MOBILITY IN NEW ZEALAND – BACKGROUND KNOWLEDGE FOR DECISION-MAKERS

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Abstract: The aim of this paper is to open the debate on the future mobility of New Zealanders based on oil depletion and Green House Gas discussions, the environmental and social impacts of private motor vehicles, the latest technological highlights and some of the outstanding policy statements made by the New Zealand (NZ) government. The main part compares the NZ situation with relevant technical improvements in Europe as a consequence of the first oil crisis and how it has developed since. New Zealand has taken a different approach over the last 10-15 years by providing affordable individual accessibility to its population without a strong focus on the environment, something the current government is seeking to fix through energy and emission control measures.

This review needs to be seen as an opinion piece that provides information from the past and outlines current developments to provide basic understanding to decision-makers in New Zealand.

Key Words: motor vehicle history in New Zealand, engine technology, emissions

1. INTRODUCTION

This paper arose through the author’s passion for mobility management and motor vehicle technology development, his interest for comparative inter-cultural (NZ - Europe) land transport development in regard to modal split choices and the focus of the direction some NZ transport and environmental policies are taking. This review is looking at the complexity of mobility, energy and emission and their impacts to provide information to decision makers.

The current Labour Government in New Zealand has been active over the last few years compiling draft strategies in order to push for fuel efficient cars and thus, reducing the emissions of vehicles by looking at tightening the rules for cheap second hand imports from Japan and Singapore and introducing emission testing at each WoF (Warrant of Fitness). Emission testing has been in place for decades in most developed countries world-wide. Basically, New Zealand ignored emission regulations for many years and only woke up recently after the release of two major studies indicating that the health effects relating to transport emissions were similar to the number of fatalities on New Zealand roads. The first study was conducted by NIWA (National Institute for Water & Atmospheric Research) in
2002 (NIWA, 2002). The second research was published in 2005 as a cooperation of MoT (Ministry of Transport), MfE (Ministry for the Environment), Health Research Council and a number of New Zealand academics (Health Research Council, MoT, MfE; 2005). This in addition to the relevance of the ‘clean and green’ image that New Zealand has gained a reputation for throughout the world. These are the basic reasons why the NZ policy makers were required to follow the world-wide trend to tighten the regulations on local pollutants.

The European Parliament released their strategy on Green House Gas (GHG) on 14 December 2006 and stated that by 2020, the EU should reduce its GHG emissions by 30% and produce 25% of its primary energy through renewables (Greens, 2006).

2. HISTORICAL REVIEW

2.1 Introduction
This chapter reviews the New Zealand changes of motor cars over time and outlines the leading European technical development in comparison.

2.2 The New Zealand situation prior to WW2
New Zealand is a nation of car enthusiasts and has been ever since the first horseless carriages were introduced in 1898 - William Mc Lean and Edward Seager imported two Benzes from France in 1898 (Wright, 2005). Historical car books mention that New Zealand towns already had parking problems in the 1920’s. The first car manufacturers were underway by the 1930’s, with General Motors opening a plant in the Hutt Valley near Wellington, followed by Ford nearby. New Zealand reached total motorisation by mid 1930’s and faced its first fuel rationalisation during WW2 that only ended in 1951. This triggered the demand for fuel efficient cars for the first time. The Humbers turned out to be the most fuel efficient cars at the time. It was also a premiere to trial alternative fuels, including coal-burning gas-producers (Wright, 2005). In the period prior to WW2 American cars or Yank Tanks were introduced for the first time to New Zealand.

2.3 The after WW2 era
European politicians and planners were convinced over the first three decades after World War 2 that private motor vehicles were the synonyms for prosperity and progress. They perceived that the flexibility of motor vehicles and buses would contribute more efficiently to the economy than trams had done prior to WW2. They started designing appropriate infrastructure towards accommodating the increasing number of private vehicles and banning trams from urban centres to open up space for cars and buses. The majority of European cities shifted from trams to bus systems, including New Zealand cities like Christchurch. Only a small number of German, Austrian, Swiss and Eastern European cities kept their tram system – Munich, Basel and Eastern German cities are good examples. This was mainly true for cities that had not suffered much from destruction during WW2. This planning regime for private motoring was shared across low density urban developments in the USA (except cities like New York), Australia and New Zealand. The main New Zealand cities had a well developed public transport system, relying mostly on buses after WW2. Wellington and Auckland had a commuter rail system, of which the Wellington commuter train network has been operating successfully up to the present date.

