TRANSFORMING TRANSPORT

21

Key points

Transport systems in Australia will change dramatically this century, independently of climate change mitigation. High oil prices and population growth will change technologies, urban forms and roles of different modes of transport.

An emissions trading scheme will guide this transformation to lower-emissions transport options.

Higher oil prices and a rising emissions price will change vehicle technologies and fuels. The prospects for low-emissions vehicles are promising. It is likely that zero-emissions road vehicles will become economically attractive and be the most important source of decarbonisation from the transport sector.

Governments have a major role to play in lowering the economic costs of adjustment to higher oil prices, an emissions price and population growth, through planning for more compact urban forms and rail and public transport. Mode shift may account for a quarter of emissions reductions in urban passenger transport, lowering the cost of transition and delivering multiple benefits to the community.

Under strong mitigation scenarios, emissions from Australian land transport will fall rapidly around the middle of the century. It will be more difficult—and more expensive—to reduce emissions radically in civil aviation, where the early emphasis will be on improvements in conventional energy use. Late in the century, civil aviation will account for a high proportion of residual emissions, despite people making proportionately more use of other modes of transport.

The path to low-carbon transport will be driven by variations in rates of technological progress across and within transport modes. Early emergence of low-cost biofuels that do not compete with food for agricultural land would reduce the need for structural change. The early emergence of a low-cost electric car, alongside the decarbonisation of the electricity sector, would secure a large place for the private car. Greater use of rail within and between our large cities is being driven by other factors, which will now be reinforced by carbon pricing.

More generally, the transformation of the transport sector, like that of stationary energy, will be driven by interactions of the emissions trading scheme with a range of other factors. These factors include:

- higher global oil prices
- research and development in vehicle and fuel technology
- population growth
- government decisions on transport infrastructure, public transport services and land-use planning, induced in part by the other factors.

This transformation will take place through three main processes, which may operate in parallel:

- vehicles becoming more fuel efficient and shifting to low-emissions fuels, such as electricity
- a shift to lower-emissions modes, such as rail and public transport, accompanied by changes in the structure of towns and cities (urban form)
- reduction in travel frequency and distances, facilitated by changes in consumption, production and distribution patterns and changes in urban form, and driven by changing relative prices.

21.1 The role of transport and its current structure

Transport can be subdivided into six sectors, categorised by purpose (passenger or freight) and by the distance and destination (local, inter-regional or international) (see Table 21.1).

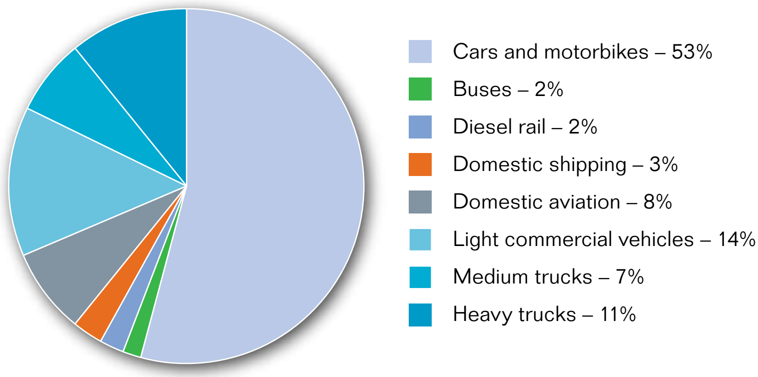
Table 21.1 Transport sectors

	Passenger	Freight
Local	Short-distance passenger travel, such as trips within cities and in regional towns	Short-distance freight trips, including urban deliveries and moving grain from farms to silos
Inter-regional	Longer-distance passenger travel between regions, cities and states and territories	Longer-distance freight movement between regions, cities and states and territories
International	Tourism and other international travel	Imports and exports

Despite the large differences between these sectors in the purpose of the trip, the length of journey and the mode of travel, all are currently dependent on petroleum-based fuels. Petroleum-based fuels currently account for around 97 per cent of Australian transport energy use in Australia (CSIRO 2008). These fuels have been relatively cheap in Australia in the recent past, largely due to low global oil prices in the 1990s and relatively low fuel taxes by international standards (Joint Transport Research Centre 2008).

Low fuel prices, in combination with patterns of urban development and the low priority given to public transport, are a key factor behind the extensive use of fuel-intensive modes of transport in Australia, including trucks and cars. These modes accounted for over 85 per cent of Australia's transport emissions in 2006 (see Figure 21.1). Long-distance freight is the exception, where rail and shipping play major roles. The efficiency of rail and shipping means that they produce a fraction of Australia's domestic emissions, despite carrying a high proportion of loads.

Figure 21.1 Australian domestic transport emissions, 2006



Note: Excludes electric rail and trams.

Source: DCC (2008a).

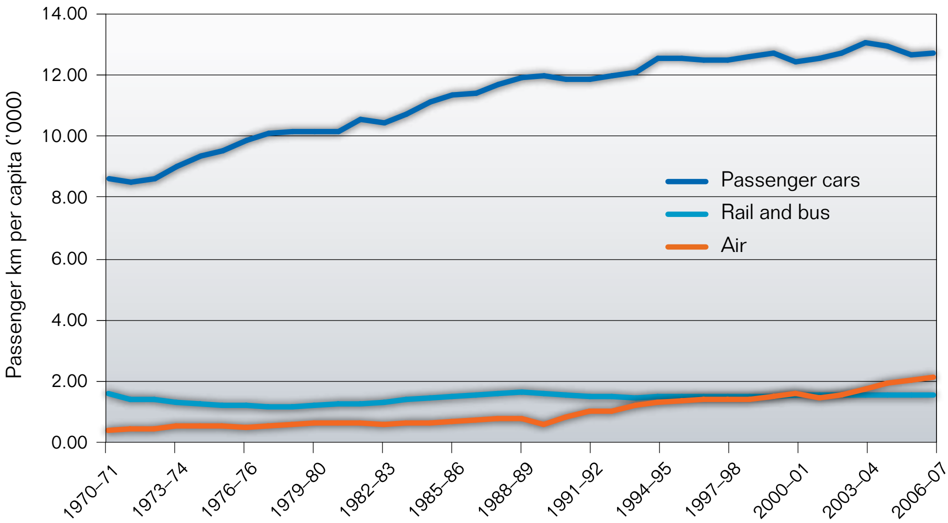
Emissions from the transport sector have grown rapidly with the increase in demand for transport, particularly higher-emissions forms of transport (see Figure 21.2). Passenger travel per person has increased, with incomes growing faster than the costs of car use and aviation (ABS 2008c, 2008d). The amount of freight carried in Australia has doubled over the last 20 years in tonne-kilometres,[1] largely caused by declining real freight rates and economic growth (BTRE 2006).

There have recently been changes in these trends. In some transport sectors there appears to have been a shift of travel to lower-emissions modes, and the rate of improvement in the fuel efficiency of the passenger car fleet has accelerated.

21.2 Causes of the transformation

The transport system is likely to undergo a profound transformation in this century, irrespective of mitigation. The main causes of these changes will be higher oil prices, new transport technologies, rising incomes and population growth. These factors will interact with an emissions trading scheme and will be mediated by market forces and government decisions on public transport and urban planning.

Figure 21.2 Passenger travel per capita by various modes, 1970–71 to 2006–07



Sources: Derived from ABS (2008a); BTRE (2007); BITRE (2008, pers. comm).

21.2.1 Global oil prices

Increases in the scarcity and price of oil will profoundly affect the costs of our current transport patterns and the relative price and competitiveness of different fuels, vehicle technologies and modes of transport.

