Ministry for the Environment
Manatū Mō Te Taiao

VEHICLE KILOMETRES TRAVELLED BY ROAD

Environmental Report Card
March 2009

Summary

Transport is a vital link that brings people and goods together across New Zealand. We rely on it to get to work and for educational, social and recreational activities. Transport also connects suppliers to markets and helps showcase our natural environment through tourism.

Road transport is the dominant mode of transportation in New Zealand. While it provides many economic and social benefits, it also has environmental and health impacts. For example, road transport is a primary source of harmful air pollutants in some urban areas. Each year in New Zealand, traffic-related air pollution is a contributing factor in a similar number of deaths as road accidents. Waterways can be affected by contaminated run-off from roads, and wastes such as used oil, batteries and tyres require careful disposal.

It is difficult to quantify the actual environmental and health impacts of road transport at the national level. However, the distance travelled on our roads (also known as vehicle kilometres travelled or VKT) is a good proxy for the pressure road transport puts on the environment. This measure is widely used internationally and domestically to assess the magnitude of the pressure and how it is changing over time.

In New Zealand, our use of road transport is intensifying. On average, we are driving further, we own more cars, they are slowly getting older, and their engine size is increasing. However, over the past few years there is evidence of 'decoupling' of the growth in VKT from economic growth (ie, the economy grew at a faster rate than VKT).

By understanding the total distance travelled on New Zealand roads, the types of vehicles we use, their age and fuel type, and how intensively we are using our road transport, we can learn more about the pressure road transport is placing on the environment. In this report card, we report on the latest full-year data available (2007).

Total distance travelled (Total VKT)

Total VKT provides a proxy measure of the overall pressure on the environment from all forms of road transport.

CURRENT SITUATION: After a slight drop in 2006, the total distance travelled on New Zealand roads in 2007 increased to 40.2 billion kilometres.

Getting worse

TREND: This continues a long-term upward trend. Between 1980 and 2000, the total distance travelled on roads more than doubled. Between 2001 and 2007, total VKT increased by 12 per cent. Major causes have been an increase in population and growth in the economy, but the average New Zealand driver is also driving further. Between 2001 and 2007, VKT per person increased by nearly 3 per cent.

Types of vehicles travelling (VKT by vehicle type)

Different vehicle types place different pressures on the environment. On average, heavy vehicles generate more greenhouse gas emissions and air pollutants for each kilometre travelled than other vehicle types.

CURRENT SITUATION: Light passenger and light commercial vehicles were responsible for most of the distance travelled on New Zealand roads in 2007 (nearly 92 per cent). Heavy trucks and buses accounted for 7.5 per cent, with the remaining distance travelled by motor cycles.

Little or no change

TREND: Between 2001 and 2007, the proportion of VKT travelled by buses and trucks increased slightly compared to light vehicles, although this trend slowed in 2007. An increase in bus travel can, however, reduce the distance travelled by light passenger vehicles.

Age of vehicles travelling (VKT by vehicle age)

As vehicles age they may become worse polluters, particularly if they are not well maintained. Older vehicles often have no emission control technology fitted. Therefore, they tend to produce more harmful exhaust emissions than newer vehicles.

CURRENT SITUATION: In 2007, vehicles between 8 and 12 years old travelled the greatest distance on New Zealand roads.

Little or no change

TREND: The vehicle fleet continued to age slowly between 2001 and 2007. This is partially due to the increase in the average age of used imported vehicles entering the fleet.

INTERNATIONAL COMPARISON: Our light vehicle fleet is old in comparison to other countries with similar levels of VKT per person. Our fleet is therefore likely to be emitting a higher proportion of harmful exhaust emissions per person, on average, than other countries with newer vehicles.

Type of fuel used (VKT by fuel type)

Petrol and diesel are the main fuel types used for road transport in New Zealand. Combustion of each fuel type produces different air pollutants and amounts of greenhouse gases for each kilometre travelled. Engine size, tuning and age also affect this.

CURRENT SITUATION: Diesel-powered vehicles were responsible for one-quarter of the VKT by road in 2007. Heavy diesel trucks accounted for 8 per cent of the total, and diesel buses 1 per cent.

TREND: Diesel vehicles make up a growing proportion of total VKT in New Zealand. While new diesel vehicles have good technology to control exhaust emissions, most of the diesel travel is by vehicles 8 to 12 years old. Because of their age, these vehicles may have higher levels of exhaust emissions harmful to human health.

Road transport intensities

Both population growth and economic activity have a significant influence on road transport activity. By comparing changes in these things, we can see how intensively we are using road transport resources. A decrease in intensity can indicate a decrease in environmental pressure.

VKT per person

VKT per person is a proxy used to show the average greenhouse gas emissions and air pollutants from road transport for each person in New Zealand.

Getting worse

TREND: Between 2001 and 2007, VKT per person intensified, increasing by nearly 3 per cent.

INTERNATIONAL COMPARISON: By international standards, New Zealanders rely heavily on road transport. The latest Organisation for Economic Co-operation and Development (OECD) comparison (2002) shows that New Zealand had the second highest VKT per person out of 30 OECD countries.

Vehicles per person

Increasing vehicle ownership promotes greater VKT and can lead to more congestion at peak times.

TREND: Light vehicle ownership is intensifying in New Zealand. In 2007 there were 70 light vehicles for every 100 New Zealanders compared to 64 in 2001.

INTERNATIONAL COMPARISON: The latest OECD comparison (2006) shows that New Zealand ranked third highest amongst OECD countries in terms of vehicle ownership per person.

VKT per GDP dollar

VKT per unit of gross domestic product (GDP) measures the relationship between economic activity and VKT.

Getting better

TREND: Between 2001 and 2007, VKT per unit of GDP dropped. This is a sign of 'decoupling' which means that GDP grew at a faster rate than VKT over this period.

INTERNATIONAL COMPARISON: The latest OECD comparison (2002) shows that New Zealand had the highest VKT per unit of GDP in the OECD.

Road freight (tonne-kilometres) per GDP dollar

Freight vehicles generally produce more greenhouse gas emissions and harmful air pollutants than light vehicles on our roads. They also produce economic value. By comparing growth in the economy and road freight, we can assess changes in intensity.

Getting worse

TREND: Since the early 1990s there has been a trend of increasing intensity in all but 2 years. This means that, overall, road freight transportation grew at a faster rate than GDP over this period.

Future watch

Record high fuel prices in the middle of 2008 may lead to an overall reduction in total kilometres travelled for the year, similar to the dip that occurred in 2006 when fuel prices also rose sharply.

Although fuel prices have dropped back, it is possible that the current economic recession will temper growth in VKT in the short term. In the longer term, it is anticipated that VKT will once again increase with increasing population and GDP, in line with historic trends.

Future increases in VKT may not put as much pressure on the environment as in the past. Along with other initiatives, the Vehicle Exhaust Emissions Rule, which took effect at the beginning of 2008, is expected to decrease the harmful exhaust emissions of new and used imported vehicles entering the fleet. The Rule requires the implementation of progressively higher emissions standards for all vehicles (light and heavy, petrol and diesel) as they enter the New Zealand fleet. It is also anticipated that small, light vehicles, which produce less greenhouse gas emissions for each kilometre travelled, will become increasingly popular.

Introduction

Road transport is the dominant mode of transportation in New Zealand. It is responsible for over 90 per cent of our national transport-related greenhouse gas emissions[1] and 67 per cent of our national freight movement (Ministry of Economic Development, 2008a; Ministry of Transport, 2008a).

Road transport is a vital link that brings people and goods together across New Zealand. We rely on it to get to work, and to access educational, social and recreational activities. Road transport also connects suppliers to markets and helps showcase our natural environment through tourism.

1 National greenhouse gas emission totals do not include emissions from international transportation.

We have a widely distributed population due to our topography, and sprawling urban centres, which contribute to a greater reliance on road transport (Ministry for the Environment, 2000).

While motorised road transport provides many economic and social benefits, it also has an environmental impact. Approximately 16 per cent of New Zealand's total greenhouse gas emissions come from road transport (see text box 1). Waterways can be affected by contaminated run-off from roads, and wastes such as used oil, batteries and tyres have an impact on our environment.

Road transport also produces exhaust gases and fine particles that can affect human health by irritating eyes, throat and lungs, and aggravating respiratory conditions such as asthma and bronchitis (see text box 2). Each year in New Zealand, traffic-related air pollution is a contributing factor in a similar number of deaths as road accidents (Fisher et al, 2002). For information on New Zealand's air quality see the Air Quality (Particulate Matter – PM_{10}) report card (Ministry for the Environment, 2009).

It is difficult to quantify the specific environmental and health impacts of road transport at the national level. However, the distance travelled on our roads (also known as vehicle kilometres travelled or VKT) is a good proxy for the pressure road transport puts on the environment. This measure is widely used internationally (eg, Beeton et al, 2006) and domestically (eg, Ministry of Transport, 2008b) to assess the magnitude of this pressure and how it is changing over time. It is also one of the measures used by the OECD to compare the progress of different countries towards environmental sustainability (Organisation for Economic Co-operation and Development, 2007).

Text box 1: Road transport and greenhouse gases

Emissions from vehicle exhausts contain carbon dioxide, methane and nitrous oxide, all of which are greenhouse gases that cause climate change. Approximately 16 per cent of New Zealand's total greenhouse gas (GHG) emissions come from road transport (Ministry for the Environment, 2008).

Between 2001 and 2007, GHG emissions attributed to road transport increased by 21 per cent (Ministry of Economic Development, 2008a). This includes emissions from diesel used for non-transport purposes (eg, farm machinery). Over the same period, total VKT increased by 12 per cent (Ministry of Transport, 2008c).

Although we don't know how much of the GHG emission increase is due to the burning of non-transport diesel, these figures suggest an increase in GHG emissions for each vehicle kilometre travelled. Possible reasons for an increase include increases in average engine size (see text box 4), increases in truck and bus travel relative to travel by other vehicle classes (see section on VKT by vehicle type on page 10), increased freight volumes, and congestion caused by more vehicles on New Zealand roads. All these things cause higher fuel use per kilometre, which equals less fuel-efficient travel. When more fuel is burnt for each kilometre travelled, more greenhouse gas emissions are produced.

CONGESTED WELLINGTON TRAFFIC

Text box 2: Health effects of particulates

A recent New Zealand study has shown that fine particles in the air (also known as particulates) are the air pollutants that pose the greatest threat to human health (Fisher et al, 2007). The study reported that exposure to particulates from vehicles contributed to 414 premature deaths in New Zealand in a year. Exposure depends on a number of factors including air movement, climate and terrain, which means potential health risks are hard to assess. The evidence is clear, however, that reducing particulate pollution reduces the frequency of a range of illnesses and the number of premature deaths.

