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Auckland Regional Council
TE RAUHĪTANGA TAIAO

Vehicles, Air Quality and Climate Change

November 2007

Aucklanders, like all New Zealanders, have a love affair with the motor vehicle which has seen us own more cars and drive them further with every passing year. In Auckland, motor vehicles are the single greatest contributor to urban air pollution, being responsible for 48 per cent to 83 per cent of pollutants in the air.

Quick Facts

Average Engine Size of a typical family car:
1960: 1.5 litres
1990: 2.4 litres
2006: 3.0 litres

Significant improvements in vehicle technology and fuel consumption have been made over the past few years however, these gains have been offset by:

- Increases in numbers of vehicles on the road (620 cars per 1000 people[1])
- Increases in distances travelled every year
- Increases in the proportion of diesel vehicles in the fleet (approximately 17 per cent of passenger cars are diesel vehicles)[2]
- Increases in the average engine size (now ~3.0 litres)

Effects of motor vehicles on air quality and health

Compared to European cities, motor vehicle emissions have led to very high concentrations of carbon monoxide (CO) and nitrogen dioxide (NO_2) in New Zealand urban areas. However, the worst air pollutant is fine particles (called PM_{10}) that can be inhaled deep into the lungs and cause serious health effects (see *Airfacts 5: Health Effects of Air Pollution*).

An estimated 250 Aucklanders[3] die prematurely every year due to the PM_{10} emitted solely from motor vehicles. This means that twice as many people die from vehicle emissions each year than from either road accidents or passive smoking! As well as deaths, vehicle pollution results in 435,000 days being lost region wide due to illness or poor health – especially in the young, the elderly and people with heart disease, respiratory disease, asthma and bronchitis. Groups with the highest levels of exposure include people who live near busy roads or road canyons with heavy traffic, road users (such as drivers, commuters and pedestrians) and people whose jobs require them to spend a long time on the roads[4].

Did you know?

Vehicles contribute to
48% PM_{10}
83% NO_x
83% CO
54% CO_2
of pollutants in urban air

[1] MfE (2006), *Gentle Footprint: Boots 'n' All*, Report ME758, Ministry for the Environment, May 2006
[2] ARC (2005), *Big Clean Up Tune Your Car Campaign* - results to be published in late 2007
[3] Fisher *et al.* (2002), *Health Effects Due to Motor Vehicle Air Pollution in New Zealand*, Report to the Ministry of Transport. NIWA
[4] WHO (2005), *Health Effects of Transport-Related Air Pollution*, World Health Organisation

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In order to improve air quality, the Ministry for the Environment (MfE) has set National Environmental Standards (NES), which must be met by 2013 (see *Airfacts 7: Air Quality Standards and Targets*). Concentrations of both PM_{10} and NO_2 in Auckland currently exceed these standards. To achieve compliance by 2013, the ARC has developed reduction targets for the three sectors – domestic, industry, and transport – and we estimate that annual PM_{10} emissions from vehicles will need to reduce by 58 per cent over 2005 levels.

Effects of motor vehicles on climate change

Motor vehicles, being largely fossil-fuelled, are also a significant contributor to greenhouse gas emissions and climate change. Although we cannot predict the exact timing and effect on the Auckland region from climate change, predictive modelling and trends tell us that Auckland could:

- Experience temperature increases between 0.6 and 3.8°C by 2080 relative to 1980.
- Experience an increased frequency of extreme weather and climate events (flooding, cyclones, storm surge and droughts) towards 2080.
- Experience gradual sea level rise, which will increase exposure to events such as storm surges and inundation of low-lying coastal land.

All of the above will have short to medium term impacts on:

- Our natural environment
- Our built environment
- Our society
- Our economic performance and prosperity

Incoming Fleet Averages

NZ actual:	220 gCO_2/km (2007) (9.5 to 10 l/100km)
NZ target:	170 gCO_2/km (2015) (6.5 to 7.4 l/100km)
Australia target:	150 gCO_2/km (2010) (~6.8 l/100km)
Europe target:	120 gCO_2/km (2020) (~5.2 l/100km)

New Zealand has signed up to the Kyoto Protocol, which sets targets for the greenhouse gas emissions of developed countries for the period 2008 to 2012 (the first commitment period). Our target is to reduce its greenhouse gases to 1990 levels or take responsibility for excess emissions.

The latest greenhouse gas inventory[5] shows that New Zealand emissions are tracking more than 25 per cent higher than 1990 levels, with much of the increase coming from the transport sector. Currently, our motor vehicles are almost exclusively fuelled by fossil fuels, such as petrol and diesel. Since 1990, fuel sales have increased dramatically in the Auckland region with petrol up by 44 per cent and diesel up by 180 per cent (see Figure 1).