Until the 1960’s most new vehicles imported into the country were British, and mostly small cars. Volkswagen, Fiats and Peugeots were probably the exception in the New Zealand fleet.
British vehicles dominated in New Zealand, as New Zealanders identified closely with the British at the time. However, there were also politics involved: Assemblers in New Zealand were forced to buy British knock-down kits and the government manipulated the process through exchange rate controls (Wright, 2005). In the mid 1950’s, the New Zealand vehicle fleet changed towards overweight monsters equipped with large thirsty V8 engines. By 1953, the first section of the Southern Motorway was opened between Ellerslie and Mount Wellington in Auckland. The AA counted at the time 69,000 Aucklanders commuting already by car which represented half of the commuting population (Wright, 2005). The term ‘congestion’ was born.

The 1960’s saw an increasing number of bigger cars being produced in and imported into New Zealand, mainly from neighbouring Australia. The GM and Ford factories in Australia constructed large vehicles suited for Australian conditions (long trips, weather conditions), something that appealed to New Zealanders, who had to overcome steep road gradients or just wanted a big vehicle for pulling a caravan or simply requiring space for their large families.

From a public transport point of view, the main centres were operating electrified trolley buses, some of which some remained operating until recently in Wellington.

Interestingly, scientists were measuring carbon monoxide levels in Queen Street, Auckland, for the first time in 1961 (Wright, 2005). But it seems to have taken politicians 45 years to progress further on emission reduction strategies.

2.4 European motoring development in the 1970’s and 1980’s.

In the mid seventies, the medium to high density cities in Europe already started facing the negative impacts of their 50’s and 60’s planning strategies, by encountering congestion, high fuel costs and rising numbers of fatalities through accidents. The first oil crisis occurred in late 1973 at the time the Arab nations embargoed oil exports in response to US support of Israel in the Yom Kippur War. Petrol prices doubled by early 1974 and petrol was rationed. In some countries vehicles were banned from driving at certain times to save petrol. Rocketing fuel prices made decision makers and car manufacturers in Europe rethink about their long-term strategies.

German, French, Italian and Japanese car manufacturers focused their research in the 1970’s on smaller and fuel efficient cars and started quickly producing them. Renault 5 (GTL), Citroen Dyane, Audi 50, VW Polo E, Opel Kadett, Ford Fiesta, Toyota Starlet and Honda Civic were good examples of the first fuel efficient small sized cars that came on the market around 1973 -1975 and were designed to fit 4-5 passengers. It needs to be highlighted that these small cars were the trigger for introducing a second car per family household. The most famous research outcomes were introduced through the k-jet mechanical injection system developed by Bosch and applied to petrol and diesel cars by Volkswagen (e.g. Golf GTI - 110 bhp, Golf Diesel – 54 bhp) as a start and the KKK turbo chargers applied to serial cars by Renault (e.g. Renault 5 Alpine Turbo, Renault 18 Turbo). Renault benefited from their Formula One racing involvement for their serial turbo production. A number of Japanese manufacturers followed by offering Turbo versions to their vehicle range (e.g. Mitsubishi Colt Turbo) but did not obtain the European image or GTI cult.

This was the beginning of a quiet revolution and the start of small and quick cars with high technological impacts on fuel efficiency and performance. It was a technological highlight, as the VW Golf GTI (released in 1976), with a weight of under 900kg managed 0-100km/h in
less than 10 sec. BMW introduced mechanical fuel injection already in the early 1970’s but only for their 3 litre luxury series (e.g. 3.0 CSI). So fuel injection systems that were affordable to smaller cars became a turning point in engine technology for most manufacturers as adding to vehicle performance and reducing fuel consumption.

It took a while for the competitors to rival the Golf GTI and the GTI became a myth. Renault was the first to introduce a Renault 5 version with 93 bhp modified by its Alpine Renault tuner in Dieppe. At the time Fiat introduced its Ritmo 105 TC and its tuned Abarth version of 130 bhp a little later. Only a year or two after the first GTI, at a time while every other manufacturer was busy trying to launch competition to the GTI, Volkswagen in cooperation with the German engine tuner Oettinger introduced the first 16 valves engine (4 valves per cylinder) for the Golf GTI 16S and extracted 136 bhp. Many other more powerful versions followed but this was the introduction of multi-valve engines that contributed to greater performance and better fuel efficiency. This whole section is to outline that Germany, France and Italy (they introduced the direct injection diesel engines) were leading the way towards fuel efficient cars. It was only Peugeot that managed around 1984 with their 205 GTI 1.9l engine and 125 bhp to be of serious competition to the Golf GTI that had in the meantime increased the engine size to 1.8l. No other manufacturer has ever been able since to rival the GTI myth that celebrated its 30 year anniversary in 2006 (figure 1).