Text box 3: What are environmental report cards?

Environment New Zealand 2007, the country's second national state of the environment report, provided information on around 115 national-scale environmental data sets. Its primary focus was to report on the 66 national data sets that constitute New Zealand's core set of 22 environmental indicators. These indicators cover 10 domains: 4 'pressures' on the environment (consumption, road transport, energy and waste), and 6 'states' of the environment (air, atmosphere, land, fresh water, oceans and biodiversity).

A key focus of the Ministry for the Environment's national environmental reporting programme is to produce a series of 'report cards' to provide updated information on the indicators reported in *Environment New Zealand 2007*. This is one such report card.

About this report card

This environmental report card assesses the pressure road transport places on the environment by measuring the distance travelled (also known as vehicle kilometres travelled, or VKT) by motorised vehicles on New Zealand roads. 'Vehicle kilometres travelled' is a widely used international proxy for the pressures of road transport on the environment and human health.

This report card looks at:

- the total distance travelled (VKT)
- the types of vehicles travelling (VKT by vehicle type)
- the age of vehicles travelling (VKT by vehicle age)
- the type of fuel used (VKT by fuel type).

By understanding the total distance travelled on New Zealand roads, the types of vehicles we use, their age and fuel type, and how intensively we are using our road transport, we can learn more about the scale and type of pressure road transport is placing on the environment.

However, there are limitations to the use of the VKT proxy. It does not reflect improvements in engine efficiency over time, which reduce greenhouse gas emissions per kilometre travelled, nor improvements in engine technology, which reduce air pollutants harmful to human health. Other limitations of the indicator are discussed in the Technical notes section.

The VKT indicator was last reported on in *Environment New Zealand 2007*, using data up to 2006 (Ministry for the Environment, 2007). This report card updates that information with data from 2007, and expands on some areas not discussed previously. VKT data for 2008 will not be available until the middle of this year. However, the case study draws on a range of other 2008 transport data.

Key findings

Total distance travelled (Total VKT)

The total distance travelled on New Zealand roads in a given year helps us measure the pressure road transport puts on the environment. This section looks at both long-term trends in VKT on New Zealand roads, and short-term changes in the year since we last reported on this indicator.

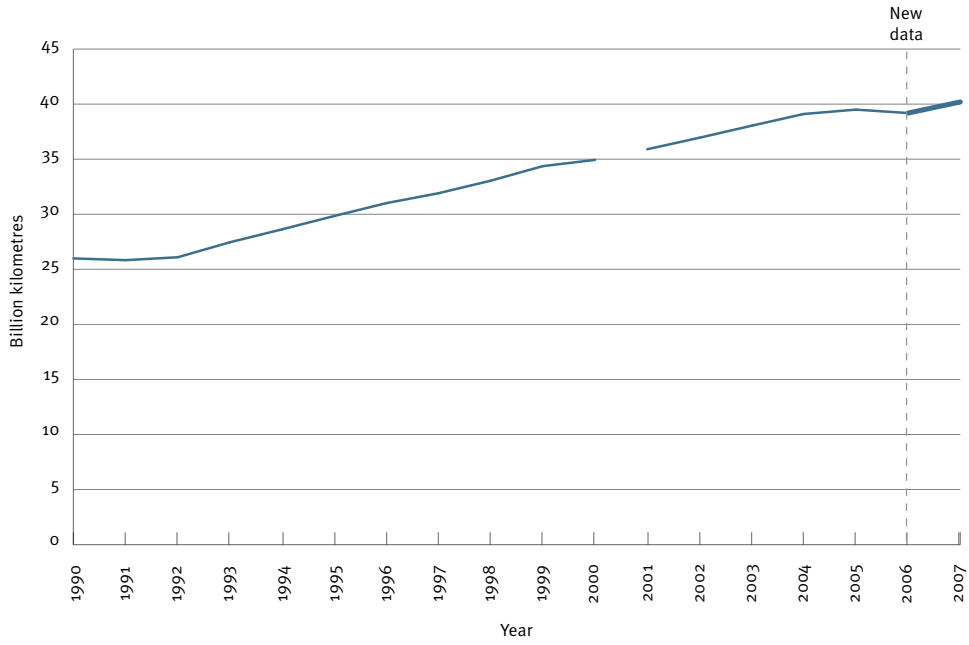
Current situation

In 2007, the total distance travelled on New Zealand roads by all types of vehicle, was 40.2 billion kilometres (Ministry of Transport, 2008c). This equals travelling from the Earth to the Sun and back 135 times.

Long-term trend

Total VKT on New Zealand roads has increased by 12 per cent since 2001 and approximately 55 per cent since 1990. Figure 1 shows a steady year-on-year increase since 1992, with the exception of 2006. This continues a long-term trend of increasing VKT on New Zealand roads – between 1980 and 2000 it more than doubled (Ministry for the Environment, 2007).

+ FIGURE 1
TOTAL VEHICLE KILOMETRES TRAVELLED (VKT) IN NEW ZEALAND, 1990–2007



Note: The gap in the trend line indicates that data was collected differently before 2001. Total vehicle kilometres travelled before 2001 cannot be directly compared with that travelled after 2001; however, it provides an estimate of the earlier trend.

Data source: Ministry of Transport, 2008c.

Getting worse

After a dip in 2006, the total distance travelled on New Zealand roads increased again in 2007.

Recent trend

From 2004, growth in the total distance travelled slowed, and in 2006, slightly decreased. This was probably in response to rising fuel prices over that period, which peaked in mid-2006. In 2007, the distance travelled on New Zealand roads again increased – by 2.6 per cent or 1.01 billion vehicle kilometres (Ministry of Transport, 2008c). The 2007 growth rate is more consistent with earlier years and suggests the mid-2006 peak in fuel prices did temporarily change travel behaviour. However, when the same prices were reached in the second half of 2007, this did not lead to a drop in VKT. This suggests that the higher prices had become normalised. The case study, 'Are fuel prices changing the way we travel?', which appears later in this report card has more information on the effect of fuel prices on behaviour.

An increasing number of New Zealanders own vehicles, and we are each driving greater distances, on average, than in the past.

Influences on VKT

More people, more vehicles, more travel

An increase in VKT can be due to several factors – more people, more vehicles in the fleet and more individual travel. These three factors have combined to steadily increase total VKT in New Zealand in recent years. Put simply, there are more of us, an increasing number of us own vehicles, and we each drive greater distances, on average, than in the past.

Generally speaking, a growing population is accompanied by a growing number of vehicles. The population in New Zealand has grown by 9 per cent or 343,700 people since 2001 – shown by the light brown line in figure 2 (Statistics New Zealand, 2008a). The dark blue line shows the 18 per cent growth in vehicle numbers since 2001 – double the population growth.

As population grows, so too does the total distance travelled by road, unless balanced by a significant drop in the distance each person drives. This could occur if freight transport and discretionary travel reduced (for example, if the economy contracted significantly), or there was a widespread shift to other transport options, such as public transport, walking or cycling.

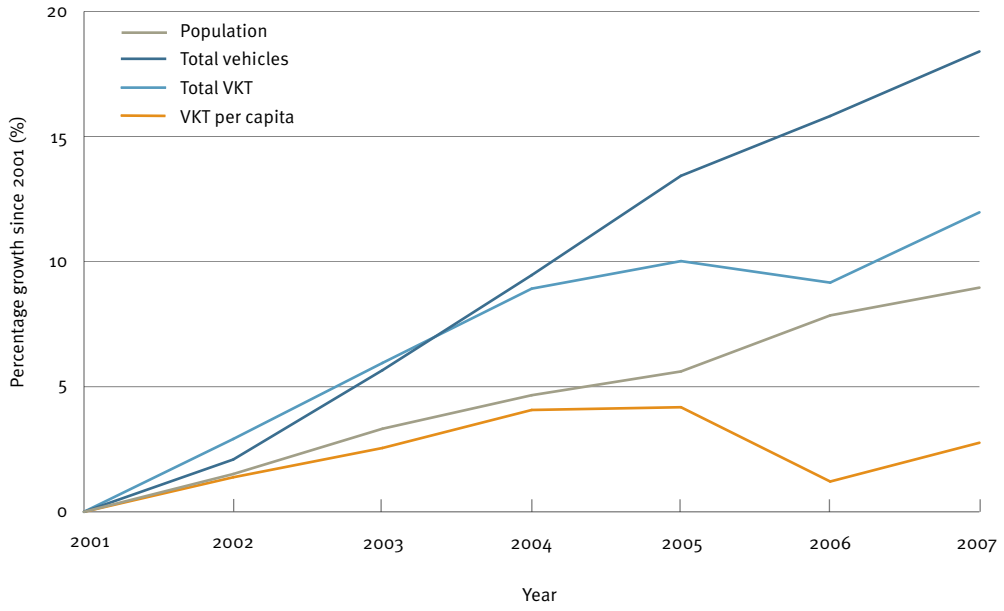
There are now more vehicles for each person in New Zealand than there were in 2001. In 2007, there were 70 light vehicles for every 100 New Zealanders, compared to 64 in 2001 (Ministry of Transport, 2008c). Generally speaking, such an increase leads to increased access to transport, an increase in total VKT, and can lead to greater congestion on our roads. More greenhouse gas emissions are produced for each kilometre travelled on congested roads.

In 1996, 45 per cent of New Zealand households had access to two or more vehicles. By 2006, this figure had risen to 54 per cent (Ministry for the Environment, 2007). Greater vehicle numbers also lead to greater waste in terms of used oil, batteries and tyres, and greater numbers of scrapped vehicles.

Increases in individual travel can also affect VKT. While changes at the individual level may appear small, they can have a significant cumulative impact. The orange line in figure 2 shows that the average distance travelled per person on New Zealand roads (VKT per capita) fluctuated between 2001 and 2007, and is currently 3 per cent higher than in 2001.

+ FIGURE 2

POPULATION, TOTAL NUMBER OF VEHICLES AND VKT IN NEW ZEALAND, 2001–2007



Data source: Ministry of Transport, 2008c.