Vehicle CO_2 emissions are directly related to the amount of fuel used. Therefore, improvement in fuel economy is an important component of the overall effort to reduce CO_2 emissions from transport. Vehicles currently entering New Zealand average between 9.5 and 10 l/100km (~220 gCO_2/km) but will be required to meet ~6.5 to 7.4 l/100km (~170 gCO_2/km) by 2015 as part of the recently announced New Zealand Energy Efficiency and Conservation Strategy[6].

[5] MfE (2007), *New Zealand's Greenhouse Gas Inventory 1990–2005*, Ref. ME811, Ministry for the Environment
[6] EECA (2007), *New Zealand Energy Efficiency Conservation Strategy*, Energy Efficiency Conservation Authority

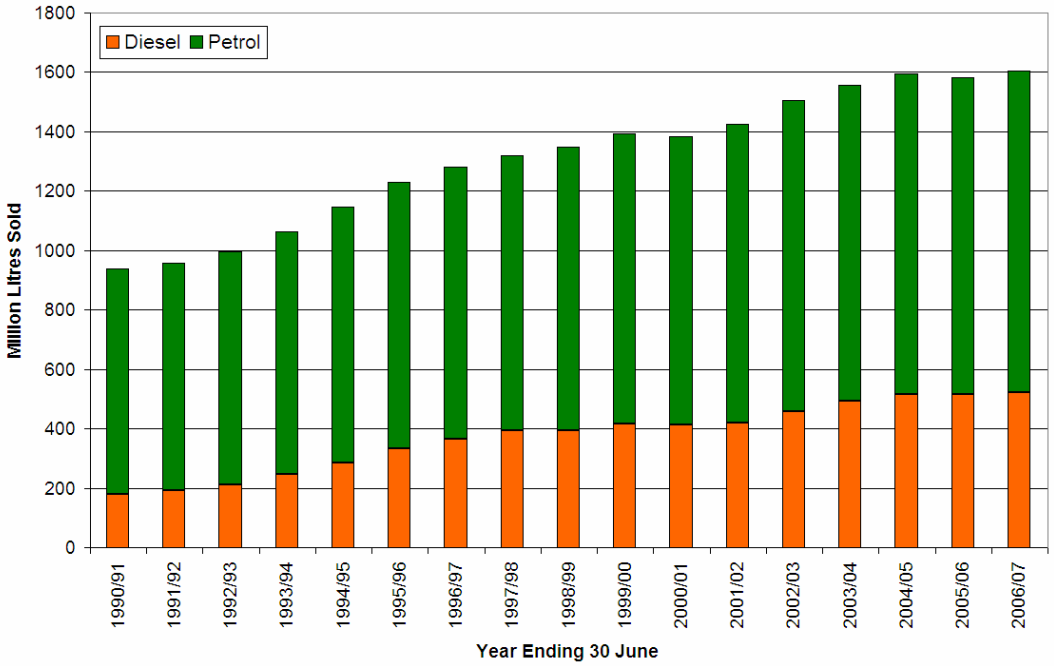


Figure 1: Annual fuel sales for the Auckland region

Petrol vs diesel

In terms of emissions, diesel vehicles produce disproportionately more PM_{10} and nitrogen oxides (NO_X) and petrol vehicles produce more CO for every kilometre driven. A typical diesel car can produce up to 20 times as much PM_{10} as a typical petrol car, and consequently diesel emissions dominate the health costs arising from vehicle emissions. In addition, diesel particles have been identified as one of the most carcinogenic (cancer causing) substances.

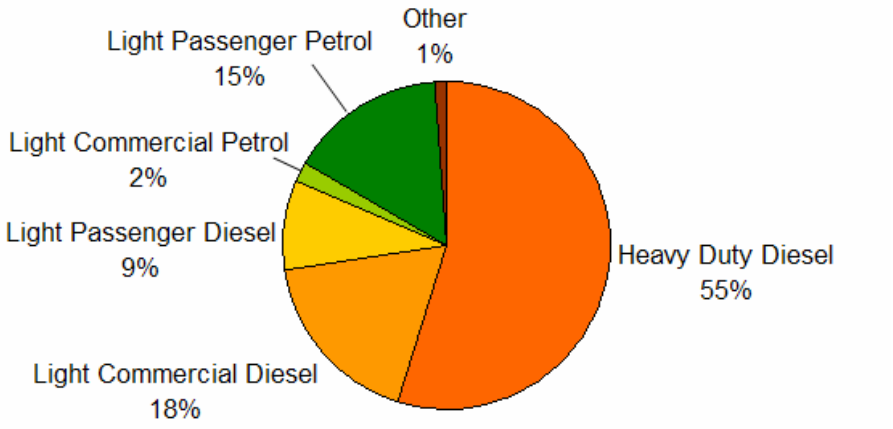


Figure 2: PM_{10} emissions from motor vehicle exhausts (2004)

