drivers but would also increase employment for those who are coordinating all the movements in a more sophisticated fashion. If the industry operators in Brisbane can demonstrate they are more efficient than Sydney or Melbourne, there is potential for our port, rail and truck industry to gain market share for container imports.

The transition away from fossil fuels is not expected to have any large positive or negative job impacts in the transport sector. Other developments such as the emergence of autonomous vehicles may have very large job impacts by reducing the need for drivers but these will happen independently of any climate change initiatives.

Implications for Queensland Climate Transition Strategy

The following action areas in the Queensland Climate Transition Strategy should incorporate elements of the initiatives proposed in the best case scenario explained in this report.

PATHWAY 1 CREATE AN ENVIRONMENT FOR INVESTMENT SHIFT AND INNOVATION

Response 1 Facilitate the zero emissions industries of the future

1.2 Develop a Demand Management and Energy Efficiency Strategy

1.3 Deliver the Queensland Electric Vehicle Strategy

1.6 Support industry to shift to sustainable biofuels

Response 2 Lead by example

2.1 Join the Under2 Coalition and support zero net emissions by 2050

2.2 Demonstrate leadership by reducing emissions from Queensland Government operations

2.3 Integrate zero net emissions goals into state infrastructure planning

2.4 Use the land use planning system to support delivery of zero net emissions

2.5 Develop a Zero Net Emissions Transport Roadmap

2.7 Integrate climate transition risks and opportunities into government decision-making

PATHWAY 3 WORK WITH QUEENSLAND'S REGIONAL COMMUNITIES TO TRANSITION

Response 5 Support Queensland communities to take action

5.1 Build leadership capacity within communities to develop place-based climate transition roadmaps

5.2 Our Transition—provide tools, data and financial support for communities

5.3 Zero net pledges and Talking Transition program

5.4 Decarbonise remote communities

5.5 Work with local governments to build climate transition capacity

Recommendations

Implement a mode shift strategy incorporating:

- Changes to Land Use Planning regulations and/or planning schemes to constrain most job and services growth to within the pedestrian catchment of train and busway stations so that public transport can provide a high level of service to a growing share of trip purposes.
- Investing in walking, cycling and place-making infrastructure rather than road widening to expand the viability and convenience of walking and cycling for more trip purposes.
- Reviewing road rules with an intention to facilitate the safe use of more low-powered sustainable vehicles on footpaths, bike paths and low-speed roads as appropriate for each specific vehicle type
- Implementing proven travel behaviour change programs, especially following any walk, cycle or public transport upgrades, to increase awareness and use of non-car modes.

Encourage electric vehicle adoption by:

- Continuing to implement the Queensland Electric Super Highway.
- Investigating other incentives to increase purchase of electric vehicles, including for car share fleets.
- Utilising TransLink contracts to incentivise bus operators to trial electric buses.
- Utilising waste levy fees to incentivise councils and contractors to trial electric refuse collection trucks.

Continue to implement the Queensland Biofutures 10-Year Roadmap and Action Plan, focusing on bio-based diesel and jet fuel substitutes that perform well against the sustainability criteria.

Work with the Australian Government to:

- Implement fuel efficiency standards in the light vehicle fleet.
- Review Australian Design Rules and allowed vehicle types to facilitate imports of a wider range of safe and sustainable low-powered vehicles
- Implement fuel efficiency and safety standards for heavy vehicles.
- Mandate electronic surveillance of heavy vehicle travel, with auditing, enforcement and crash investigations to ensure all businesses are incentivised to operate legally under the Heavy Vehicle National Law, including Chain of Responsibility provisions.
- Work toward electronic charging of all heavy vehicles based on mass, distance and location of travel.
- Regulate or incentivise the airlines to improve fuel efficiency for domestic travel.
- Invest in further High Speed Rail planning and begin corridor protection or acquisition, especially for the link between Newcastle, Sydney and Canberra so it can be aligned with the new Western Sydney airport before incompatible decisions and developments occur.

Investigate the health impacts of diesel emissions and consider prohibitions of non-Euro 4 (and eventually non-Euro 5) compliant diesel engines in some urban centres and sensitive airsheds.

Implement a Smart Freight Demonstration Program to incentivise businesses to invest and innovate to optimise freight logistics or manufacture and trial electric bus and truck services for urban areas.

Ensure all transport infrastructure and policy decisions are made transparently following community engagement and analysis of co-benefits such as air quality, physical activity, accessibility, congestion, energy security, climate change resilience and employment impacts.

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