A growing economy

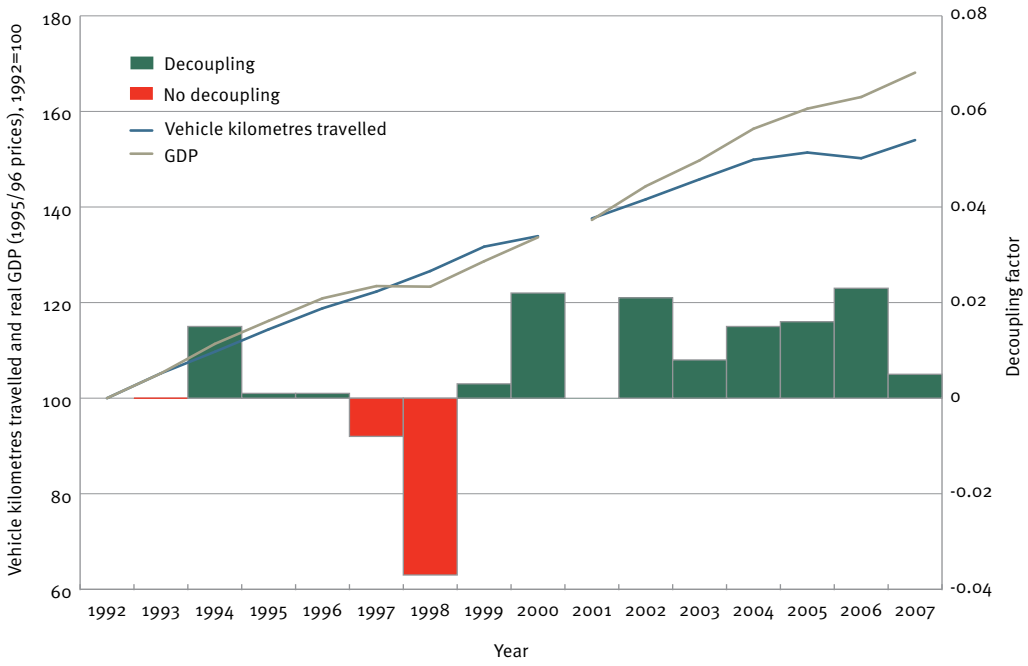
Over the past few years, before the recent economic recession, the high New Zealand dollar and economic growth are likely to have contributed to both increasing vehicle numbers and VKT.

Gross domestic product, or GDP, is an indicator of economic growth. By comparing trends in both real GDP and vehicle kilometres travelled on New Zealand roads, we can study the relationship between economic growth and transport activity.[2] Typically, a more buoyant economy encourages greater travel for business and recreation.

Since the early 1990s, real GDP and total VKT both increased (see the left axis in figure 3). From an environmental perspective, we would like to see the economy (ie, GDP) grow at a faster rate than the growth rate of VKT (ie, for a drop in VKT per unit of GDP to occur). This is called decoupling – the growth rate of an environmental pressure (eg, VKT) is less than that of its economic driving force (eg, GDP) (Organisation for Economic Co-operation and Development, 2002).

+ FIGURE 3

TOTAL VKT AND REAL GDP IN NEW ZEALAND, 1992–2007, 1992=100



Note: VKT data was collected differently before 2001. Data collected before 2001 cannot be directly compared to data collected after this date.

Data sources: Ministry of Transport, 2008c; Statistics New Zealand, 2008b.

The right axis in figure 3 reports the annual decoupling factor. It is calculated as the percentage change from one year to the next in VKT per unit of GDP. Decoupling occurs when the value of the annual decoupling factor is positive, as represented by the green bars in figure 3. These green bars indicate that real GDP has grown at a faster rate than total VKT from one year to the next. This means that each dollar of productivity requires fewer vehicle kilometres of travel and therefore places less pressure on the environment. Conversely, the red bars in figure 3 indicate that total VKT grew at a faster rate than real GDP from one year to the next, and show a lack of decoupling.

Getting better

Between 2001 and 2007, GDP grew at a faster rate than VKT.

Between 1992 and 2000, total VKT and real GDP increased at a similar rate (figure 3). The lack of decoupling seen in figure 3 in 1997 and 1998 was largely influenced by the Asian financial crisis which affected GDP at that time (Ministry of Economic Development, 2007).

Between 2001 and 2007, total VKT increased by 12 per cent while real GDP increased by 22.5 per cent – this is evident in figure 3, in the diverging lines from 2001 onwards. This indicates that VKT

2 Real GDP is GDP adjusted for inflation. In this report card, GDP values have been adjusted to 1995/96 prices. In terms of the relationship between economic growth and transport activity, the OECD notes that economic growth is just one factor affecting transport demand – "other factors include increasing income levels, rising car ownership, fuel prices, transport system improvements, competition between public and private transport, land use patterns and demographic changes" (Organisation for Economic Co-operation and Development, 2002).

decoupled from GDP year-on-year, as seen in the underlying green bars. The decoupling factor in 2007 was lower than previous years, which makes it difficult to predict future trends.

There are some limitations to this decoupling measure. Because it only covers road transport, it does not capture shifts to other modes of transport such as rail or air, nor does it make allowance for the fact that not all travel is economically motivated, but occurs for social and other reasons.

International comparisons

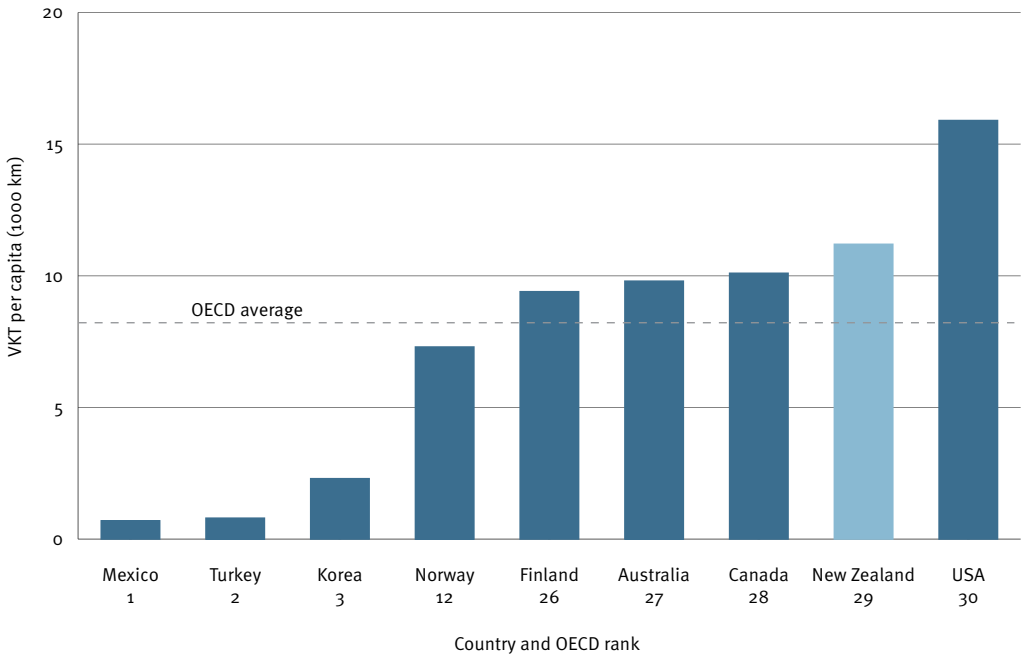
VKT per person

In 2002, New Zealanders drove greater distances per person than all but one other OECD country.

The latest OECD comparison (2002) shows that New Zealand had the second highest VKT per person within the OECD, ranking us 29th out of 30 (figure 4). Each New Zealander averaged 11,200 kilometres of travel over the year. This is partially due to our comparatively small population distributed across a relatively large land area. The most comparable OECD countries, in terms of population density and total population, are Norway and Finland.[3] In 2002, the VKT per person of both countries was less than New Zealand's (figure 4). Finland was ranked 26th with 9400 VKT per person, while Norway was ranked 12th with a VKT per person of 7300. To provide a sense of New Zealand's performance, also shown in figure 4 are the three best and worst performers for VKT in the OECD, and Australia, our nearest OECD neighbour.

+ FIGURE 4

VKT PER PERSON FOR SELECTED OECD COUNTRIES, 2002



Data source: Organisation for Economic Co-operation and Development, 2007.

VKT per GDP dollar

The latest OECD comparison (2002) shows that New Zealand had the highest VKT per unit of GDP in the OECD (Organisation for Economic Co-operation and Development, 2005).

Vehicles per person

In terms of vehicle ownership per person, New Zealand also ranks highly in the OECD. The latest OECD comparison (2006) shows that New Zealand ranked third amongst OECD countries, with 74 road vehicles per 100 people. Topping the list was Portugal with 78 vehicles per 100 people, followed by the United States with 76 (Organisation for Economic Co-operation and Development, 2008).[4]

3 In 2004, Norway had a population density of 14.2 inhabitants/km² and a population of 4.6 million. Finland had a population density of 15.5 inhabitants/km² and a population of 5.2 million. By comparison, in 2004, New Zealand's population density was 15 inhabitants/km² and the population was 4.1 million.

4 There is some variation between countries in the classification of 'vehicles'. These OECD figures refer to all road vehicles as opposed to light vehicles or cars. However, some countries also include motor cycles in their reported totals. This may be the case for the reported figures for Portugal.

Key findings

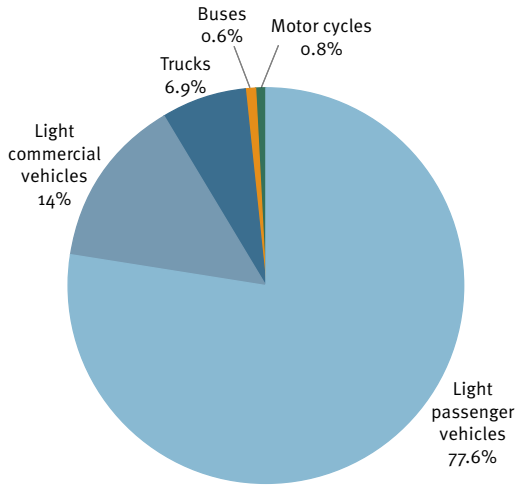
Types of vehicles travelling (VKT by vehicle type)

Larger, heavier vehicles have a greater effect on the environment than smaller lighter ones (Gordon et al, 2007). They tend to have bigger engines and are often diesel powered. This section looks at the types of vehicles travelling on New Zealand roads.

Current situation

Figure 5 shows the share of total VKT in New Zealand for each type of vehicle in 2007. The light vehicle fleet – light passenger vehicles and light commercial vehicles – was responsible for 91.6 per cent of the total distance travelled. The remaining 8.4 per cent was contributed by heavy trucks and buses, and motor cycles.