Over time, the emissions differences between petrol and diesel vehicles have been reducing but, even with the latest Euro 4 standards, the limits for diesel vehicles are still more than three times higher for NO_X and around five times higher for PM_{10}. Consequently, the ARC has adopted a current fleet policy specifying that all replacement vehicles must be petrol-fuelled unless there is sufficient justification and a special need for diesel.

Many overseas countries do offer diesel vehicles that are as clean as petrol in terms of PM_{10} emissions but these vehicles cannot be used in New Zealand yet because the sulphur content in our fuel is still too high. In 2009, the government will require zero sulphur diesel to support the clean Euro 5 diesel technology.

Biofuels

Biofuel is any fuel derived from recently living organisms such as plants, animals and their by-products (e.g. manure, garden waste and crop residues). Unlike other natural resources such as petroleum, coal and nuclear fuels, biofuels are a renewable energy source. They have the advantage of being 'carbon neutral' - although burning them releases carbon into the atmosphere, they have already absorbed that carbon as plants. For this reason, they are championed as a way to reduce CO_2 released into the atmosphere by using them to replace non-renewable energy sources.

The principal biofuel used as a petrol substitute is *bioethanol*, which is produced by a sugar fermentation process. The main sources of sugar used to produce ethanol are crops (such as corn, maize, sugar beet and wheat) or waste (such as waste straw, sawdust, and whey). When blended with petrol, the proportion of ethanol in the mixture is indicated by the letter "E" followed by a number. The most common blend is 10% ethanol and 90% petrol (E10). Most existing petrol vehicles already in the New Zealand fleet can run on E3 with no engine modifications but some of the new vehicles entering New Zealand are certified for E10. Looking at other environmental benefits, E10 is essentially neutral with some air quality benefits (due to reduced CO emissions) offset by concerns about enhanced groundwater contamination.

The principal biofuel used as a diesel substitute is *biodiesel*, which can be produced from straight vegetable oil, animal oil/fats, tallow and waste cooking oil. When blended with diesel, the proportion of biodiesel in the mixture is indicated by the letter "B" followed by a number. The most common blend is 5% biodiesel and 95% diesel (B5). Most existing diesel vehicles already in the New Zealand fleet can run on B5 with no engine modifications but some vehicles can operate at up to B40 with minor modifications. Significant emissions improvements for PM_{10} and NO_X have been found for B10 to B40 blends.

The New Zealand Government has recently announced biofuels sales obligation targets to take effect from 2008[7]. The obligation will require companies that sell petrol or diesel to also sell biofuel, with the amount set as a percentage of total combined petrol and diesel sales per year (initially of 0.53% and progressively rise each year to a maximum target of 3.40% by 2012).

Internationally, significant concerns are being voiced[8] over the production of biofuels from food crops causing rising food prices, increased clearing of forests, with many processes being energy inefficient. In New Zealand, however, many of the feedstocks proposed for biofuel production are waste streams (e.g. whey for ethanol and tallow for biodiesel). In all cases, full life cycle assessments should be undertaken to quantify the true greenhouse gas benefits of any biofuel before being adopted.

LPG and CNG

LPG and CNG were promoted during the "oil crisis" in the 1970s and at one stage New Zealand was a world leader their use and technology. However, sales declined sharply after the crisis was resolved and the price differences between LPG/CNG and petrol/diesel reduced. Currently, there is limited technical expertise and infrastructure remaining to support a major resurgence in the use of LPG/CNG. In addition, the environmental benefits from these, largely non-renewable, fossil fuels are fewer than other alternatives.

[7] MoT (2007), *Biofuels Sales Obligation Final Policy*, Ministry of Transport, available from www.transport.govt.nz/biofuels-440-index/
[8] OECD (2007), *Biofuels: Is the cure worse than the disease?*, Organisation for Economic Co-operation and Development

Hydrogen, hybrids, and electric cars

In modern cars, emissions of toxic compounds and greenhouse gases result from burning diesel and petrol in air. In an ideal world, it would be better to produce no emissions (as in an electric car) or cleaner emissions such as water vapour (as in a hydrogen powered car) or markedly reduced emissions (as in a hybrid car).