Oil prices have risen steeply over the last few years and are likely to remain well above those of the late 20th century. World oil prices have more than tripled from an average of under US$30 per barrel in the 1990s to an average of over US$90 so far in 2008, with a peak of nearly US$150 in July 2008 (US Energy Information Administration 2008a, 2008b). The modelling undertaken for the Review assumes that oil prices will remain above $75 (US$60). However, prices could rise much further if conventional oil reserves come under pressure, partly because the cost of extracting and processing oil from other sources such as tar sands is higher than from conventional sources (CSIRO 2008: 14).

Higher oil prices will improve the competitiveness of alternative fuels, such as synthetic diesels, biofuels and electricity. They will provide incentives to travel less or by more fuel-efficient vehicles and modes.

21.2.2 Technology and fuel development

Higher oil prices have already stimulated investment in research and development for a variety of alternative fuels and vehicle technologies, including liquid fuels (produced from shale, tar sands, natural gas and coal), biofuels, fuel-cell hydrogen vehicles and electric vehicles. The take-up of these fuels and technologies will depend on:

- when commercial feasibility is demonstrated
- relative costs

- the size of the resource base for the fuel
- compatibility with existing commercial and public infrastructure.

The prospects for several of these technologies appear excellent, although it is uncertain when they will become fully competitive and which technologies will do relatively well. However, it is likely that a relatively low-cost, low-emissions vehicle technology will become competitive in the coming decades, and possibly within the next 10 years.

21.2.3 Population growth and economic growth

Australia's population and income growth (see Chapter 11) will dramatically increase transport demand, requiring major expansions to transport systems. Population growth will increase the competitiveness of modes such as public transport and intercity rail, as their costs per passenger decrease with scale (Mills & Hamilton 1994). Similarly, economies of scale in infrastructure provision and costs of traffic congestion mean that it will be increasingly cost effective to meet the needs of a growing population through denser urban settlements and greater use of rail and public transport.

Income growth is likely to increase the demand for long-distance transport, and in particular for aviation. Based on trends in the relationship between income and per capita demand for transport in Australia, the Bureau of Transport and Regional Economics suggests that the demand for local land transport in Australia's capital cities may be approaching a saturation point, with increases in income beyond 2020 not leading to further increases in per capita urban car use (2007: 27).

Economic growth will increase the demand for freight transport, heightening congestion pressures.

21.2.4 The emissions trading scheme

In the early years of the emissions trading scheme, it is likely that high global oil prices will have a larger impact on the cost of petroleum-based transport than an emissions price. The tripling in global oil prices from 1997 to 2008 more than doubled the average cost of petrol in Sydney, from 74 cents to $1.52 per litre (ABS 1997, 2008b). This increased the cost of travel in an average medium-sized car by around 10 per cent if the fixed costs of car ownership are considered.[2] An emissions price of $20 per tonne CO_2-e would increase the cost of petrol by around 5 cents a litre, and the cost of travel in a medium-sized car by less than 1 per cent. The impact of an emissions price will become more substantial as it rises over time. For example, an emissions price of $200 per tonne of CO_2-e would increase the cost of petrol by around 50 cents a litre.

Applying an emissions price that reflects the full contribution of aviation to climate change will be complex but is required for effective mitigation. Radiative forcing from aviation may be two to four times the impact of its carbon dioxide emissions alone, due to the complex effects of emissions such as nitrogen dioxide and cloud formation at high altitude, although there is uncertainty around these figures (IPCC 1999). Based on the UK Government's methodology for calculating emissions from flights for the purpose of offsets, a carbon price of $20 per tonne CO_2-e would increase the cost of a one-way flight from Sydney to Brisbane by $2.50 per passenger, and a price of $200 per tonne of CO_2-e by around $25 (Department for Environment, Food and Rural Affairs 2008).

21.2.5 How the factors interact through market forces

Higher oil prices and an emissions price will increase the price of petroleum-based fuels, potentially lowering demand for them.

The response to higher fuel prices strengthens over time. The Bureau of Infrastructure, Transport and Regional Economics (2008b) estimates that a 10 per cent increase in fuel prices leads to a 1.5 per cent reduction in car fuel use within one year, but around 4 per cent in the longer run. Goodwin et al. (2004) estimate reductions in fuel consumption associated with a 10 per cent increase in fuel prices of 2.5 per cent within one year and 6 per cent in the longer run. This is because the options to reduce fuel consumption increase with time, through use of more fuel-efficient vehicles, development of public transport infrastructure and changes to urban structure.

Individuals' responses to higher fuel prices will be affected by their incomes—which are expected to rise strongly over the coming century.

The higher the oil price, the lower the emissions price will need to be to make the transition to lower-emissions options competitive.

However, an emissions price and higher oil prices do not have identical effects. First, higher oil prices will improve the competitiveness of all alternative fuels —including liquid fuels produced from shale, tar sands and coal, which all involve much higher emissions per unit of energy than fuels from conventional oil sources. By contrast, an emissions price will selectively encourage lower-emissions fuels. The Garnaut–Treasury modelling projects that fuels such as coal-to-liquids would have a significant place in the market by 2050 if there were no mitigation, but not if an emissions price were introduced. Second, an emissions price will increase the incentive for reducing the use of all fuels that produce emissions, not just petroleum-based fuels.

There are three categories of response to higher oil prices and an emissions price:

- using vehicles that are more fuel efficient or run on alternative fuels
- switching to other modes such as rail and public transport
- reducing the demand for transport.

Vehicle emissions efficiency

The combined effect of rising oil prices and an emissions price will drive greater fuel efficiency, including through the take-up of hybrid petrol–electric vehicles, smaller cars and fuel substitution. The latter includes the substitution for petrol by fuels that can be used more efficiently, such as diesel, and by fuels that produce fewer emissions per litre, such as liquefied petroleum gas and ethanol.

The demand for travel

The amount of travel is likely to fall in response to higher fuel prices, including through:

- improved freight logistics, such as consolidating loads
- substitution of travel with other options, such as telecommunications
- travelling less often and staying longer
- travelling shorter distances by adjusting the origin or destination.

Travelling shorter distances will be supported by changes in urban form, such as increased urban density, which brings destinations such as homes and work, shops and recreation closer together. Population growth is likely to increase the density of some urban areas, facilitating reductions in per capita travel. However, government decisions will have a significant impact on urban density, as there are a range of externalities that affect land use decisions.

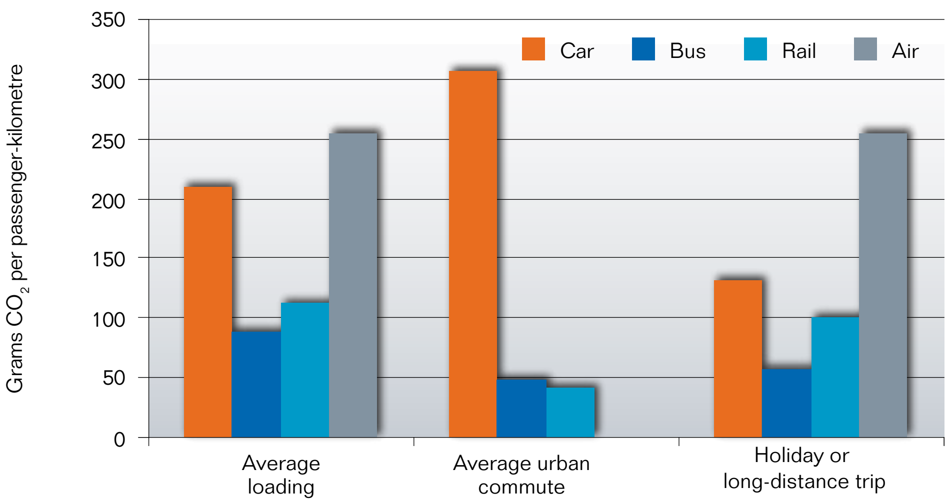
Changes in mode

Higher oil prices and an emissions price will encourage switching to more fuel-efficient and lower-emissions modes of transport, such as rail, shipping, public transport, walking and cycling. For example, shifting bulk freight from road to rail could reduce emissions and fuel use by 60 per cent (BITRE 2008, pers. comm.).