+ FIGURE 5
TOTAL VKT BY VEHICLE TYPE IN NEW ZEALAND, 2007



Note: Data discrepancies between the text and the figure are due to rounding.
Data source: Ministry of Transport, 2008c.

Long-term trend

Figure 6 shows how different vehicle types have contributed to VKT on New Zealand roads since 1990. The dashed line indicates the new data acquired since we last reported on this indicator.

Looking at the trend since 2001, there has been an 11 per cent growth in light fleet travel. However, combined, truck and bus travel has grown by 23 per cent (Ministry of Transport, 2008c). Although these heavy classes only represent a small proportion of total VKT in New Zealand, they consume a disproportionately high amount of transport fuel, almost entirely diesel. This means that even a small increase in VKT travelled by the heavy vehicle classes leads to a more significant increase in greenhouse gas emissions and air pollutants harmful to human health.

Road freight transportation

The majority of heavy vehicles travelling on New Zealand roads are freight vehicles. Growth in the economy tends to stimulate growth in road freight transport in the same way that it affects growth in total VKT (see section on Total distance travelled (Total VKT) on page 6).

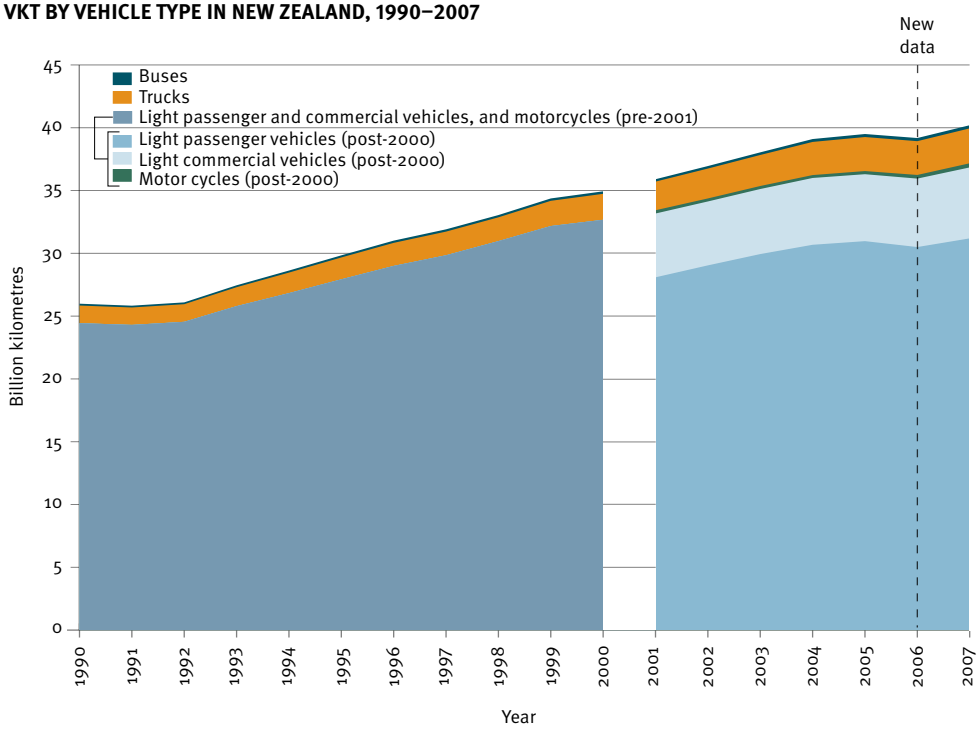
Since the early 1990s, real GDP and road freight transport both increased (see the left axis in figure 7).[5] From an environmental perspective, we would like to see decoupling, that is, for the economy (ie, GDP) to grow at a faster rate than the growth rate of road freight transport (for more on decoupling see page 8).

The right axis in figure 7 reports the annual decoupling factor. It is calculated as the percentage change from one year to the next in road freight transport per unit of GDP. Decoupling occurs when the value of the annual decoupling factor is positive, as represented by the green bars in figure 7.

5 Road freight transport is measured in tonne-kilometres, where one tonne-kilometre equates to moving one tonne of goods by one kilometre.

+ FIGURE 6

VKT BY VEHICLE TYPE IN NEW ZEALAND, 1990–2007



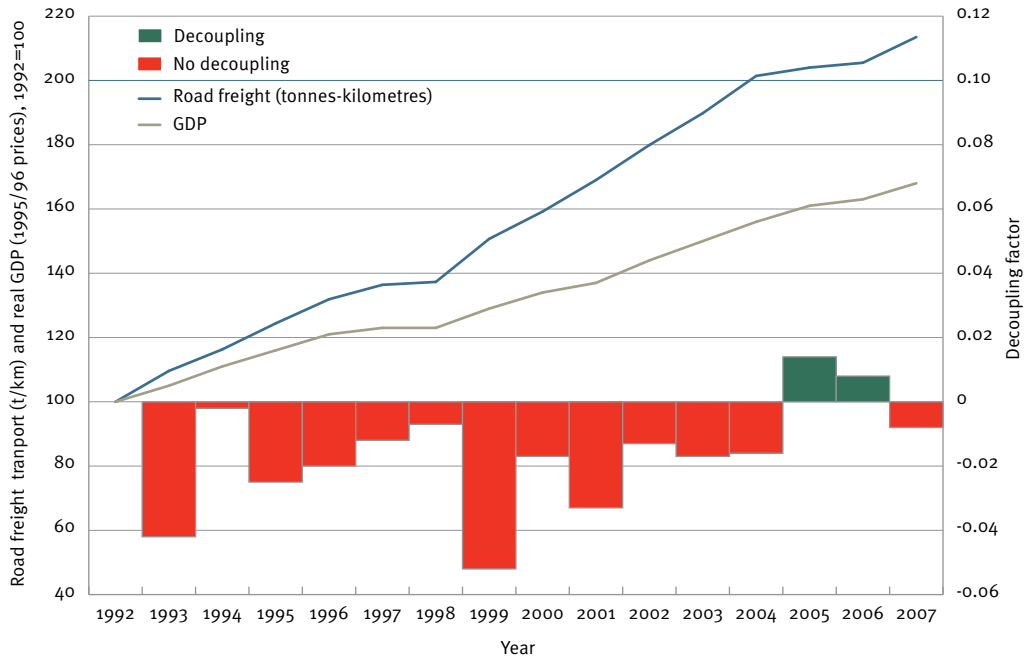
Note: The gap in the data indicates a change in data collection methods. Before 2001, VKT data for light passenger vehicles, light commercial vehicles and motor cycles were collected together.

Data sources: Ministry of Transport, 2008c; Ministry of Transport, Unpublished a.

These green bars indicate that real GDP has grown at a faster rate than road freight transport from one year to the next. This means that each dollar of productivity requires fewer tonne-kilometres[5] of travel and therefore places less pressure on the environment. Conversely, the red bars in figure 7 indicate that road freight transport grew at a faster rate than real GDP from one year to the next, and show a lack of decoupling.

+ FIGURE 7

ROAD FREIGHT TRANSPORT AND REAL GDP IN NEW ZEALAND, 1992–2007, 1992=100



Data sources: Ministry of Transport, 2008c; Statistics New Zealand, 2008b.

Getting worse

Between 1992 and 2007, road freight transport grew at a faster rate than GDP.

Between 1992 and 2004 road freight transport increased by 101 per cent while real GDP increased by 56 per cent (figure 7). This indicates that road freight transport grew at a faster rate than real GDP (as seen in the underlying red bars), and hence placed greater pressure on the environment for each dollar of GDP produced.

In 2005 and 2006 road freight transport grew at a slower rate than real GDP. This indicates that road freight transport decoupled from GDP in this period, as seen in the underlying green bars. This trend was reversed in 2007 when, once again, road freight transport increased at a faster rate than real GDP.

There are some limitations to this decoupling measure. Because it only covers road freight transport, it does not capture shifts to other modes of freight transport such as rail or sea. Nor does it make allowance for more efficient loading of vehicles – for example, two tonnes carried by one truck puts less pressure on the environment than two loads of one tonne carried separately in two trucks.

Bus transportation

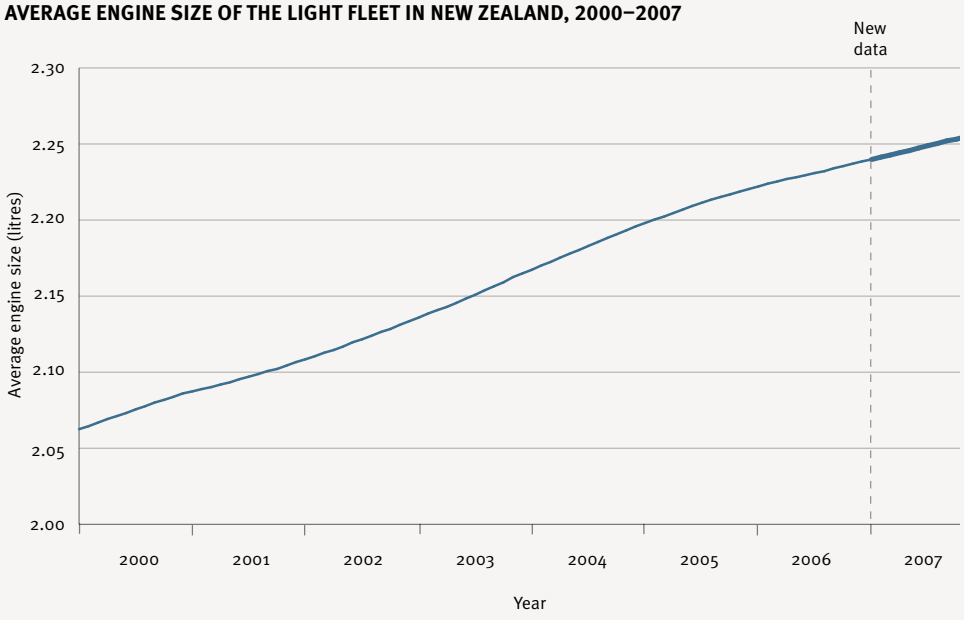
Although buses only make up approximately 10 per cent of heavy vehicle travel in New Zealand, between 2001 and 2007 there was a 36 per cent growth in bus travel (Ministry of Transport, 2008c). This potentially reduces the overall road transport pressure on the environment by reducing the number of private vehicles on the road.