The next revolution was the introduction of a Diesel vehicle that needed to come across as fashionable, fun, performing, practical and of course cheap to run. It turned out to be the VW Golf Diesel, 1978, first a 4 gear, then as 5 gear manual called E version – for economy, using less than 5 l/100km. Many E- versions appeared on the market, including BMW with their petrol fuelled 525E in the 80’s.

Mercedes Benz (e.g. /8 series) and Peugeot (e.g. models 204D, 304D, 403D, 404D, 504D) were known in the 1960’s and 1970’s for their Diesel fleet. They were mostly driven by taxi
drivers and farmers (they filled them with subsidized cheap tractor diesel) but they were horribly boring, ugly and slow.

So it was a VW Golf again – this time a Diesel version – that became the benchmark for all following Diesel cars. It was the PSA group, representing Peugeot and Citroen that introduced a new 1.9 l Diesel engine with slightly better performances than the VW Golf by having 6 bhp more. By 1984 Volkswagen introduced the first Golf Turbo Diesel (GTD) with 70 bhp that was replaced by a direct Diesel fuel injected engine (TDI) around 1989 and the famous common rail injection shared by all modern Diesel cars in the 1990’s. Fiat nevertheless played the biggest role in direct diesel injection technology in the mid/late 1980’s.

The situation in the USA (e.g. California) and Japan (as an example for Asia) was totally different. There were stringent emission control regulations in place at an early stage that required to equip their petrol cars with catalytic converters and banned Diesel cars by limiting the NOx emission to a low level (e.g. lower than EU 4). It needs also to be highlighted that the generally low population density in the USA and a large part of the population living in rural areas contributed to a love affair with SUV’s (sport utility vehicles) equipped with large powerful V8 engines. Cheap petrol, low taxes, a low density planning environment and a poorly developed public transport network were the basis for this development.

Japan, a country of high population density associated with an excellent public transport network and a policy of high costs to run private vehicles, realised that the future of their car manufacturing industry may rely on globalisation by producing reliable cars for everyone. They concentrated on markets that were traditionally not orientated to the European car manufacturers and succeeded by providing value for money based on traditional technology - type Toyota Corolla. It was only later that companies like Toyota and Honda picked up on technological R&D development after having made a name for reliability.

All manufacturers exporting to the USA had to match the required emission standards. This was a great experience in preparation to EU1 emission norm, introduced in Germany in the late 1980’s. It is also useful to mention that Volkswagen learned first hand with their plant in Brazil about alternative fuels, like Ethanol. The details listed above are important factors to underpin the credibility of research undertaken by companies like Volkswagen and the way they perceive the future, discussed later in this paper.

In summary, in the 70’s and 80’s the European car manufacturers were seen as the leaders in engine technology in relation to the mix of economy and performance. The US and Japanese emission standards can be seen as a pioneering step towards cleaner engines.

2.4 The New Zealand land transport situation from the 1970’s to the 1990’s.

New Zealand was hit hard by the 1973 oil crisis and the subsequent one in 1979 (Iranian Revolution). Some of the measures were to drop the speed to 80km/h (1973) and banning cars one day of the week in order to reduce the national fuel consumption. Smaller cars, mostly imported from Japan this time were the consequence of high oil prices. Japanese Cars were not known for being specifically fuel efficient in those days. Honda can probably been seen as the most advanced in technology at that time. The Japanese car industry was more focusing more on reaching the world market by distributing their products world-wide, something the Europeans had not been so good at doing. This is probably the reason Toyota has been so successful all over the world over the last 3 decades. New Zealand had a number of Japanese assembling plants in New Zealand – Toyota, Honda, Mitsubishi – from the early 1970’s to
mid 1990’s, where the tariffs on cars were lifted and cheap second-hand Japanese and Singaporian motor vehicles started to flood the New Zealand market. The focus was on providing affordable mobility to basically every New Zealander. The fact that the roading infrastructure programme did not follow the same speed as the second hand car imports created an increasing traffic congestion problem to cities like Auckland.

3. **THE 21st CENTURY**

3.1 Politics

The race for technological fuel savings has not stopped since the early 1970’s and thus, it can be stated that the first oil crisis in 1974 has been an excellent catalyst for this technological revolution. The Americans and English continued for a while producing motor vehicles of high engine volumes to extract high power, as their technology was not as advanced at that stage and the patents were based with European firms.