The Bureau of Infrastructure, Transport and Regional Economics produced estimates for the Review of typical emissions intensities of various modes of transport (Figure 21.3).

The emissions intensities of modes will vary with changes in vehicle technology and fuel sources. As low-cost, low-emissions road vehicles are developed, the

Figure 21.3 Emissions intensity of passenger modes, 2007



Note: Includes a modest rate of global warming potential for aviation of 168 per cent of carbon dioxide emissions.

Source: BITRE (unpublished data).

competitive advantage of more fuel-efficient modes of transport will decline. This will moderate the pressure for mode shift from higher oil prices and an emissions price.

There are substantial opportunities for mode shift in local passenger transport, particularly in urban areas. Over the last two decades, only around 20 per cent of commuters in Australian capital cities travelled to work by public transport, walking and cycling. In contrast, in many European and Asian cities these modes account for more than 50 per cent of trips. The potential for mode shift is discussed in more detail in section 21.4.2.

If population growth increases urban density, this could mean that more people use public transport, walk and cycle in their daily lives. While increased urban density does not automatically lead to the take-up of these modes, there is evidence that well-planned higher-density environments facilitate them (Newman & Kenworthy 1999). In addition, the cost of public transport per passenger declines with higher patronage, and higher density can support increased demand.

Some major changes in the proportion of the transport task undertaken by different modes will be determined by the market on its own. In freight, it is likely that a portion of the task will be transferred to rail and shipping. In passenger transport, public transport use could increase where services either already exist or can be expanded by the private sector, for example through intercity coach services.

In many sectors, governments' responses in delivering infrastructure and services, and influencing urban form will have a critical effect on the extent of mode shift.

21.2.6 The role of governments

Firms and individuals will only be able to express their demand for mode shift if there are suitable services and infrastructure. Surveys suggest that the main reasons that people do not currently use public transport relate to the lack of suitable quality infrastructure and services (ABS 2003). Governments have a role in delivering these infrastructure and services.

Governments are also responsible for land use planning. The types of transport infrastructure in which governments invest can further influence urban form. Public transport services, for example, may attract residents to higher-density environments. Conversely, investing in highways can lead to lower urban density. A growing population means that major changes to Australia's cities and transport systems are inevitable, and governments have an opportunity to influence fundamentally the way that urban areas develop and function into the future.

Even in the absence of an emissions price, there are many good reasons for governments to improve infrastructure and services for public transport, walking and cycling and to increase urban densities. Following business-as-usual trends, avoidable traffic congestion would cost Australians $20.4 billion by 2020

(BTRE 2007). The same amount of space dedicated to one bus or rail line can carry 10 times or more the number of people per hour as one lane of freeway (Vuchic 1981, 2005).

In addition to efficiency reasons for changing transport patterns, there are also major equity considerations. Individuals and communities are economically and socially disadvantaged if they lack access to employment, services and social opportunities. Currently, 14 per cent of Australians who are over 18 years of age do not have access to a car (ABS 2006c) and may be disadvantaged if they do not have alternative transport options. People who do have access to cars face major risks of social exclusion and financial hardship if they live in car-dependent areas and oil prices rise (Dodson & Sipe 2007).

In locations where the co-benefits of investing in more compact urban form and mode shift are significant, mode shift will be a low-cost mitigation option. For example, an assessment by the Bureau of Transport and Communications Economics (1996) estimated that upgrading rail lines between cities to support the transfer of some freight from truck to rail would be a no-regrets measure, providing economic benefits and reducing emissions. In locations where the co-benefits are small, mode shift will be a high-cost mitigation option.

The relative merits of different urban structures and transport patterns will vary between regions and even suburbs. However, the rising price of fossil fuels and emissions, and increasing population, add to the case for investment in more compact cities and better public transport, walking and cycling infrastructure.

21.3 Economic modelling results: a possible future?

The economic modelling undertaken by the Review jointly with the Australian Treasury paints one picture of a possible future for the transport system, considering the interaction of some of the factors discussed in section 21.2. The modelling assessed the impact of a carbon price on a range of different transport forms, including private cars, road freight, rail passenger, rail freight, shipping and aviation. CSIRO and the Bureau of Infrastructure, Transport and Regional Economics used a partial equilibrium model to assess the take-up of different fuels and technology in road transport to 2050, and the outputs were fed into the economy-wide mitigation modelling conducted jointly by the Review and Treasury and the independent modelling of climate change impacts conducted by the Review. As discussed in Chapter 11, three technology scenarios were assumed: ‘standard’, ‘enhanced’ and ‘backstop’. This section focuses on the outcomes of the standard technology assumptions. A scenario was also modelled that examined the impact of higher global fossil fuel prices.

Changes in urban form, which could have major effects on future transport patterns, were excluded by assumption in the modelling.

21.3.1 Economic growth and emissions from transport

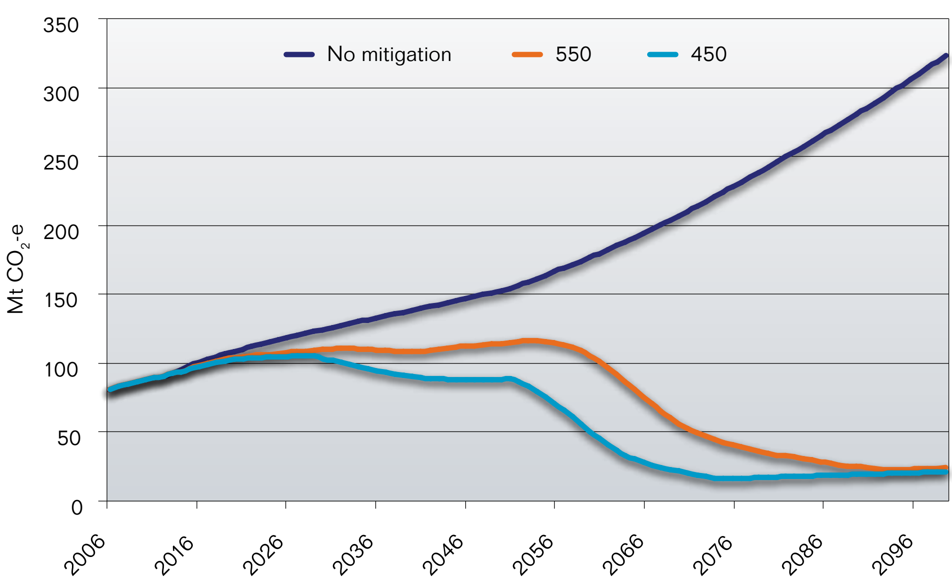
In the no-mitigation scenario, demand for all types of transport rises throughout the century due to increasing incomes, population and economic activity. Aviation is the fastest-growing transport type, reflecting growing incomes and an increased proportion of international and domestic spending on tourism. Bus, taxi and passenger rail use also increase with increased income. Private car use grows more slowly, in line with population growth, due to saturation of per capita demand early in the modelling period.

Road freight and shipping increase roughly in line with overall economic growth, and the growth in rail freight is influenced by the expansion of mining output.

Total transport activity under the 550 standard technology scenario is little different from the no-mitigation scenario, reflecting the relatively small impacts on transport costs from the carbon price compared to the impacts on sectors such as electricity. Demand for aviation and shipping grows slightly slower than in the no-mitigation scenario. Road transport shows a larger drop in activity, and rail transport activity increases relative to the no-mitigation scenario. This indicates that the carbon price induces a modest shift from road to rail for both freight and passenger transport, although the model structure does not allow the extent of mode shift to be quantified in passenger-kilometres or tonne-kilometres.