Text box 4: Engine size

Engine size is typically related to both fuel consumption and vehicle exhaust emissions. Generally speaking, larger engines consume more fuel and generate more greenhouse gas emissions and air pollutants[6] per kilometre travelled than smaller engines (Ministry for the Environment, 2007). In 2007, the engine size of the average light vehicle in New Zealand continued to increase despite rising fuel prices. The average light fleet engine size in December 2007 was 2.26 litres, up from 2.24 litres in December 2006 when we last reported on this indicator. Figure 8 shows that this continues a trend that has seen the average engine size of the light fleet increase by 8 per cent since 2000.

+ FIGURE 8

AVERAGE ENGINE SIZE OF THE LIGHT FLEET IN NEW ZEALAND, 2000–2007



Data source: Ministry of Transport, 2008c.

6 Larger engines do not generate more air pollutants than smaller engines when equivalent emissions control technology is fitted (United Kingdom Vehicle Certification Agency, 2008).

Little or no change

The contribution of each vehicle type to VKT has remained largely the same between 2006 and 2007, despite earlier increases in heavy vehicle travel.

Recent trend

The trend of increasing heavy vehicle travel was not so pronounced in 2007. Between 2006 and 2007, light fleet travel grew by 2.5 per cent, while truck and bus travel grew by 3 per cent (Ministry of Transport, 2008c). This means there was no significant change in the proportion of travel by each main vehicle type.

Motor cycle travel, which makes up less than 1 per cent of New Zealand's VKT, was the exception. In 2007, there was an upsurge in motor cycle travel with an increase of 13 per cent in the motor cycle VKT, demonstrating that motor cycles have become an increasingly popular form of transport (Ministry of Transport, 2008c). This is also reflected by a 47 per cent increase in motor cycle numbers since 2003, although, at only 3 per cent, motor cycles remain a very small part of the whole vehicle fleet.

An increase in motor cycle numbers is important from both an environmental and human health perspective. New Zealand has no specific controls on the exhaust emissions from motor cycles. Increasing motor cycle travel could therefore lead to increased emissions of harmful pollutants, although this depends on the type of travel that the motor cycle is replacing. Exhaust emissions from a motor cycle, especially a two-stroke motorcycle, may be worse than from a light late-model passenger vehicle with good emissions control technology, but better than from a larger, older, more polluting vehicle (United States Environmental Protection Agency, 2003).

Key findings

Age of vehicles travelling (VKT by vehicle age)

This section looks at the age of vehicles travelling on New Zealand roads, and the average age of the fleet as a whole. Older vehicles tend to have higher exhaust emissions of harmful pollutants, such as carbon monoxide, hydrocarbons and the oxides of nitrogen. This is partly due to deterioration in the engine's efficiency, but also due to the older technology used in earlier engine designs. As an example, an air quality study which sampled the emissions of 40,000 vehicles in the Auckland region found that carbon monoxide and nitric oxide emissions from a 2003 vehicle were approximately five times lower than those from a similar vehicle eight years older. Hydrocarbon levels were half those of the older vehicle (Fisher et al, 2003). Older vehicles may also have poorer fuel efficiency, and therefore create more greenhouse gas emissions for each kilometre travelled than similar newer vehicles (Ministry for the Environment, 2007).

Age alone cannot be relied on to determine the environmental effects of road transport. Fisher et al's 2003 study also showed that good vehicle maintenance reduces harmful exhaust emissions – the best-maintained 20 per cent of older vehicles (21–23 years old) emitted fewer pollutants than the worst-maintained 20 per cent of vehicles under two years old.

Current situation

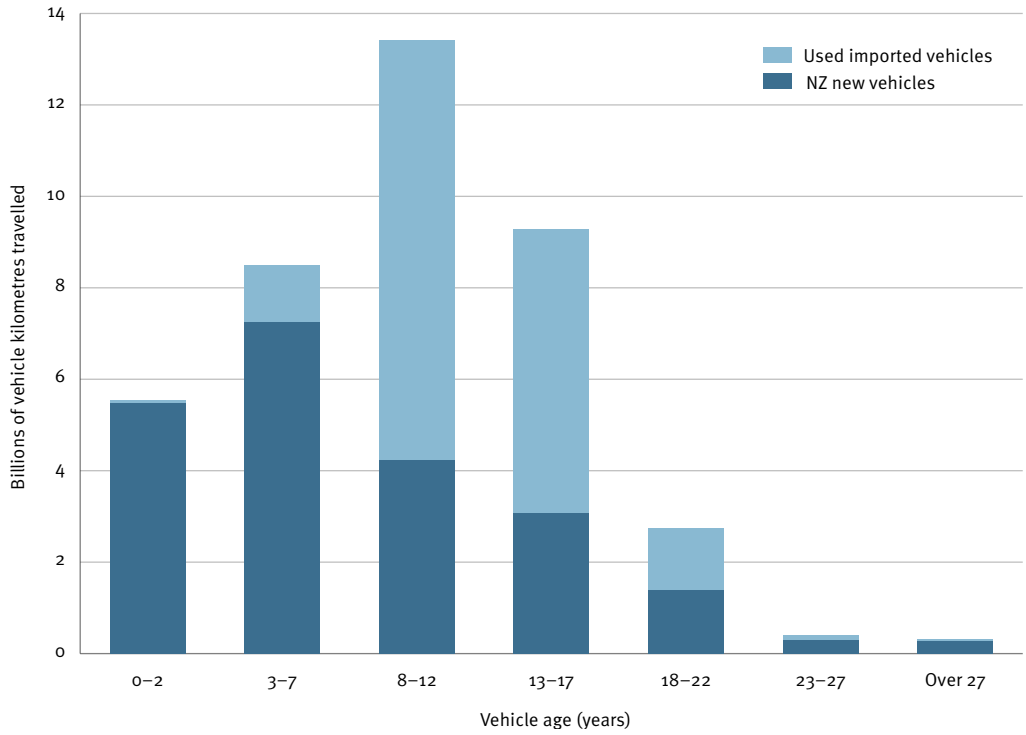
In 2007, the highest proportion of kilometres travelled in New Zealand (33 per cent) was completed by vehicles between 8 and 12 years old (figure 9). Thirty-two per cent of the New Zealand vehicle fleet falls into this age bracket, primarily because of the large number of used imported passenger vehicles of this age. The second largest group, contributing 23 per cent to total VKT, was 13 to 17 years old.

Figure 9 shows that the contribution of used imported vehicles to total kilometres travelled in 2007 is biased towards older vehicles. New Zealand-new vehicles[7] are responsible for most VKT in the younger age brackets. The import of older used vehicles into New Zealand has contributed to a slight increase in the average age of vehicles travelling on our roads.

7 New Zealand imports all of its vehicles – both new and used. Within this document 'New Zealand-new vehicles' refers to brand new vehicles sold for the first time in New Zealand. 'Imported vehicles' refers to second-hand vehicles that are brought into New Zealand and sold here.

+ FIGURE 9

TOTAL VKT BY VEHICLE AGE IN NEW ZEALAND, 2007



Data source: Ministry of Transport, 2008c.

Trend

Little or no change

On average, New Zealand vehicles are aging slightly.

In 2007, the average age of the vehicle fleet was 12.04 years, an increase from an average of 11.87 years in 2001 (Ministry of Transport, Unpublished b). While this appears to be a relatively small change, when one considers the distance travelled compared to the age of the vehicle (also known as travel-weighted average age),[8] the changing age profile of the New Zealand vehicle fleet becomes clearer.

Since newer vehicles travel further on average than older vehicles, the travel-weighted average age is generally younger than the average age of the fleet. The travel-weighted average age of the light fleet increased from 10.7 years in 2001 to 11.3 years in 2007 (Ministry of Transport, 2008c). While this is a more significant change, both figures illustrate the gradual ageing of the New Zealand vehicle fleet, a trend shared by some other countries such as the United States (Yurko, 2008). In New Zealand, this is caused in part by the increasing age of used imported vehicles (see text box 5). It also suggests that New Zealanders may be keeping their vehicles road-worthy for longer.

International comparison

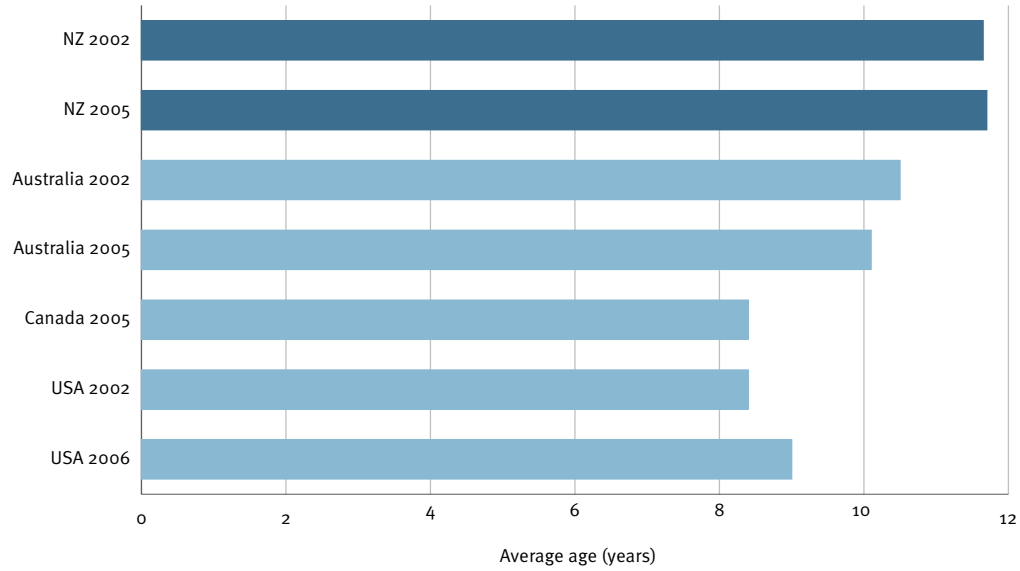
The New Zealand vehicle fleet is relatively old by international standards.

The New Zealand vehicle fleet is relatively old by international standards. Figure 10 shows how our light fleet compares to other OECD countries that also have high per person travel. Our vehicles are, on average, nearly two years older than Australian vehicles, and an even wider margin exists compared to other countries.

8 The travel-weighted age is calculated by multiplying each vehicle's age by the number of kilometres that it travels, adding the totals and dividing by the total kilometres travelled. For example, if the fleet was a 10-year-old vehicle doing 4000 kilometres a year, and a 4-year-old vehicle doing 10,000 kilometres a year, the average fleet age would be 7 years (4+10)/2. But the average travel-weighted fleet age would be 5.7 years – (10 years x 4000 km + 4 years x 10,000 km)/(4000 + 10,000).