An upcoming strong Green movement in a number of European countries in the mid to late 1970’s, led by the 68 generation, forced governments to deal with environmental impacts such as: air and noise pollution due to traffic congestion and high traffic volumes in cities. This drove authorities to focus on mitigation measures. Despite the continuation of high petrol prices in the late seventies and early eighties, private motor vehicles and the number of vehicles per household were on the rise and not declining, as private cars were associated with individuality, freedom, fun, status, safety and of course quality of life. These qualities are similar in both hemisphere and are not likely to change, unless there is a physical barrier that will drive human behaviour to shift from individual transport to public transport or to change their lifestyles (e.g. shifting from residential rural living to city living). These barriers can be poor weather conditions (e.g. snow) that will make people shift modes or no space to park their cars or highly congested cities (e.g. large cities like New York, Shanghai, Tokyo, London, Paris). In fact all these Mega-cities have developed an efficient public transport (PT) system or are heavily involved improving their PT systems, like China (e.g. Rail network) and South American cities with Bus Rapid Transit networks.

3.2 Environmental impacts

Despite a large number of international conferences about climate change over the last 30 years – Kyoto and Rio were probably the most famous ones – the general public did not heed any warnings. It is sad to see that it needed a major catastrophe in a developed country (e.g. floods in New Orleans 2005) and resulting rising fuel costs to trigger the discussion on the future of energy for land transport. Some may argue that the media should have raised the matter much earlier as the flood events in Bangladesh, South China and India have increased over the last decades. However, those countries being developing countries did not gauge the level of interest as their economy did not impact on our lifestyles. The hurricanes in the Gulf of Mexico however, damaged a number of plants impacting on fuel storage and distribution all over the world. The 18 months following the New Orleans hurricanes gave a wake-up call to all policy makers world-wide to reflect on the future of fossil energy.

3.3 Technology

3.3.1 Introduction

It has been amazing to see how many innovative solutions have been stored in the drawers of manufacturers waiting for crude oil prices to rise. Suddenly hybrid motor vehicles seemed to
become the solution overnight for many people. Biofuel was probably another word being “Googled” by many people. Most people are only following the issue with recent interest as they do not wish to lose what they love most – their personal freedom private motor vehicle represents.

This section provides an overview of a number of new technologies and opens up discussions basics on energy and emission control. It needs however to be clear that by adoption of all innovative technologies, the increase of motor vehicles around the globe will contribute to further congestion and thus emissions and fuel demand in whatever form.

3.3.2 Hybrid cars
Hybrid cars may not be the end solution but for many politicians it seems a step into the right direction, especially as available quickly. Many car manufacturers reacted quickly in order not to lose their market share and equipped their end of range vehicles with additional electric engines (e.g. Lexus, Porsche Cayenne) and market these high cc rated vehicles cynically as eco-cars. The Japanese manufacturers Toyota and Honda were the first to offer medium sized hybrid models associated with petrol engines. European manufacturers took a while to react on offering a hybrid solution as most believed that low emission Diesel vehicles were still the most viable option. Many European manufacturers are currently fine tuning their Diesel hybrid models that will be released in the near future. It was amazing to see Smart launching a micro hybrid in 2007 that reduces its CO₂ from 112 to 102g/km (Finanz und Wirtschaft, 2007).

A NZ radio station broadcasted in 2006 an interview about hybrid cars with British journalists from the UK consumer association. They were not convinced that hybrids would be the solution of the future after having tested a luxury Lexus hybrid. They identified that the hybrid car relied a lot on its petrol engine, especially when operating the air conditioning. They were not able to get the fuel consumption that was promised in the sales brochure. The consumers are still reluctant to purchase medium sized hybrids as the long-term reliability, the maintenance costs and resale value are unknown.

3.3.3 Electric cars
Currently there are a number of new players (e.g. Tesla in USA) introducing electric cars that run on lithium batteries and able to run over a distance of over 400km without recharging and accelerate from 0-60km/h in 4 seconds (Boutin, 2006). Despite a lack of detailed information about this innovative vehicle that has been developed with the assistance of Lotus, it is important to mention that it is not new that electric engines are more efficient than petrol/diesel engines and are able to develop 100% torque in a constant way. However, the cost of the Tesla lies between a Porsche and a Ferrari, so not cheap.