With no carbon price in place, transport emissions in the no-mitigation scenario nearly quadruple by 2100. In the 550 standard technology scenario, transport emissions are around 70 per cent below their 2006 levels by 2100 (Figure 21.4).

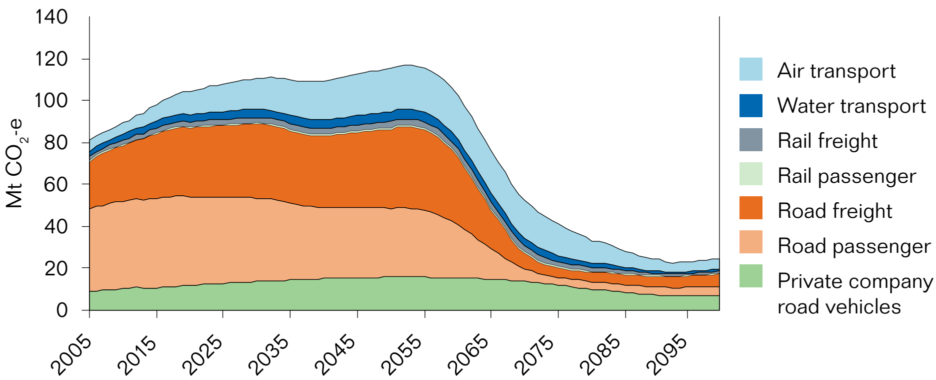
Figure 21.4 Projected emissions from the domestic transport sector with standard technology assumptions, 2006–2100



Source: These results were generated using MMRF.

In the 550 standard technology scenario, following the introduction of the carbon price in 2013, much of the increased road transport activity is offset by improvements in vehicle technology. Emissions increase by around 40 per cent from 2006 levels to 2050, but are 25 per cent lower than in the no-mitigation scenario. After 2050, road transport emissions decline rapidly with the adoption of electric road vehicles. Emissions intensity from aviation, shipping and rail transport declines gradually over the modelling period (Figure 21.5).

Figure 21.5 Breakdown of transport sector emissions in the 550 standard technology scenario, 2006–2100



Note: Emissions data do not take into account the impacts of climate change.

Source: These results were generated using MMRF.

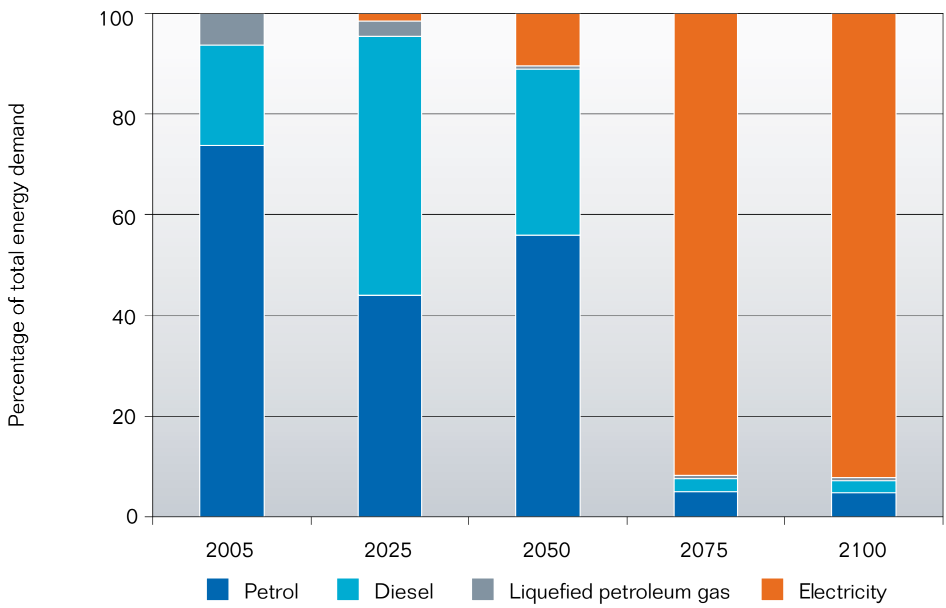
21.3.2 Road transport technology

The Garnaut–Treasury modelling undertook more detailed 'bottom–up' modelling of road transport for the period out to 2050, as this sector currently makes the largest contribution to transport emissions. The majority of emissions reductions from transport in the 550 standard technology scenario come from changes in road vehicle technology.

The bottom–up modelling covered a wide variety of technologies and fuels, including petrol, diesel, gas, coal-to-liquids, ethanol, biodiesel and electricity. In the short term, the number of fuels and engine types used in road transport increase in both the no-mitigation and 550 standard technology scenarios. Under the 550 standard technology scenario, non-conventional oil sources such as coal-to-liquids do not become competitive due to their high emissions. Lower-emissions fuels such as ethanol and natural gas increase their share of the market, and more efficient diesel engines displace petrol engines. The shares of many fuels then declines, with a shift back to petrol as hybrid petrol–electric and plug-in vehicles become cost-competitive around 2020 and 2030 respectively (see Figure 21.6). By 2050, hybrid petrol–electric vehicles and plug-in hybrids account for 50 per cent and 13 per cent, respectively, of the road transport undertaken in Australia.

In the long run, the emissions price and technology development result in a more limited range of fuels and technologies remaining competitive. In the 550 standard technology scenario, in the next 40 years fully electric vehicles are taken up primarily for passenger travel, and account for 14 per cent of the transport task in 2050. After 2050, electric vehicles become the predominant technology, and there is a rapid increase in electricity demand from the road transport sector under standard technology assumptions (see Figure 21.6).

Figure 21.6 Modelling of road transport fuel use in a 550 standard technology scenario



Source: These results were generated using MMRF.

21.3.3 Other transport modes

Other transport modes include rail, shipping and aviation. The modelling did not include specific fuel-switching and technology options for these modes of transport. Instead, under standard technology assumptions, the model assumes a gradual shift towards low- and zero-emissions fuels at approximately the same rate as road transport moves towards electric vehicles. It was assumed that by the end of the century zero-emissions fuels account for 90 per cent of fuel use in these transport modes, and that petroleum-related fuels account for the remaining 10 per cent.

Different results would emerge with more specific technology and fuel assumptions in these sectors. For example, it is possible that the aviation sector may still be producing some emissions in 2100, as there are currently more limited prospects for zero-emissions fuels in that sector, although the inclusion of biofuel elements in aviation fuel is proceeding more rapidly than had been considered likely a few years ago. There appear to be fewer constraints in adopting zero-emissions fuels in the ancillary road, rail and shipping sectors.

21.3.4 Technology assumptions

The technology assumptions in the 550 standard technology scenario represent an estimate of the cost, availability and performance of technologies based on historical experience, current knowledge and a cautious view of future trends. The assumptions incorporate improvements in existing technologies and the gradual, slow emergence and wide-scale deployment of new technologies, such as electric cars. The assumptions also incorporate learning effects, which result in substantial reductions in the cost of new technologies over time.

Strong globally coordinated mitigation action creates a large and sustained shift in relative prices (and therefore relative competitiveness) of high-emissions and low- or zero-emissions technologies. It would be surprising if these developments did not result in faster technology improvements and stronger changes in consumer preferences than might be expected on the basis of past experience and current knowledge. Faster improvements in fuel and engine efficiency and low- or zero-emissions fuel sources in the transport sector would bring forward the decarbonisation of the transport sector.

In addition to faster decarbonisation, technology improvements could also result in deeper and lower-cost decarbonisation. The standard technology scenarios assumed that there are limits to the decarbonisation possible for various modes of transport. As noted, the modelling assumed that the maximum take-up of zero-emission fuels for the rail, shipping and aviation sectors was 90 per cent in 2100. As a result, a rising carbon price imposes ever-increasing costs on the economy from the remaining 10 per cent of carbon-intensive transport. Technologies that enabled further decarbonisation could therefore significantly lower the cost of mitigation.