Hydrogen vehicles can convert the chemical energy of hydrogen to mechanical energy in one of two methods: combustion or electrochemical conversion in a fuel-cell. In combustion, the hydrogen is burned in engines the same way as petrol. In fuel-cell conversion, the energy is stored like in a battery and used to power an electric traction motor. There are significant technological difficulties still to be resolved with hydrogen as most all of today's hydrogen is produced using fossil energy resources so, despite its potential, hydrogen vehicles will not be the solution in the medium term.

Hybrid vehicles, on the other hand, have been available in New Zealand since March 2004, when Toyota launched the Prius and Honda launched the Civic Hybrid. Any vehicle that combines two or more sources of power that can provide propulsion power is a hybrid. A typical hybrid vehicle conserves fuel. It recaptures energy lost through braking and decelerating and the engine stops when the car is stationary. The recaptured energy is stored in a battery pack as electricity. When required, the stored electricity is used to power an electric motor that either assists the vehicle's petrol engine during acceleration or supplies total power for a limited period.

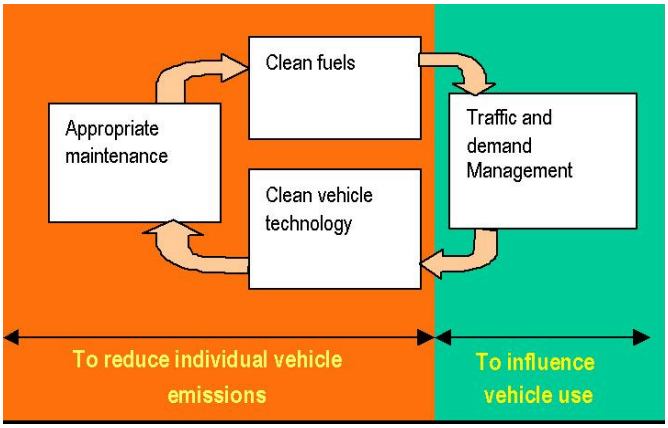
Currently, these vehicles combine a small to medium petrol engine (1.3 to 1.5l) with an electric motor (10 to 50kW) and can achieve fuel consumption ratings of 4.6 l/100km (~105 gCO_2/km) versus a typical New Zealand car at 9.0 l/100km. Most hybrids currently available are petrol-electric, although many manufacturers are signalling diesel-electric hybrids in the works.

Electric vehicles are a key part of the government's strategy for tackling climate change in New Zealand. They produce almost no pollution (if charged by renewable energy) but can only travel 80 to 160 km between charges. However, electric cars are generally time-consuming and inconvenient to recharge and uptake worldwide has been slow.

As an interim measure internationally, while manufacturers seek to address these problems, there is a strong trend towards offering "plug-in hybrids". These vehicles expand on the hybrid concept by allowing for the battery pack to be even further recharged through plug-in charging. While a conventional hybrid vehicle may travel short distances in pure electric mode, plug-in hybrids are designed to travel extended distances with little or no assistance from the petrol engine. Even before the charge is depleted, the petrol engine may be called on to provide additional power for recharging the battery, accelerating, passing, and merging. We are yet to see these vehicles available in New Zealand but they may well bridge the gap until electric vehicles are more widely available.

What can you do to make a difference?

A number of areas need to be targeted at the same time to effectively reduce vehicle pollution. Things you can do to make a difference include:



Clean Fuels

- buy petrol vehicles until Euro 5 available in 2009 (if urban driving)
- fill up with biofuel blends (if suitable for your car)

Clean Vehicle Technology

- match your vehicle choice with normal driving mode
- buy vehicles with good emissions performance ratings e.g. Euro 3
- opt for high fuel efficiency (see www.fuelsaver.govt.nz)

Appropriate Maintenance

- tune/service your car and opt for certified parts
- keep your tyres pumped up
- remove roof racks when not needed
- take unused items out of boot and cabin
- drive smoothly and at the speed limit

Demand Management

- avoid short trips – walk or cycle instead
- enrol your kids in a "walking school bus"
- carpool or use public transport
- co-ordinate your trips and take your smaller car
- telecommute or opt for flexi-hours
- encourage your workplace to develop and adopt a sustainable travel plan

For further information, visit our publications page on our website at www.arc.govt.nz where we have a range of factsheets available in various air quality issues. Alternatively, contact us on 09 366 2000.