The Volkswagen engine R&D manager Wolfgang Steiger reports in an article called ‘Renaissance of Electric Cars’ that he sees the future in electric cars and not in hybrids. The debate was about the difference of hybrid cars and pure electric (fuel cells) cars. Steiger outlined that it was uneconomic to produce expensive hybrid cars as they were in reality just electric cars with own their electricity generator on board. It made far more sense to have single electric engines powered by single fuel cells, especially if electricity can be generated at low costs (Gruenweg, Pander, 2007). This debate would in many countries link directly to nuclear energy discussions but considering a variety of alternative sustainable sources, it could be a step into the future, by relying on non carbon sources. Steiger did not criticise in any way the various research projects Volkswagen had been undertaking but outlines very
clearly that the future shift towards reduction of motor vehicle emissions and dependency of oil will rely on the future efficiency of lithium battery technology. The author believes that in the last 15 years research funds were partially wrongly allocated to the automobile industry and not sufficiently into the electrotechnic industry that deal with battery technology. So there is substantial future research required into the development of battery capacity.

Next to the Tesla car, the English firm PML Flightlink (based in Alton in the UK) has just presented a Mini that develops 652 bhp, accelerates in 4.5s from 0-100km/h and reaches a top speed of 240km/h. The Mini is equipped with 4 electric engines that are directly integrated in each wheel. The combination of Lithium battery and high performance condenser allow an operation time of 4 hours. However the vehicle is able to run 1,500km as such, as a small 250ccm 2 cylinder engine of 20 bhp effectively boosts the battery if required. So it is not a full electric car, as it claimed to be, but a hybrid car with a small engine. This is different from a Lexus GS 450h hybrid that operates a large 3,500ccm engine.

3.3.4 Hydrogen
A recent German research study showed that governments should focus more on the production losses of some sources of energy. The German Ministry for the Environment (UBA – Umweltbundesamt) identified production losses or petrol around 10-12%, CNG/LPG around 7-8% but approximately 25-60% for hydrogen cars. This shows that the current hydrogen cars, running under H7 Hydrogen, are operating well but not efficiently. The consumption of the BMW 760i test vehicle was 3.8kg per 100km. With a tank fitted of 7.8kg, the test vehicle was only able to run 200 km at approximately 60 EUR, about double the price of the same car run on petrol (Maintz, 2006). The current outcome is that hydrogen will only be a solution if the production losses are reduced and ‘cheap’ nuclear energy can produce hydrogen.

3.3.5 Compressed air
The French engineer Guy Negre experimented with motor vehicles running on compressed air, at approximately 300 bars. He developed a 35 BHP car running at a maximum speed of 110km/h that can reach a distance of 200km at a medium speed of 60km/h. The filling of compressed air takes approximately 3 minutes by charging on a 240V source (Air Car, 2005).
Despite the general public believing hybrids will be the future, recent European transport magazines and newsletters forecast a trend to small Diesel and petrol engines in the short to medium term future with electric engines as a serious alternative if the battery capacity problem is solved and sustainable energy supply is available at an affordable rate.

3.4 Energy
Large oil companies like Exxon and BP are not substantially concerned about the oil depletion debate but fully agree that substantial investment funds need to go into research and development of low and zero carbon technologies. This is mainly due to a rapid increase of energy demand, for passenger transport and for freight transport. BP identifies the average annual energy growth rate to be 1.7% for passenger transport and 2.3% for freight transport with China leading with 3% for passenger transport and India with 3.8% for freight transport. These percentages are based on 50 year predictions for the period of 2000-2050. The percentage figures considered for a shorter period (2000-2030) were even slightly higher (Egger, 2005; Gardner, 2005).

The NZ Ministry of Economic Development commissioned research to analyse the security level situation of fuel supply to New Zealand (Covec, 2005a). The main recommendation outlined that New Zealand was similar in comparison with other countries, where a 90 day storage capacity was required. However, given its high level of import dependency and remote geographic location, New Zealand should have oil security stockholding above 90 days to stay in a commercially optimal situation.

The European situation is not balanced from a fuel type supply point of view. Europe has to import about 30% of its Diesel from Russia, whereas it exports their 91octane petrol to the USA, due to overcapacities. This is mainly due to the fact that the European vehicle fleet has shifted to more fuel efficient Diesel vehicles. This has not happened in New Zealand yet, due to tax regulations (e.g. road user charges).