21.3.5 Modelling faster technology development with ‘enhanced’ and ‘backstop’ technology assumptions

The Review modelled the possible impacts of more rapid low-emissions technology development in the transport and electricity generation sectors globally. In this ‘enhanced technology’ scenario (see Chapter 11), technology improvements lead to a decrease in the demand for emission permits from transport and electricity generation, which lowers permit prices. This shows that faster development of road transport technology could bring forward the decarbonisation of the transport sector and reduce aggregate economic costs. However, under a fixed emissions cap, accelerating emissions reduction in transport would not necessarily accelerate decarbonisation of the economy as a whole. Instead it could allow higher emissions in other sectors and/or reduce the purchase of international emission permits.

In the enhanced technology scenario, electric vehicles become cost-competitive 20 years earlier than in the standard technology scenario but, as a result of lower carbon prices, they are taken up more slowly than in the standard technology scenario. The combined effect of faster development and slower take-up sees electric vehicles become a major component of the fleet around a decade earlier in the enhanced technology scenario than in the standard technology scenario.

Hybrid vehicles also become a major component of the fleet earlier in the enhanced technology scenario, but then are replaced earlier by electric vehicles.

Rates of technology development also affected mode shift in the modelling. Non-road transport activity (including rail and pipelines) is lower in 2100 in the enhanced technology scenario than in the standard technology scenario. This suggests that the faster that cost-competitive low-emissions road transport technologies are developed, the lower the pressure for mode shift.

The Review independently modelled a scenario in which a technology is developed that could provide unlimited emissions reductions at an emissions price of \$250 per tonne of CO_2-e (the 'backstop technology'). The effect of introducing a backstop technology is that emissions continue to fall but the carbon price no longer rises. As a result, the introduction of a backstop technology halts further transition to low-emission vehicles in the transport sector.

While this indicates that a backstop technology would reduce the pressure from the carbon price on the transport sector, in all likelihood once a transition to a particular type of road vehicle has built up momentum it would continue.

21.3.6 Modelling of higher fossil-fuel prices

A sensitivity run was undertaken that examined the potential impacts of sustained high fossil fuel prices. In this scenario, the extraction costs for oil, gas and coal were increased by 50 per cent in both the no-mitigation and 550 standard technology scenario. This raises the price of coal in 2050 in the no-mitigation scenario by 16 per cent, gas by 28 per cent and oil by 42 per cent relative to the standard no-mitigation scenario. This oil price would still be lower in 2050 than the peak of almost US\$150 in July 2008. These price rises result in general substitution away from fossil fuels, but within the energy sector there is substitution towards coal, which is the most emissions-intensive fuel.

The net effect is a small reduction in global emissions in the no-mitigation scenario—5 per cent lower at 2050—which reduces the overall scale of the mitigation task in the 550 standard technology scenario. It also narrows the cost gap between conventional and low-emissions technologies, so that advanced vehicle technologies become cost-competitive at lower carbon prices. As a result, in the high fossil fuel price 550 standard technology scenario, the global carbon price is 15 per cent lower in 2100 than in the 550 standard technology scenario. Higher fossil fuel prices result in an immediate shift to non-road modes of transport and distribution (including rail and pipelines) compared to the standard scenario, and electric and hydrogen vehicles are developed and adopted around five years earlier.

21.4 The path to transformation: a picture of future transport

The Garnaut–Treasury modelling explored a number of scenarios for the transport system in the future. Other outcomes are possible, including faster or slower emissions reduction at higher and lower cost. Nevertheless, emission reductions are likely to follow the pattern suggested by the modelling, with emissions stabilising over the coming decades, dropping rapidly as low-emissions road vehicles become competitive and tailing off as emissions intensity falls in aviation and shipping. However, it is possible that transport emissions could:

- grow more slowly over the coming decades if lower-emission vehicles and modes are taken up more extensively than the modelling suggested
- fall a decade or more earlier than projected in the 550 scenario if zero-emissions vehicles become cost-competitive more quickly
- fall to lower levels in 2100 if limits to reductions in emissions intensity at high carbon prices were not so tight.

Across the whole transport sector, changes in vehicle technology are likely to account for the vast majority of transport emissions reductions. Shifts to lower-emissions modes of transport are likely to account for a smaller proportion of early emissions reductions, but deliver multiple benefits as they occur gradually over the next five decades and beyond. Reductions in transport activity will probably result in a relatively small reduction in emissions in the long term.

A combination of some or all of changes in vehicle technology, mode shift and demand reduction will occur in each of the six transport subsectors discussed in section 21.1. The Garnaut–Treasury modelling is economy-wide and does not allow disaggregation of local, inter-regional and international travel, so discussion of the potential to reduce emissions faster than modelled in each sector must be qualitative.

In local passenger transport there are significant opportunities for rapid reductions in emissions over the next 30 years, with potential both for mode shift and for early adoption of low-emissions vehicles. There are also prospects for low-emissions vehicles in inter-regional passenger transport, but these may take longer to be realised, and there is significant opportunity for mode shift.

In both local and inter-regional freight there are good prospects for significant emissions reductions in the next two decades. In local freight there are better short-term prospects for vehicle changes than in inter-regional freight, but in inter-regional freight there is greater potential for mode shift.

Emissions from international passenger and freight transport are likely to fall later than in the other sectors, due to more limited opportunities for mode shift and longer useful life of existing vehicles. However, significant emissions reductions in these subsectors are still likely within this century.

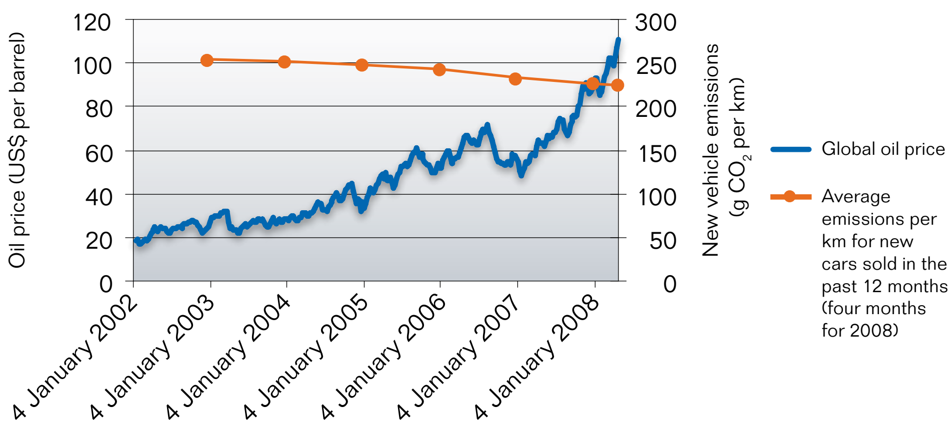
Together, the changes in each sector will add up to significant reductions in transport emissions. Given the pressures from higher oil prices, major changes in transport emissions could be achieved at relatively low cost.

21.4.1 Local passenger transport

Changes in car technology are likely to be relatively rapid in local passenger transport and could be faster than suggested by the Garnaut–Treasury modelling. Smaller cars, hybrids and short-range electric vehicles are well suited to local transport, which involves short-range and stop–start driving. There are also substantial opportunities for mode shift and reductions in transport demand.

First, in the 550 standard technology scenario the share of car travel by 'light and small' cars was assumed to increase from 35 per cent to 45 per cent over the 44 years from 2006 to 2050. A faster shift is possible. Over just the last five years, with rising oil prices the proportion of new cars purchased that were small and light vehicles increased from around 35 per cent to 45 per cent of the market (FCAI 2008b), resulting in the emissions intensity of new vehicles decreasing by around 10 per cent (Figure 21.7). If these purchasing patterns continue over the next decade, the efficiency of the whole fleet would improve substantially.