+ FIGURE 10

AVERAGE AGE OF THE NEW ZEALAND LIGHT FLEET COMPARED WITH OTHER COUNTRIES WITH SIMILAR PER CAPITA TRAVEL



Notes: (1) Data was not available for Canada in 2002 and the US in 2005 (2006 data for the US has been included instead). (2) Median values have been used for the United States. Averages would be higher, if they had been available.

Data source: Ministry of Transport, 2008c.

Text box 5: Imported vehicles

Used imported vehicles have had a variety of impacts on the New Zealand fleet. Until recently, a used imported vehicle had better exhaust emissions control technology than the same vehicle purchased new in New Zealand, due to more rigorous emissions standards in the country of origin. The availability of small, cheap, used imports displaced some older larger vehicles from the New Zealand fleet during the 1990s, but it also encouraged significant growth in overall vehicle numbers.

Imported vehicles have also affected the age profile of the New Zealand vehicle fleet. In 2002, the introduction of the New Zealand Frontal Impact Standard limited the import of used vehicles to those manufactured after 1996.[9] Initially, this reduced the average age of imported vehicles by limiting them to vehicles that were six years old or less. However, this effect has diminished each year, as importers continue to source vehicles from just after 1996, as they are generally cheaper than newer vehicles.

As a result, each year, both the average age of the fleet and the travel-weighted age have increased slightly. In 2007, the average age for used light vehicles imported into New Zealand was 8.2 years (Ministry of Transport, 2008c). The greatest proportion (22 per cent) were nine years old, and nearly two-thirds were manufactured before 2000 (ie, were more than seven years old). Between 2002 and 2007, the average age of used vehicles imported into the light fleet increased from 7.1 to 8.2 years. This trend is also reflected in the average age of used imports in other vehicle classes.

This trend is not expected to continue. The introduction of the Land Transport Vehicle Exhaust Emissions Rule in 2008 will have the effect of gradually reducing the average age of used vehicles imported into New Zealand (see Future watch section).

9 A few older vehicles that meet the standard are still imported.

Key findings

Type of fuel used (VKT by fuel type)

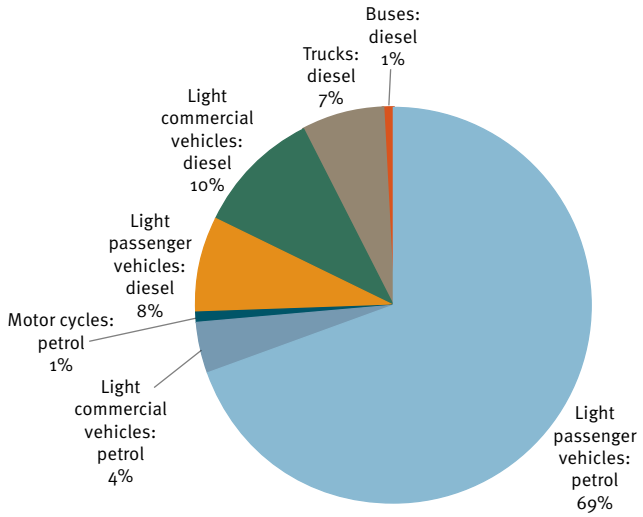
This section looks at the types of fuel used by vehicles travelling on New Zealand roads. This has important implications for air quality. Diesel vehicle exhaust emissions can contain particulates, which aggravate respiratory illnesses such as asthma and bronchitis. Petrol-powered vehicles usually produce fewer particulates, but higher levels of hydrocarbons, carbon monoxide and oxides of nitrogen, which can cause eye and throat irritation, dizziness and headaches (Fisher et al, 2007).

The level of air pollutants emitted by a vehicle depends on a number of factors, including the type and blend of fuel, how well the vehicle is tuned and maintained, its exhaust emissions control technology, the size and age of the engine, and driver behaviour. On 1 January 2006, the sulphur content in diesel in New Zealand was reduced from 500 parts per million (ppm) to 50 ppm. It was further reduced to less than 10 ppm, essentially zero-sulphur diesel, on 1 January 2009. It is recognised worldwide that such a reduction results in a significant reduction in particulate emissions (Fisher et al, 2007) both by reducing the emissions from existing vehicles and by allowing the introduction of low emission vehicles.

Current situation

In 2007, three-quarters of total kilometres travelled were completed by petrol-powered vehicles. Figure 11 shows that light passenger vehicles were responsible for most of the petrol travel, with light commercial vehicles and motor cycles making up the remainder. The light fleet also dominated the diesel travel, contributing 18 per cent of total VKT, while together, trucks and buses were responsible for 8 per cent.

+ FIGURE 11
VKT BY VEHICLE TYPE AND FUEL TYPE IN NEW ZEALAND, 2007



Data source: Ministry of Transport, 2008c.

Trend

Between 2001 and 2007, the number of diesel vehicles grew by 45 per cent, compared to an increase of 18 per cent in the overall vehicle fleet. There has been a 31 per cent increase in total diesel travel since 2001. During the same period, petrol travel has increased by just under 7 per cent.

Between 2006 and 2007, kilometres travelled by diesel vehicles increased by 4 per cent, while kilometres travelled by petrol vehicles increased by 2 per cent (Ministry of Transport, 2008c). Consequently, the proportion of total kilometres travelled by diesel-powered vehicles is also increasing. In 2001, diesel travel made up 22 per cent of total kilometres travelled. By 2007, this had risen to 26 per cent.

A high proportion of diesel travel in New Zealand is undertaken by older vehicles, with most falling into the 8 to 12 year age bracket. These older diesel vehicles are more likely to emit higher levels of particulates (Fisher et al, 2003). The implications of an increasing diesel fleet are discussed in the text box 6.

Text box 6: Implications of the growing popularity of light diesel vehicles

From an environmental and health perspective, the increasing size of the light diesel fleet has a number of implications for New Zealand.

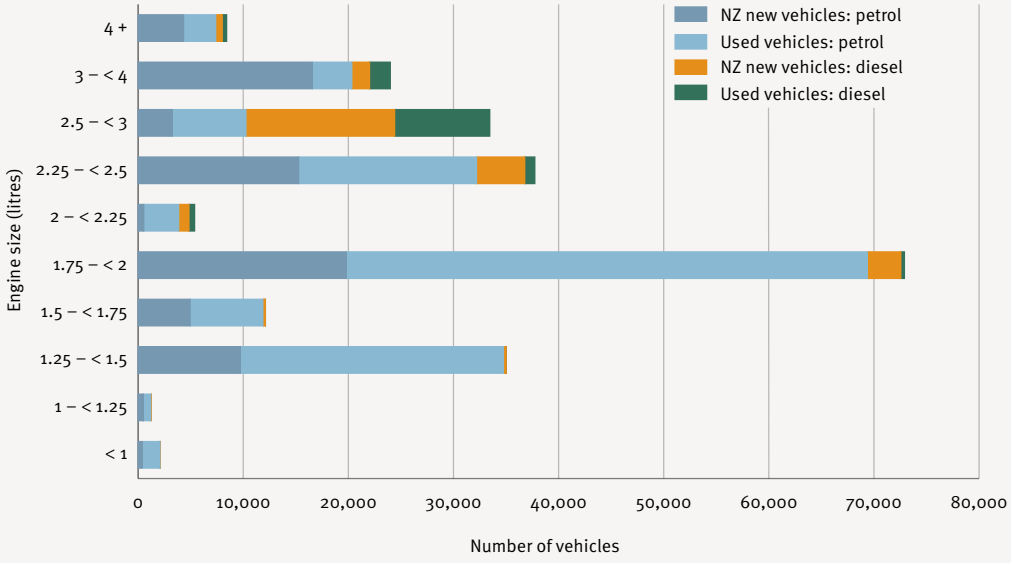
A diesel vehicle of a given engine size is more fuel efficient (by about one-third), and produces less greenhouse gas emissions than a petrol engine of equivalent size (New Zealand Transport Agency, 2009). However, in 2007, the average engine size of light diesel vehicles entering the fleet was 2.8 litres, compared to 2.2 litres for petrol vehicles (figure 12). As a result, the efficiency gains of diesel engines are often offset by increased engine size.

Older diesel engines can also produce significant levels of exhaust particulates (see text box 2) – 72 per cent of all diesel vehicles in New Zealand are more than seven years old. In 2007, 6 per cent of the vehicles entering the fleet were used diesels. These vehicles may emit higher levels of pollutants than their newer counterparts. The Vehicle Exhaust Emissions Rule, which took effect at the beginning of 2008, will limit the importation of these older vehicles (see Future watch section).

Improvements in exhaust emissions control technology mean new diesel vehicles with small engines, manufactured to the latest emissions standards, have a positive effect on the environment. They produce low levels of harmful exhaust emissions and less greenhouse gas emissions than their petrol counterparts. In 2007, 11 per cent of the vehicles entering the light fleet were brand new diesels, and 2 per cent had engine sizes under 2.25 litres (Ministry of Transport, 2008c).

+ FIGURE 12

VEHICLES ENTERING THE LIGHT VEHICLE FLEET BY ENGINE SIZE IN NEW ZEALAND, 2007



Data source: Ministry of Transport, 2008c.

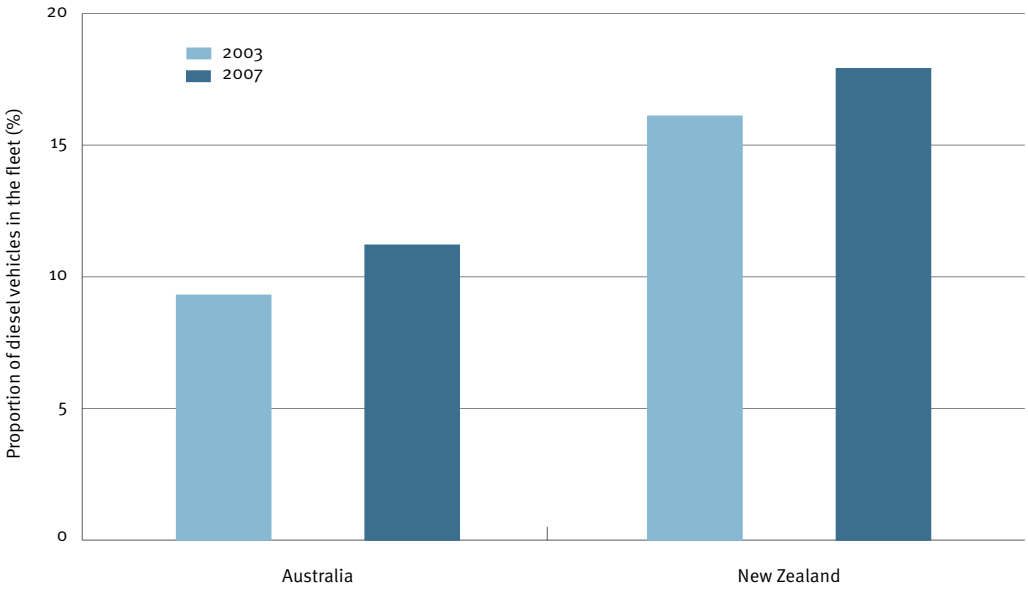
International comparison

The trend towards an increasing proportion of diesel-powered vehicles can be seen worldwide. In 2007, four European countries had more than 50 per cent diesel vehicles in their passenger fleets (European Environment Agency, 2009). Figure 13 shows how New Zealand compares with our nearest neighbour, Australia. In 2007, the proportion of diesel vehicles in New Zealand was 18 per cent, significantly higher than the 11 per cent reported for Australia. The difference is largely due to the different compositions of the light fleet – 15 per cent diesel in New Zealand and 8 per cent diesel in Australia (Australian Bureau of Statistics, 2007; Ministry of Transport, 2008c).