3.5 Fuel efficiency
It is clear that it is possible to reduce the fuel consumption in New Zealand by renewing the fleet and setting fuel saving goals. The Ministry of Transport (MoT) started the process into looking at fuel efficiency by commissioning a strategy report (MoT, 2001). Land Transport NZ launched a new website for consumers in 2006 (www.fuelsaver.co.nz), indicating the official manufacturer fuel consumption of every new car available in New Zealand (Land Transport NZ, 2006). The NZ Minister for Energy presented in November 2006 in association with EECA a discussion document about the labelling of vehicles in relation to fuel economy (EECA, 2006). There is some indication that government wishes to introduce a star rating, similar to those used on other appliances like fridges. Those who are passionate about cars will probably lift their eyebrows but a proper labelling of fuel consumption in litres per 100 km would certainly be a move in the right direction to help customers buying a car. A German website called ‘Spritmonitor’ enables the general public to display the fuel consumption of their vehicles and share their experience with other motorists. This system provides access to real field data provided by consumers and not by manufacturers testing in ideal conditions (Spritmonitor, 2006).

There are a number of issues to consider with regard to fuel consumption reduction – it will be difficult to renew the current fleet quickly without penalising some parts of the population and keeping in mind that a reduction of fuel consumption means a loss of tax revenue for the government. The New Zealand government is aware of the socio-economic impact such
changes may have on the general public. There have been a number of studies conducted by Covec in cooperation with MoT (Covec, 2005b). The reality is that New Zealanders may in the medium term future have to upgrade their vehicle fleet to more fuel efficient cars and pay for this. The reduction of fuel consumption may not be perceived so much as a benefit at the time of purchase. Additionally, they will be penalised for the loss in fuel tax revenue by being charged a new type of fee to use the roading infrastructure. Thus, in reality the general public will be hit in the pocket twice and the car manufacturers will benefit from this move. Certainly it will reduce emissions but this is difficult to predict as to how much and will not reduce congestion problems as German studies have shown that people will modify their shopping habits and lower the quality of food they purchase to keep their car running.

3.6 Emissions

A number of draft submissions are currently under public consultation and awaiting legislation within the next year or two, prior to the next central government elections in New Zealand. Irrespective which government will lead New Zealand after the next election, there will be no backtracking as New Zealand needs to cherish its high value status of ‘clean, green and 100% pure’ image in order to sustain its economic position in the world market. The current proposals go clearly towards regulating emission standards for new and existing cars. Figure 4 highlights the progress from Euro 1 to Euro 5 for diesel vehicles.

Figure 4: Progress in emission standards (Egger, 2005)

Germany is a good example that shows that vehicle emissions decreased significantly as a result of tougher emission laws (e.g. from Euro 1 to Euro 4 within approximately 18 years), despite the total kilometres driven went up. Though Co2 may not be solved totally, there are
opportunities to reduce the level of CO₂ emissions by concentrating on the vehicle fleet and most effectively by encouraging less driving (Topp, 2001).

Politically, it is important to assess what type of fuel New Zealand should favour in the future, petrol or diesel? The current road user charge system may need to be modified to be able to reduce fuel consumption quickly in NZ and encourage more diesel vehicles to be imported. From an emission point of view, diesel engines will produce higher NOx emissions than petrol cars but also be more efficient and consume less fuel. Volkswagen has just released for their USA diesel exports a new type of catalytic convertor called Bluethet using the injection of urea to reduce NOx. The Euro 5 emission norm will be introduced in Europe by 2009 and it is not clear how well it will deal with the NOx problem of diesel engines.

Table 1 shows a selection of modern vehicles (all Euro 4) available in Germany and compares a number of factors, such as type of car (SUV, 2 -4 door, sports car), engine size (in ccm), engine power (in kw and bhp), fuel type (Petrol, Diesel, Electric – hybrids, CNG), fuel consumption (in litres per 100 km), CO₂ (in g per km), the maximum speed (in km/h) and the price (in EUR). The CO₂ emissions are highlighted in bold and are in decreasing order from the top. The data are mainly extracted from the research Horn et al. conducted which was published in the German motoring magazine Autobild (Horn et al., 2006).