Figure 21.7 Average new car emissions and oil price, January 2002 – April 2008



Sources: FCAI (2008a); US Energy Information Administration (2008a).

Second, partially and fully electric vehicles appear set to become cost-competitive in the near future, potentially faster than projected by the modelling (see Box 21.1).

Third, there are substantial opportunities for mode shift in local passenger transport if governments invest in infrastructure and urban planning. The modelling allowed for reductions in car activity and growth in demand for bus and train activity, but did not explicitly model the transfer of passenger journeys from car to bus or rail, or consider walking and cycling.

Box 21.1 Hybrid, electric and hydrogen vehicles

Production of hybrid petrol–electric vehicles has grown rapidly since the release of the Toyota Prius in 1997. By 2008, more than one million units of this model had been sold worldwide (Toyota Motor Corporation 2008). Sales of hybrids in Australia grew from just 0.2 per cent of cars sales in 2005 to 0.78 per cent of sales in January to July 2008 (FCAI 2008a; BITRE 2008b).

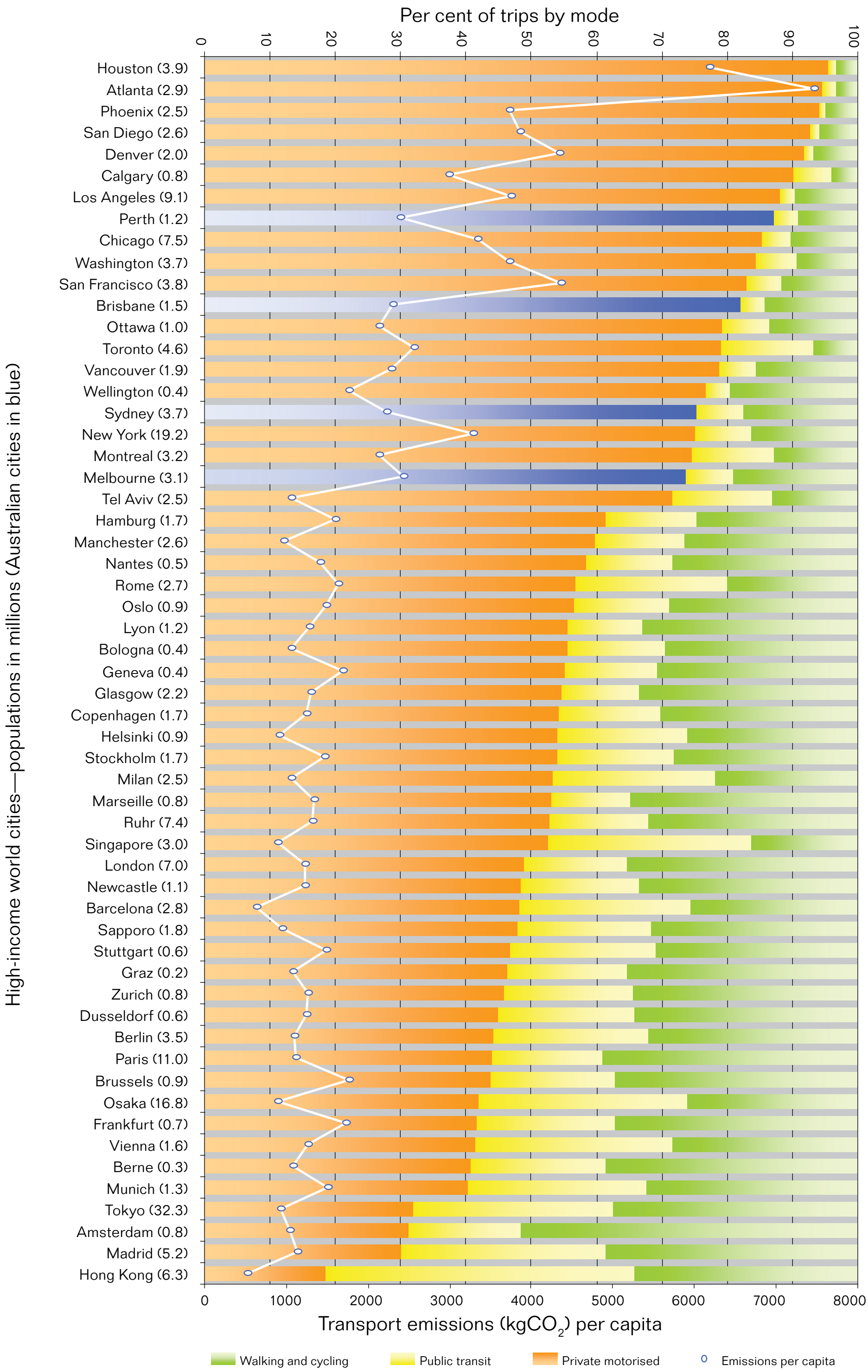
Electric vehicles are likely to become cost-competitive for local travel earlier than for long-distance travel. Battery capacity is a major part of an electric vehicle's cost, and short-range driving requires less battery capacity than longer-range driving (IEA 2008). The cost and reliability of batteries has improved dramatically over the last decade, making plug-in hybrid and fully electric vehicles that can refuel on electricity appear increasingly viable. Electric vehicles that are suitable for short-range use are already available, and both Toyota and General Motors have announced that they will release plug-in hybrids, with ranges of several hundred kilometres, by late 2010.

The emissions of electric vehicles will depend on the source of the electricity. To illustrate the point, an electric car today would generate about 30 per cent more emissions than a petrol-fuelled car of similar dimensions if the electricity had the average emissions intensity of the Australian grids. It would generate about 85 per cent less emissions than the equivalent petrol car if it drew its power from the average supplies to Tasmania. It would generate about 60 per cent more emissions than the equivalent petrol car if it drew its power from the average supplies to Victoria. If there were a widespread shift to electric vehicles, transport emissions would be tied to the emissions from the stationary energy sector. As the stationary energy sector decarbonised, emissions generated by transport activity would decline.

There is active research and development in a number of countries on the use of hydrogen in vehicles, including for energy storage in electric vehicles. Hydrogen can be produced by several means, including using electricity to split the water molecule and reforming natural gas, and so could be produced using low-emissions electricity. Its widespread use for motor vehicles would require larger investment in commercial infrastructure than a car directly recharged with electricity. Nevertheless, it could win a place in the future if its costs fall significantly.

Public transport, walking and cycling accounted for 12 per cent to 26 per cent of trips in Australian cities in 1995, but in many high-income European and Asian cities these modes accounted for more than 50 per cent of trips (Figure 21.8). Even within Australian cities there are significant variations in mode share between suburbs. For example, public transport, walking and cycling make up almost 50 per cent of trips to work in some local government areas in inner Melbourne but less than 10 per cent in many of the outer suburbs, where recent growth has been concentrated (ABS 2006b).

Figure 21.8 Trip mode, population and emissions in 57 high-income cities, 1995–96

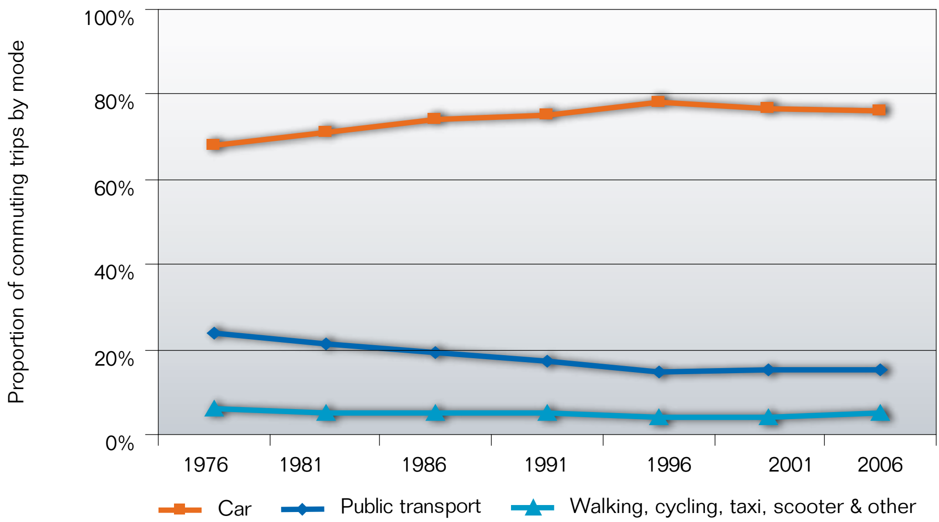


Note: Population figures are for study areas in 1995–96, which may differ from other definitions of urban areas.