Between 2003 and 2007, the proportion of diesel vehicles increased by 2 per cent in both Australia and New Zealand, suggesting that diesel vehicles are becoming increasingly popular in both countries.

+ FIGURE 13

PROPORTION OF DIESEL-POWERED VEHICLES IN NEW ZEALAND AND AUSTRALIA



Data sources: Australian Bureau of Statistics, 2007; Ministry of Transport, 2008c.

Case study

Are fuel prices changing the way we travel?

Figure 14 shows transport fuel prices have been rising over the past few years, with particularly sharp increases in the past year or so. In mid-2008, fuel prices reached unprecedented levels, peaking in July with regular petrol reaching $2.18 a litre (Ministry of Economic Development, 2008b).[10] Has this led to a change in the way we travel?

While we don't yet have VKT data for the 2008 year, changes in public transport use, and reported reductions in traffic volumes suggest the answer is 'yes'.

Significant increases in public transport use were observed in the main centres during 2008. In Auckland, average rail patronage for the 12 months to July 2008 increased by 20 per cent. Train passenger numbers in July 2008 were 32 per cent higher than in July 2007, stretching capacity on the network at peak times (Auckland Regional Transport Authority, Unpublished; Taylor, 2008). Auckland buses saw more modest growth in patronage, with average boardings for the 12 months to July 2008 increasing by 3.5 per cent. However, the opening of the Northern Busway in February 2008 encouraged significant numbers to switch to public transport. It is estimated that this service was largely responsible for a 6 per cent drop in traffic on the Auckland Harbour Bridge in 2008 (Taylor, 2008).

10 The Ministry of Economic Development samples a limited number of forecourt prices on a weekly basis. Regional variations may not be reflected in this figure.

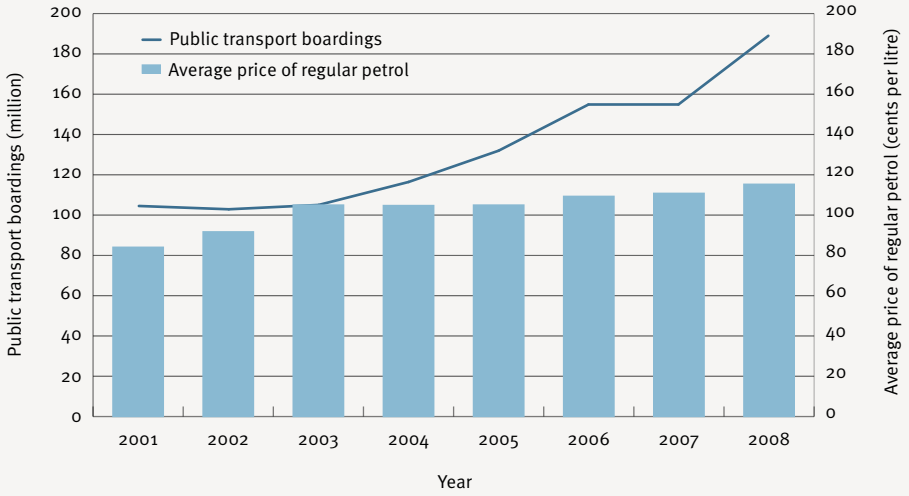
Train patronage in Wellington increased by 3.4 per cent in the 12 months to June 2008, with a corresponding growth of 0.7 per cent in bus patronage (Metlink, 2008). This lower growth can be partially explained by the fact that Wellington already has a relatively high use of public transport. Bus patronage also increased in Dunedin, reducing the number of cars on the roads. Traffic counts dropped between 4 and 11 per cent at major intersections in the city from March to June compared to the same period in 2007 (Stevens and Jones, 2008). This trend was echoed throughout the country – national traffic volumes were down by 7.5 per cent in August 2008 compared with the previous year (New Zealand Transport Agency, 2008).

Public transport trends in the main centres were indicative of what was happening around the rest of the country. Nationally, there was a 4 per cent growth in public transport boardings for the year to June 2008 compared with the previous year.

While the link between fuel prices and total public transport boardings over the past seven years seems weak (figure 14), uptake of public transport is influenced by a number of factors, including the convenience, capacity, reliability and the relative cost of public versus private transport. Fuel price rises may also cause shifts to other forms of transport, such as cycling and walking.

+ FIGURE 14

TOTAL PUBLIC TRANSPORT BOARDINGS AND REGULAR PETROL PRICES IN NEW ZEALAND, 2001–2008



Notes: (1) Petrol prices are annual average prices based on the calendar year. The average for 2008 includes prices up to 14 November. (2) Public transport boardings include bus, train and ferry totals, and are based on a year from July to June.

Data sources: Ministry of Economic Development, 2008c; Ministry of Transport, 2008b.

Fuel price increases also affect New Zealanders' vehicle choices. A 2007 report found that an early response to increasing prices was to reduce fuel consumption by shifting to smaller, more fuel-efficient vehicles (Kennedy and Wallis, 2007). In the first three quarters of 2008, the fuel efficiency of vehicles being registered in New Zealand improved slightly for both new and imported vehicles for the first time (Ministry of Transport, 2008d). This was accompanied by an increase in the sale of New Zealand-new small and light vehicles, and a corresponding drop in large vehicle sales (Ministry of Transport, 2008d). New SUV sales also dropped by 10 per cent in 2008, after increasing by 20 per cent between 2006 and 2007.

Between July and November 2008, however, transport fuel prices dropped significantly. The price of regular petrol fell by a third, to $1.45 a litre – its lowest level for the year (Ministry of Economic Development, 2008b). As a result, an immediate upswing in traffic volumes was observed throughout New Zealand, with national traffic figures for October 2008 only 1.6 per cent below figures for October 2007 (New Zealand Transport Agency, 2008).

Future watch

As described in the case study, the price of transport fuel in New Zealand increased significantly to mid-2008. When this happened in 2006, the total kilometres travelled that year decreased. It is anticipated that there will be a similar drop in total VKT for the 2008 calendar year.

Although fuel prices have subsequently dropped, we do not expect there will be a large increase in VKT in 2009, owing to the economic recession. It is expected that the economic downturn will limit discretionary travel and slow the growth in freight transport volumes.

That said, during the last economic downturn of 1997, which was sparked by the Asian financial crisis (Ministry of Economic Development, 2007), estimated growth in the total distance travelled on our roads did not slow significantly (see figure 3). This suggests that a high proportion of travel is not discretionary (ie, it occurs regardless of the economic climate).

Conversely, freight transport is closely linked to the economy and may therefore experience a greater drop during times of recession. Figure 7 shows that the 1997 Asian financial crisis coincided with a flattening off in both GDP and freight transport.

In the medium term, unless there is a significant sustained shift to other modes of transport, total VKT in New Zealand is expected to continue to gradually increase in line with population increases and growth in the economy, just as it has done for many years.

Because the rate of population growth in New Zealand is projected to halve in the next 25 years (Statistics New Zealand, 2007), we can, however, expect to see a flattening-off of growth in total VKT in the long term (Ministry of Economic Development, 2006). This tailing-off in population growth is also predicted to slow the growth in vehicle numbers in coming years.

Future increases in VKT may not, however, put as much pressure on the environment as in the past. We expect the fuel economy of the vehicle fleet to continue to gradually improve, due to improved engine technology and increased consumer demand for lighter, smaller, more fuel-efficient vehicles (Ministry of Economic Development, 2006). Improved fuel economy means less greenhouse gas emissions are produced for each kilometre travelled on New Zealand roads. Changes to vehicle fuels used could also alter fuel economy and greenhouse gas levels – for example, use of biofuels or electric vehicles.

The Land Transport Vehicle Exhaust Emissions Rule, which came into effect at the beginning of 2008, aims to reduce the harmful exhaust emissions of vehicles entering the fleet. From 2008, new petrol and diesel vehicle models must meet the Japan 05 emissions standard. Used imported light petrol vehicles must meet the Japan 98 emissions standard, while used imported heavy petrol vehicles must meet the Japan 00/02 standard. From 2008, used imported diesels must meet the Japan 02/04 standard. In subsequent years, these standards will be tightened up. Used diesel and petrol vehicles will have to comply with the Japan 05 standard by 2010 and 2012 respectively (Ministry of Transport, 2007).

These improvements need to be placed in context. In 2007, used imports added around 5 per cent more vehicles to the New Zealand fleet. A similar number of vehicles – mainly older – were scrapped in the same year. It will therefore take a number of years for significant improvements in harmful exhaust emissions to occur in the fleet as a whole. Moreover, the Vehicle Exhaust Emissions Rule may cause a drop in the number of vehicles imported, as – within a relatively short time – they will be newer and probably more expensive. Consequently, there may be a trend to keep older, possibly more polluting vehicles on the road for longer (Colegrave, 2007).

Further information

For further information on transport and the environment, see *Environment New Zealand 2007*, the second national state of the environment report, available at www.mfe.govt.nz/publications/ser/enz07-dec07/index.html. For further information on transport policies and legislation relating to the environment, see the Ministry of Transport website: www.transport.govt.nz/environment1-index. For information on what you can do to reduce the impact of your travel on the environment, visit www.sustainability.govt.nz.