Table 1: Comparative characteristics of test cars (created after data from Horn et al., 2006; Finanz und Wirtschaft, 2007; Die Zeit, 2007; Euro Finanzen, 2007)

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Exact type</th>
<th>Type d=door</th>
<th>Engine [ccm3]</th>
<th>Power [kw / bhp]</th>
<th>P/D</th>
<th>Fuel l/100 km</th>
<th>Co2 [g/km]</th>
<th>Max speed [km/h]</th>
<th>Price [EUR]</th>
</tr>
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<tbody>
<tr>
<td>Audi Q7</td>
<td>SUV</td>
<td>4,163</td>
<td>257/350</td>
<td>P</td>
<td>11.1</td>
<td>326</td>
<td>248</td>
<td>65,000</td>
<td></td>
</tr>
<tr>
<td>Mazda RX8</td>
<td>2 d</td>
<td>2X654</td>
<td>170/231</td>
<td>P</td>
<td>8.9</td>
<td>284</td>
<td>235</td>
<td>35,000</td>
<td></td>
</tr>
<tr>
<td>Porsche 911</td>
<td>sport</td>
<td>3,596</td>
<td>239/325</td>
<td>P</td>
<td>9.0</td>
<td>266</td>
<td>285</td>
<td>78,000</td>
<td></td>
</tr>
<tr>
<td>Mercedes CLS</td>
<td>4 d</td>
<td>3,498</td>
<td>215/292</td>
<td>P</td>
<td>9.4</td>
<td>222</td>
<td>250</td>
<td>58,000</td>
<td></td>
</tr>
<tr>
<td>BMW 535D</td>
<td>4 d</td>
<td>2,993</td>
<td>200/272</td>
<td>D</td>
<td>6.7</td>
<td>211</td>
<td>250</td>
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</tr>
<tr>
<td>Lexus GS 450</td>
<td>4 d</td>
<td>3,456</td>
<td>218/296</td>
<td>P/E</td>
<td>7.4</td>
<td>186</td>
<td>250</td>
<td>66,000</td>
<td></td>
</tr>
<tr>
<td>VW Golf GT TSI</td>
<td>2/4 d</td>
<td>1,390</td>
<td>125/170</td>
<td>P</td>
<td>6.7</td>
<td>173</td>
<td>220</td>
<td>23,500</td>
<td></td>
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<tr>
<td>VW Caddy delivery</td>
<td>2d</td>
<td>1,968</td>
<td>51/69</td>
<td>D</td>
<td>5.3</td>
<td>170</td>
<td>142</td>
<td>14,000</td>
<td></td>
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<tr>
<td>Citroen C2</td>
<td>2 d</td>
<td>1,360</td>
<td>65/88</td>
<td>P</td>
<td>5.8</td>
<td>163</td>
<td>180</td>
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<tr>
<td>Opel Astra</td>
<td>2/4 d</td>
<td>1,364</td>
<td>66/90</td>
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<td>146</td>
<td>178</td>
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<tr>
<td>VW Passat Variant TDI Blue Motion</td>
<td>5d</td>
<td>n/a</td>
<td>n/a</td>
<td>D</td>
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</tr>
<tr>
<td>Opel Combo tour</td>
<td>4 d</td>
<td>1,598</td>
<td>71/90</td>
<td>P/ CNG</td>
<td>-</td>
<td>133</td>
<td>166</td>
<td>17,600</td>
<td></td>
</tr>
<tr>
<td>Honda Civic hybrid</td>
<td>2/4 d</td>
<td>1,339</td>
<td>70/95</td>
<td>P/E</td>
<td>4.7</td>
<td>109</td>
<td>185</td>
<td>23,000</td>
<td></td>
</tr>
<tr>
<td>Smart Micro hybrid</td>
<td>2d</td>
<td>n/a</td>
<td>52/71</td>
<td>P</td>
<td>4.3</td>
<td>103</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>VW Polo 1.4 TDI</td>
<td>2/4</td>
<td>1,422</td>
<td>59/80</td>
<td>D</td>
<td>3.8</td>
<td>102</td>
<td>176</td>
<td>15,800</td>
<td></td>
</tr>
<tr>
<td>Smart Smart CDI</td>
<td>2</td>
<td>n/a</td>
<td>33/43</td>
<td>D</td>
<td>3.3</td>
<td>88</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>VW Lupo 1.2 TDI**</td>
<td>2</td>
<td>1,191</td>
<td>45/61</td>
<td>D</td>
<td>3.0</td>
<td>81</td>
<td>165</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

* P = Petrol     D = Diesel     E = electric (hybrid)     CNG = CNG gas
** not manufactured anymore
The data in table 1 indicate a strong correlation between fuel consumption and CO₂ consumption. From a consumer perspective, the cars in the lower part of the table represent the most sustainable vehicles. The VW Lupo TDI obtained the best values but in reality, it was not a selling success and as a consequence was taken from the market. The VW Polo TDI stands probably at this stage for the most attractive choice.