Sources: Derived from Kenworthy & Laube (2001) and Kenworthy (2008).

A small shift from cars to other modes is already occurring in Australia. The census, which provides national data on mode share in Australia, indicates the share of commuting by car in Australian capital cities stabilised and started to decline slightly between 1996 and 2006 (Figure 21.9).

Figure 21.9 Mode share for journeys to work in Australian capital cities 1976–2006



Source: Derived from Mees et al. (2007).

Since the last census in 2006 there has been a resurgence in public transport use in many parts of Australia after several decades of stagnation, although it is not yet clear whether this represents a mode shift. In a recent survey, 19 per cent of respondents stated that they had used public transport more in the last year in response to higher petrol prices (Nielsen 2008). In 2007–08 public transport patronage in south-east Queensland was 5 per cent higher than in the year before (Queensland TransLink Authority 2008, per comm.). In both Melbourne and Perth patronage was 7.7 per cent higher (Victorian Department of Transport 2008, pers. comm.; Public Transport Authority of WA 2008, pers. comm.).

The patronage of rail services grew even faster. In 2007–08, rail patronage in Sydney was 5.1 per cent higher than the year before (Rail Corporation New South Wales, pers. comm.), and in Melbourne 12.7 per cent higher, stretching some services to capacity. Perth was 19 per cent higher, partly reflecting extension of rail services. Increases in patronage are also occurring in some regional areas. Following improvements in the frequency and affordability of Victorian regional rail services, patronage grew by 29 per cent between 2005–06 and 2006–07, and a further 21.8 per cent in 2007–08 (V/Line 2007, 2008 pers. comm.).

The number of commuters travelling to work solely by foot in major Australian cities increased from 3.5 per cent of trips to 4 per cent of trips between 2001 and 2006 (2006 census data reported in Mees et al. 2007). In some cities and suburbs it makes up a much larger proportion of trips, with 7.6 per cent of commuters walking to work in Hobart (Mees et al. 2007).

In most Australian capital cities, around 1 per cent of people cycled to work in 2006. Cycling is increasing rapidly in some Australian cities. The number of cyclists on measured routes in Sydney increased by 11.4 per cent per annum between 2003 and 2007, and on key routes in Melbourne by 20 per cent per annum from 2006 (Road Transport Authority 2008; Bicycle Victoria 2008).

In Canberra, 2.5 per cent of commuters already cycle to work (Mees et al. 2007). In the United States, where travel is dominated by car, cycling accounts for 3.5 per cent of trips to work in Portland, a city of over half a million people (US Census Bureau 2007). In many European cities cycling rates are much higher—for example, bicycles account for 12 per cent of traffic in Berlin, a city of around 3.5 million people (Senate Department for Urban Development 2007). Thirty-six per cent of trips to work are made by bicycle in Copenhagen, a city with a population of around half a million (City of Copenhagen 2007).

The Review's modelling did not consider the potential for reduction in demand for urban transport that could arise from changes in urban form, as people substitute shorter distance trips for longer trips.

Governments have a strategic choice about whether to invest in mode shift and more compact urban forms. The need to plan our towns and cities for population growth provides us with an opportunity to plan for different densities and public transport structures.

Changes in urban structure and mode could be implemented immediately in new suburbs and settlements. In established areas, it will take longer for the necessary system-wide changes to transport and land use to evolve. Significant mode shift will not occur overnight, or within one electoral cycle. However, a steady improvement in transport facilities and urban form over several decades accumulate to major effects on total travel demand and shifts in mode.

The combination of changes in vehicle efficiency, mode and demand could have significant impacts on emissions even without further technological development. On average, the European cities in Figure 21.8 have 60 per cent of the per capita emissions of the Australian cities, and wealthy Asian cities less than 40 per cent. The largest sources of difference relate to public transport infrastructure and use.

21.4.2 Local freight transport

The vast majority of local freight is carried by trucks and light commercial vehicles (BTRE 2006). Technological changes in these vehicles will account for almost all of the emissions reductions in this sector. Local freight vehicles could change rapidly, as short distances and stop–start conditions make hybrid engines and electric vehicles highly suitable. In addition, the use of central refuelling depots reduces their dependence on the development of widespread alternative fuel infrastructure. The modelling projected slow but in the end substantial take-up of hybrid and electric freight vehicles. Emissions from this sector could fall faster than modelled if, as seems likely, these technologies became commercially attractive sooner.

There is likely to be limited mode shift. Short travel distances and the need to travel to a wide range of destinations mean that road vehicles are likely to continue to dominate local freight. However, some demand reduction would occur almost immediately in response to higher fuel prices through more efficient practices, such as greater consolidation of deliveries.

21.4.3 Inter-regional passenger transport

Inter-regional passenger travel is largely made by car and air. Cars account for 87 per cent of all intrastate trips and 38 per cent of interstate trips. Aviation accounts for 55 per cent of interstate trips (Tourism Research Australia 2007). Other modes, including coaches and ferries, account for a smaller proportion of inter-regional transport. Reductions in emissions are likely to arise from a combination of changes in vehicle technology, mode shift and demand reduction.

There will be changes in the emissions intensity of the full range of passenger vehicles, including cars, coaches, rail and aeroplanes. Changes could occur faster than projected in the modelling if a suitable low-emissions long-distance road vehicle technology were developed in the near future, such as biodiesel from sources that did not compete with food production for land.

Aviation increased in efficiency significantly in the last century. The fuel efficiency of the US air fleet increased by 60 per cent between 1971 and 1998 (IEA 2008). High oil prices are already driving investment in research and development on a number of alternative fuels, including biofuels and hydrogen. There appear to be prospects for use of biofuels in the coming decades, but in the short to medium term the prospects for a near zero-emissions fuel in aviation appear more limited than in other modes. Unless there is a breakthrough with alternative fuels, higher oil prices and an emissions price are likely to increase the cost of flying relative to other forms of transport.

If long-distance road and aviation technologies were to improve slowly, higher oil prices and an emissions price could slow the growth in per capita inter-regional travel. Video-conferencing could supplant some business trips, and some discretionary transport, such as holidays, could be reduced or replaced by shorter trips.

However, growing incomes over this period may offset rising long-distance travel costs, and there are options to switch to other modes rather than reduce travel. For medium-distance journeys, which are currently largely made by car, passengers could shift to bus services and regional rail. For longer-distance journeys now made by car or air, passengers could shift to high-speed rail.

High-speed rail is a major component of long-distance travel in Europe, Japan, Korea and China, linking cities that are several hundred to a thousand kilometres apart. While the prospects for competitive high-speed rail for intercity journeys in Australia have seemed limited in the past, high oil prices, an emissions price, rising incomes and a growing population on the east coast improve the prospects of cost-competitive high-speed rail links between major cities.

Now is a good time for the Commonwealth Government and the governments of New South Wales, Victoria, Queensland, South Australia and the Australian Capital Territory to examine why intercity passenger train services in Australia are inferior to those in European and high-income Asian countries, with a view to removing barriers to the emergence of high-quality inter-regional rail services in Australia.