For more detailed information on the transport data used in this publication, see *The New Zealand Vehicle Fleet: Fleet Statistics 2007* published by the Ministry of Transport and available at www.transport.govt.nz/vehicle-fleet-annual-statistics-1/ and the *Transport Monitoring Indicator Framework* available at www.transport.govt.nz/transport-monitoring-indicator-framework.

Technical notes

Limitations of this indicator

The 'vehicle kilometres travelled' indicator only accounts for kilometres travelled by road vehicles. It excludes rail, sea or air transport modes, which also have effects on the environment.

Transport emissions are only one of a number of factors that contribute to adverse air quality. Industry and household heating can also be significant sources of harmful air pollutants. This indicator does not provide a direct measure of the effect of transport emissions on air quality and human health at the national scale. However, it does provide an indication of the pressure on human health from road transport and how this is changing over time. For more information on New Zealand's air quality see the Air Quality (Particulate Matter – PM_{10}) report card (Ministry for the Environment, 2009).

Traffic congestion is not accounted for – during peak periods, more fuel is consumed and more emissions are generated per kilometre travelled than during off-peak periods. Nor does the indicator take into account improvements over time in fuel quality or exhaust emissions control technology.

There are a number of other environmental effects of road transport that are not discussed in this report card (eg, contamination of storm water from road run-off, vehicle noise, the effects of road construction and the disposal of vehicle wastes, including scrapped vehicles).

Since 2001, the vehicle kilometres travelled on New Zealand roads have been estimated from odometer readings, taken from all vehicles during Warrant and Certificate of Fitness tests. Compared to earlier estimation techniques, this provides a more accurate record of the total distance travelled, by all vehicle types, within a given year. However, vehicle travel undertaken by unregistered vehicles is not included in reported VKT.

References

Auckland Regional Transport Authority. Unpublished. ARTA Public Transport Data, 2002–2008.

Australian Bureau of Statistics. 2007. *Motor Vehicle Census*. Retrieved from www.abs.gov.au/ausstats/abs@.nsf/mf/9309.0 (23 October 2008).

Beeton RJS, Buckley KI, Jones GJ, Morgan D, Reichelt RE, Trewin D. (2006 Australian State of the Environment Committee). 2006. *Australia State of the Environment 2006*. Canberra: Department of the Environment and Heritage.

Colegrave F. 2007. *Update and Extension of Vehicle Emissions Modelling*. Prepared for the Ministry of Transport by Covec Ltd. Retrieved from www.transport.govt.nz/assets/NewPDFs/Emissions-Update-and-Extension-Final-Draft-Report.pdf (21 November 2008).

European Environment Agency. 2009. *TERM32 Dieselisation*. Retrieved from dataservice.eea.europa.eu/atlas/viewdata/viewpub.asp?id=3883 (11 March 2009).

Fisher GW, Rolfe KA, Kjellstrom T, Woodward A, Hales S, Sturmam AP, Kingham S, Petersen J, Shrestha R, King D. 2002. *Health Effects Due to Motor Vehicle Air Pollution in New Zealand*. Retrieved from www.transport.govt.nz/assets/PDFs/health-effects-of-vehicle-emissions.pdf (27 November 2008).

Fisher GW, Bluett JG, Xie S, Kuschel GI. 2003. *On-road Remote Sensing of Vehicle Emissions in the Auckland Region*. Prepared for the Auckland Regional Council by the National Institute of Water and Atmospheric Research. Retrieved from www.arc.govt.nz/albany/fms/main/Documents/Environment/Pollution/TP%20No_198%20%20On-Road%20Remote.pdf (21 January 2009).

Fisher G, Kjellstrom T, Kingham S, Hales S, Shrestha R. 2007. *Health and Air Pollution in New Zealand*. Retrieved from www.hapinz.org.nz/index.shtml (23 October 2008).

Gordon D, Greene DL, Ross MH, Wenzel TP. 2007. *Sipping Fuel and Saving Lives: Increasing Fuel Economy Without Sacrificing Safety*. Prepared for The International Council on Clean Transportation. Retrieved from www.theicct.org/documents/ICCT_SippingFuelFull_2007.pdf (13 November 2008).

Kennedy D, Wallis I. 2007. *Impacts of Fuel Price Changes on New Zealand Transport*. Prepared for Land Transport New Zealand by Booz Allen Hamilton (NZ) Ltd. Retrieved from www.landtransport.govt.nz/research/reports/331.pdf (23 October 2008).

Metlink. 2008. *Public Transport Statistics*. Retrieved from www.metlink.org.nz/story21978.php (23 October 2008).

Ministry for the Environment. 2000. *Curbing the Sprawl: Urban Growth Management in the United States – Lessons for New Zealand*. Wellington: Ministry for the Environment.

Ministry for the Environment. 2007. *Environment New Zealand 2007*. Wellington: Ministry for the Environment.

Ministry for the Environment. 2008. *New Zealand's Greenhouse Gas Inventory 1990 – 2006: An Overview*. Retrieved from www.mfe.govt.nz/publications/climate/greenhouse-gas-inventory-overview-apro8/index.html (27 February 2009).

Ministry for the Environment. 2009. *Air Quality (Particulate Matter – PM_{10}) Environmental Report Card*. Retrieved from www.mfe.govt.nz/environmental-reporting/report-cards/air/2009/index.html (13 February 2009).

Ministry of Economic Development. 2006. *New Zealand's Energy Outlook to 2030*. Retrieved from www.med.govt.nz/templates/MultipageDocumentTOC____21862.aspx (19 November 2008).

Ministry of Economic Development. 2007. *Economic Development Indicators 2007*. Retrieved from www.med.govt.nz/upload/53549/Indicators-Report-2007.pdf (26 February, 2009).

Ministry of Economic Development. 2008a. *New Zealand Energy Greenhouse Gas Emissions, 1990–2007*. Retrieved from www.med.govt.nz/upload/63349/GHG%20Report.pdf (21 January 2009).

Ministry of Economic Development. 2008b. *Weekly Average Components of Regular Petrol Price*. Retrieved from www.med.govt.nz/templates/Page____38621.aspx (21 November 2008).

Ministry of Economic Development. 2008c. *Energy Data File June 2008*. Retrieved from www.med.govt.nz/templates/MultipageDocumentTOC____36571.aspx (23 October 2008).

Ministry of Transport. Unpublished a. VKT Projections, 1990 to 2000. Data set provided by the Ministry of Transport for the purpose of this environmental report card.

Ministry of Transport. Unpublished b. Fleet Average Ages. Data set provided by the Ministry of Transport for the purpose of this environmental report card.

Ministry of Transport. 2007. *Land Transport Rule: Vehicle Exhaust Emissions 2007*. Retrieved from www.landtransport.govt.nz/rules/vehicle-exhaust-emissions-2007.html (13 November 2008).

Ministry of Transport. 2008a. *The New Zealand Transport Strategy 2008*. Wellington: Ministry of Transport.

Ministry of Transport. 2008b. *Transport Monitoring Indicator Framework*. Retrieved from www.transport.govt.nz/tmif/TMIF.htm (11 November 2008).

Ministry of Transport. 2008c. *The New Zealand Vehicle Fleet*. Retrieved from www.transport.govt.nz/the-new-zealand-vehicle-fleet-1/ (23 October 2008).

Ministry of Transport. 2008d. *Vehicle Fleet Statistics: July–September Quarter of 2008*. Retrieved from www.transport.govt.nz/quarterly-vehicle-fleet-statistics-1 (9 December 2008).

New Zealand Transport Agency. 2008. *Traffic Volumes Monthly Report, October 2008*. Retrieved from www.transit.govt.nz/content_files/shtv/SHTG-200810.pdf (20 November 2008).

New Zealand Transport Agency. 2009. *Features to Look for in your Car*. Retrieved from rightcar.govt.nz/features.html (10 March, 2009).

Organisation for Economic Co-operation and Development. 2002. *Indicators to Measure Decoupling of Environmental Pressure from Economic Growth*. Retrieved from http://www.olis.oecd.org/olis/2002doc.nsf/LinkTo/NT00002ADA/$FILE/JT00126227.PDF (19 March 2009).

Organisation for Economic Co-operation and Development. 2005. *Environment at a Glance: OECD Environmental Indicators 2005*. Paris: OECD.

Organisation for Economic Co-operation and Development. 2007. *OECD Environmental Performance Reviews: New Zealand*. Paris: OECD Publishing.

Organisation for Economic Co-operation and Development. 2008. *OECD Factbook 2008: Economic, Environmental and Social Statistics*. Retrieved from oberon.sourceoecd.org/vl=1061927/cl=27/nw=1/rpsv/factbook/ (18 March 2009).

Statistics New Zealand. 2007. *National Population Projections: 2006 (Base)–2061*. Retrieved from www.stats.govt.nz/products-and-services/hot-off-the-press/national-population-projections/national-population-projections-2006-base-hotp.htm?page=para002Master (19 November 2008).

Statistics New Zealand. 2008a. *Population Indicators*. Retrieved from www.stats.govt.nz/tables/population-indicators.htm (12 November 2008).

Statistics New Zealand. 2008b. *Gross Domestic Product: December 2007 Quarter*. Retrieved from www.stats.govt.nz/store/2008/03/gross-domestic-product-dec07qtr-hotp.htm?page=para004Master (13 February 2009).

Stevens S, Jones A. 2008. Dunedin turns to public transport. *Otago Daily Times*. 28 August 2008. Retrieved from www.odt.co.nz/your-town/dunedin/19804/dunedin-turns-public-transport (23 October 2008).

Taylor C. 2008. It's crush hour on board city trains. *The New Zealand Herald*. 7 September 2008. Retrieved from www.nzherald.co.nz/auckland-regional-transport-authority/news/article.cfm?o_id=382&objectid=10530956 (23 October 2008).

United Kingdom Vehicle Certification Agency. 2008. *New Car Fuel Consumption and Emissions Figures Booklet, May 2008*. Retrieved from www.vcacarfueldata.org.uk/downloads/may2008.asp (11 February 2009).

United States Environmental Protection Agency. 2003. *Frequently Asked Questions – In Depth Information for Motorcycle Owners on EPA's New Emission Standards for Highway Motorcycles*. Retrieved from www.epa.gov/otaq/regs/roadbike/420f03045.pdf (21 January 2009).

Yurko A. 2008. *Can Increases in Real Consumer Incomes Explain the Aging of Motor Vehicles in the US?* Retrieved from mpra.ub.uni-muenchen.de/8850/1/MPRA_paper_8850.pdf (8 December 2008).

FOR MORE INFORMATION about road transport see *Environment New Zealand 2007* at www.mfe.govt.nz

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