4. TECHNICAL OUTLOOK

Volkswagen (VW) has already proven with their new Golf 1.4 TSI to be able to extract 170 bhp out of a 1.4l petrol engine. VW also produces a 1.4l diesel engine in their Polo that consumes approx. 3.8l per 100km, mixed traffic by allowing a maximum speed of nearly 180km/h (Horn et al., 2006). The French PSA group (Citroen and Peugeot group) and Fiat have similar small capacity direct injected diesel engines in their range (e.g. 1.3l multi-jet Fiat engine). GM Germany – Opel – has been producing a new 1.4l petrol engine twin jet (Twinport) in their Corsa/Astra/Combo model achieving power (66KW- 90BHP) and low petrol consumption.

VW is also developing the CCS (combined combustion system) DIESOTT, a mix of the best of both, Diesel and Petrol engine. There is not much technical information available at this stage, except that the engine requires a special fuel that is manufactured synthetically from LPG or from growing natural resources. VW projects the CCS to be widely manufactured by 2015 but it is too early to assume that CCS may be the solution to reduce consumption and emissions.

It is interesting to read or listen to the general public as there is a perception that Hybrid cars are the way forward. The author predicts that at least up to 2020, the traditional Diesel countries will continue producing Diesel engines, but of small engine size with a high level of technology to obtain powerful vehicles. This new type of small volume engines has already been launched (e.g. 1.3l multi-jet Diesel Fiat/GM) by some manufacturers and the trend towards substantial fuel consumption and emission reductions continue to the commercial light vehicle sector. The industry is still producing high powered vehicles as the general public demands them - only a strict tax system will reduce them.
Many of the large cars (type BMW 700, Mercedes 280+, Lexus) have already converted their range to Diesel engines or will combine hybrid propulsion with a classic petrol engine. This move is mainly for non Diesel countries, like USA, Asia, and Australasia to provide these markets with ECO type cars. Many big SUV’s can already be ordered with dual powered engines. These high spec, high market vehicles will not be disadvantaged through a higher price that comes from the additional hybrid engine. These status symbol vehicles are already expensive and those buying them will not argue about the price difference as they will associate it happily with their ecological conscience. However, the current medium range hybrid vehicles (Toyota Prius, Honda) available on some markets now are overpriced unless financial compensation is offered to the motorist. Some companies have opted to buy these hybrid vehicles but most will admit that a marketing strategy has coloured their choice.

In the light vehicle sector, Nissan in cooperation with Renault are trying to set a trend with the development of the Cabstar that is designed to function as a hybrid vehicle in combination of a 40kw electric engine and a 3l common rail diesel engine. The development of this car is based on Japanese experience that have trialled light commercial hybrid vehicles in the past but with smaller engines around 25kw (Correze, 2006).

5. NEW ZEALAND OUTLOOK

It seems very clear that in addition to improving technology (e.g. fuel efficient cars, emission reductions, carbon free energy) – which was the main focus of this paper- human behaviour and lifestyles will need to change dramatically. The focus will rely on Transport Demand Management strategies - travel behaviour (e.g. reduction of individual travelling – commuting and leisure purposes), sourcing of commodities from close markets, residential living (close to public transport corridors), provision of appropriate infrastructure for soft modes, modern and attractive public transport systems and leisure opportunities within urban environments, energy education strategies and road tolling system. Only a combination of all those will contribute to a sustainable solution, as the current New Zealand proposals on reducing fuel consumption and emission will not tackle the problem of congestion at all.

It is a real concern that the outcomes of the proposed legislation changes will increase mobility costs to the general public but may neither reduce congestion nor become an incentive for the general public to change their transport behaviour and use public transport (PT unfortunately increases costs at a similar level to the increase of private motoring costs).

The last few years showed a strong push for integration of all modes of transport into a variety of governmental strategies in New Zealand. However, it seems that the public perception of the future and the market driven environment (e.g. cheap residential living in the rural outskirts of cities) are not heading in the same direction. Has the public consultation process and bottom-up approach failed in New Zealand, or do personal objectives of the general public not match Government objectives?

The challenge of the NZ government is to seek for solutions that will reduce congestion and emission problems, deal with an increase of private vehicles, encourage people to shift modes when appropriate. The Government is now confronted with the need of taking action in a big way - in regard to investments for public transport, TDM measures and infrastructure for soft modes. It is concerned of the huge budget spending and is seeking for funding opportunities (e.g. PPP - private public partnerships) that will minimise costs to the NZ tax payer.
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