21.4.4 Inter-regional freight

Long-distance freight transport is made by a range of modes. In 2000, around 28 per cent of non-urban freight tonne-kilometres was carried by road, 37.6 per cent by rail, 33 per cent by ship and 0.05 per cent by air (BTRE 2006). Inter-regional freight may experience less rapid improvement in the emissions intensity of vehicle technology than local freight, but more mode shift.

The development of near zero-emissions trucks for inter-regional freight may take longer than for local freight, due to the additional energy storage required for long-distance travel. Accordingly, the Review's modelling placed some limitations on the adoption of hybrid and electric vehicles for long-distance travel prior to 2050, and assumed that biodiesel would not become commercial. Emissions could fall faster from this sector if biodiesel or another low-emissions fuel were developed.

Rail and shipping also have opportunities for fuel switching. Gains may take several decades to realise fully after the development of new technologies, due to the long working lives of these vehicles.

There are immediate and growing opportunities for mode shift, particularly from road to rail, given that the cost of road freight has been increasing faster than the cost of rail and shipping (ABS 2008d). The majority of bulk freight, such as mining products and grain, is already carried by rail and shipping; the Bureau of Transport and Regional Economics (2006) projected that this will continue even in the absence of an emissions price.

Around 75 per cent of non-bulk freight, such as manufactured goods, is currently carried by road, due to its ability to deliver door to door (BTRE 2006). Road is likely to retain a significant component of the non-bulk task, but part of the 15 per cent of road freight that is currently used for intercity trips could be transferred to rail (BTRE 2006: 158). In the longer term, the development of a more substantial rail freight network, along with intermodal terminals that allow the rapid transfer of goods between trucks and trains, could permit an even greater share of freight to be transferred from road to rail. The Review's modelling allowed for some limited shift of freight from road to rail.

The demand for inter-regional freight will be affected by changes in production and distribution patterns. Producing goods at several sites for local consumption, rather than at one site with wider distribution, can reduce transport costs. As both production and transport costs will involve some greenhouse gas emissions, a broad-based emissions trading scheme that includes stationary energy, industrial processes and transport is necessary to achieve the lowest-cost emissions reduction over the whole production and distribution process.

21.4.5 International passenger and freight

International passenger travel is now almost exclusively by air. Cruise ships account for only a small section of the tourist market. Conversely, shipping accounted for over 99 per cent of international freight by weight in 2006–07, with aviation carrying a small but valuable load (less than 0.1 per cent of freight by weight but 13 per cent by value) (BITRE 2008a). Vehicle technology improvements and demand changes are likely to account for the majority of emissions reductions in this sector.

There are prospects for improving the emissions efficiency of shipping and aviation. Some of these changes will take several decades to develop and implement, with the result that the cost of international transport could rise with emissions pricing in the short term. The fuel consumption and emissions of existing ships can be lowered by reducing their speed and retrofitting them with technologies such as kite-sails and biofuels (IEA 2008). New ships will be able to take advantage of additional options, including changes to hull design. As noted in section 21.4.3, there are good prospects for improved aviation efficiency, but more limited prospects for zero-emissions fuels than for other modes. The Review's modelling assumed that emissions in these sectors would decline slowly over the century. A breakthrough in technology in the coming decades would result in faster and lower-cost emissions reduction in this sector.

The demand for international freight transport will grow more slowly if shipping and aviation prices increase. Higher international transport costs would increase the advantage of producing goods closer to their site of consumption, which may result in some goods being produced domestically rather than imported. In addition, relative costs of processing some bulk mineral and energy commodities before export may decline, promoting processing in Australia.

Depending on how high oil prices rise and how long alternative fuels take to come to market, international passenger transport may grow more slowly than it otherwise would have done. In the short term, the emissions price is likely to have a smaller impact than higher fuel prices on aviation costs. Later in the century the emissions price could have a more significant impact on the demand for aviation if low-emissions fuels have not emerged. Very high oil and emissions prices would result in people choosing to travel less often and by slower modes such as ships. Any such tendency would be moderated if alternative, low-emissions aviation fuels became cost-competitive.

21.4.6 Faster, deeper, cheaper

The Garnaut–Treasury modelling concludes that the cost of the transition to a lower-emissions transport system will be relatively modest. Transport emissions could be reduced faster and at lower cost if:

- governments plan for more compact cities and invest in a shift from high-emissions modes to rail, public transport, walking and cycling
- a range of road vehicle technologies become commercial sooner than assumed

- technologies are developed in the coming decades that substantially reduce emissions from aviation, shipping, rail, ancillary road transport and the residual emissions from road.

21.5 Fostering the transformation

There are many opportunities for decarbonising the transport system. Low-cost transformation of the transport sector will require policy steps beyond the introduction of an emissions trading scheme.

Two key issues stand out. First, governments will need to respond to changing economic conditions by focusing on denser urban form and investing more in public transport infrastructure. Second, there are a range of policies that distort the costs of vehicle ownership and use. Government also has a useful role in dissemination of information, as discussed in Chapter 17.

21.5.1 Cities for the new cost environment

Australian governments have an opportunity to choose how settlements will develop. With population set to increase by about two and a half times in a century, the continued development of settlements on their current patterns would generate infrastructure, traffic congestion and equity problems. The alleviation of these problems through planning for more dense development around better public transport infrastructure would have incidental advantages for reducing the cost of adjusting to an emissions constraint.

21.5.2 Distortions in the prices of vehicle ownership and use

A number of established policies impede the take-up of more fuel-efficient, lower-emissions vehicles. The introduction of an emissions trading scheme provides an occasion for governments to consider whether the distortions arising from these policies outweigh their benefits.

There is a strong case for reducing imposts on purchasing and owning vehicles and replacing them with charges on using a vehicle. One way to do this would be to allow the full cost of the emissions permits to flow through to fuel prices, and to use the permit revenue to fund reductions in sales taxes, import duties and vehicle registration charges.

Several taxes apply to the upfront price of vehicles but not other goods, including import tariffs and stamp duty. Tariffs on vehicles manufactured abroad distort the market for vehicles, at the margin slowing the diffusion of new, low-emissions vehicles. Given that 81 per cent of vehicles sold in Australia in 2007 were manufactured abroad (Commonwealth of Australia 2008) and at the present time lower-emissions vehicles tend to be imported, this biases purchase patterns against low-emissions vehicles. In addition, four-wheel drive vehicles have a 5 per cent import tariff advantage over passenger cars, reducing the cost of these more emissions-intensive vehicles relative to other imported cars. There is a strong case for the Commonwealth Government reducing and equalising import tariffs as soon as possible.

There are also charges applied to vehicle ownership, such as registration fees and insurance, where the costs that the charges are sometimes supposed to cover are affected by the distances travelled. These charges increase the cost of owning a vehicle and, as the costs do not increase with use, provide no incentive for people to use their cars less. Options for relating vehicle charges more closely to use include shifting the third-party personal injury insurance component of registration fees to fuel excise. This is a use-related cost that should rise as use rises. This shift could be done in a revenue-neutral way and would require an agreement on revenue distribution between state and territory governments (which currently collect these charges) and the Commonwealth Government (which collects fuel excise).

Some policies reduce the cost of vehicle use or create incentives for use. The fringe benefits tax provisions attempt to value benefits provided by employers to employees as part of salary packages in order to appropriately tax them. However, the current treatment of vehicles and parking spaces distorts decisions towards private vehicle use and greater demand of transport overall (Commonwealth of Australia 2008). These provisions could be improved by:

- ensuring the salary sacrifice arrangements are mode neutral
- amending the statutory fraction method to ensure it is distance neutral.

Notes

1 Freight activity is typically measured in 'tonne-kilometres', the tonnes of freight carried multiplied by the distance it is carried. Passenger transport activity is measured in 'passenger-kilometres', the number of people carried multiplied by how far they travelled.

2 Based a medium-sized car driven 15 000 kilometres a year over five years (RACV 2008).

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